

QUANTIFY IMPACT OF WIND EROSION ON ORGANIC MATTER CONTENT UNDER MANAGEMENT PRACTICES, WADI EL RAML, NWCZ, EGYPT

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Wind soil erosion is one of the land degradation processes in North Western Coastal Zone (NWCZ) of Egypt. It was assessed under condition of wheat crop grown on a sandy loam soil in Wadi El Raml in 2018/2019. Three tillage treatments of no-tillage (NT), minimum tillage (MT) and conventional tillage (CT) were assessed with or without organic manuring ($30 \text{ m}^3 \text{ ha}^{-1}$) combined with or without mulching (with rice straw covering 60% of soil surface). The aim of the study was assessment the impact of wind erosion on wheat yield and soil organic matter content (SOM) under different tillage practices under rainfed agriculture at Wadi El Raml in NWCZ. The highest bulk density was associated with NT. Losses ($\text{kg m}^{-2} \text{ y}^{-1}$) of about 275, 221 and 173 were shown in the CT, MT and NT treatments, respectively. The erodibility average values and loss of OM and TN were highest in the bare soil. Soil loss materials for the bare soil was higher than for the cultivated soils, which gave their the highest loss of $275 \text{ kg m}^{-2} \text{ y}^{-1}$ with non-manured non-mulched CT and the lowest of $16 \text{ kg m}^{-2} \text{ y}^{-1}$ for the manured and mulched NT. The highest wheat yield was obtained with manured and mulched CT. The results of this study showed that the use of $30 \text{ m}^3 \text{ ha}^{-1}$ of organic manure and 60% of the coverage with rice straw in each cultivation type led to improving the soil content of organic matter and reducing soil loss by erosion by wind. This study emphasized the benefits of conservation tillage, such as improving bulk density as a guide to soil quality, which keeps it from degradation, as happens with conventional tillage. The study also recommended the use of conservation tillage in cultivated cereal crops for more than one season under rainfed conditions in Egypt to increase the content of soil organic matter, thus increasing crop productivity compared to the traditional tillage system to achieve sustainable agricultural production in NWCZ of Egypt.

Keywords: soil erodibility, rainfed agriculture, conventional tillage, conservation tillage, organic manure, soil cover

Soil erosion is a major land degradation in North West Coastal Zone (NWCZ) of Egypt. It threatens rainfed agriculture in the region, which occupies 70.1% of rainfed agriculture (Wassif et al., 2014). The soils of NWCZ are mostly cultivated with cereal crops (Wassif et al., 2013 and Sharkawy et al., 2014). NWCZ soils are very vulnerable to erosion due to its undulating. Misuse and mismanagement of lands in this area can accelerate soil erosion by wind (Ghaley et al., 2018). Fryrear et al. (2008) reported that wind erosion in the NWCZ of Egypt is a major problem because of the sandy nature of soils. There are many examples of successful erosion control, the widespread of which minimum tillage and no-tillage practices (FAO, 2019).

The aim of the present investigation is to assess wind-soil erosion control and soil organic matter (SOM) by conservation tillage, organic manure and soil mulching by plant residue in wadi El Raml area, NWCZ, Egypt.

MATERIALS AND METHODS

The field experiment was performed in Wadi El Raml area located at west Matrouh city about 13 km and extended from southwest to northeast of the city. Fig. (1) shows the wadi lie within the latitudes of 31° 09' 00", 31° 21' 00" North and within the longitudes of 27° 06' 00", 27° 12' 00" East. The total area of this wadi is about 194 km² about (18476 ha). This work was conducted in 2018-2019 season. It is occupied about 1 ha, three replicates and the main plots involved 3 tillage systems i.e. conventional tillage (CT), minimum tillage (MT) and no-tillage (NT). The sub-plots were 2 treatments, i.e. without manuring and with organic manure (30 m³ ha⁻¹). Sub-sub-plots involved 2 mulching treatments, i.e. no-mulch and mulching with rice straw covering 60% of plot surface area. The wheat crop was cultivated in first December 2018 in all plots using conservation tillage machine and harvested in April 2019. The specifications of machine used in this experiment were hanging behind the tractor with three hitch points. The machine consisted of two units with about 2 m working width the first unit for tillage consists of seven shanks with chisel blade arranged in two rows and the second unit for sowing crop seeds in rows with 16 cm between them, as shown in fig. (2). So that seeds of wheat were cultivated in rows, spaced with 18 cm. Each treatment with its replicates was carried out in a rectangular field (5×130 m) oriented in NW to SE direction. Table (1) shows some soil properties of initial soil. It is clear that soil texture is sandy loam. Soil bulk density (BD) reached 1.67 Mg m⁻³ and it is considered poor of soil organic matter (SOM) and total nitrogen (TN) content.

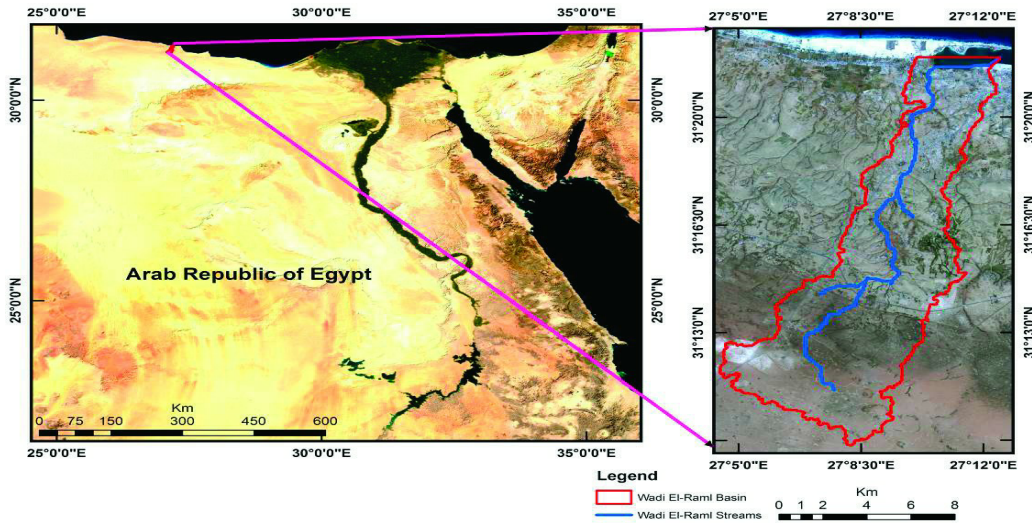


Fig. (1). Location map of at Wadi El Raml area, NWCZ of Egypt.

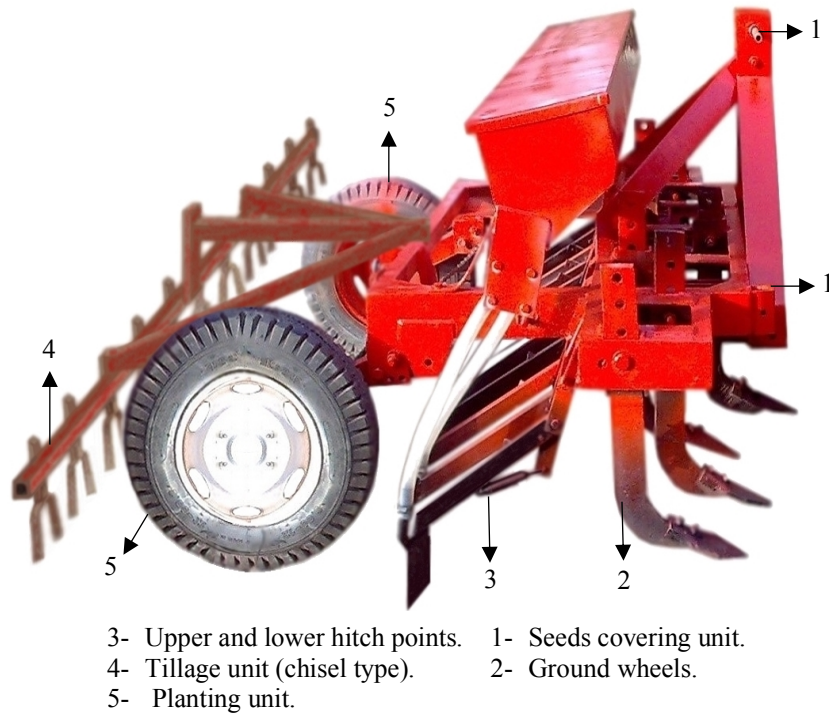


Fig. (2). Combination machine for conservation tillage.

Table (1). Some soil properties surface layer (0-20 cm) for the initial soil at Wadi El-Ramal, NWCZ, Egypt.

Treatment Tillage type	Particle size distribution (%)				Texture class	BD (Mg m ⁻³)	OM (g kg ⁻¹)	TN (g kg ⁻¹)
	CS*	FS*	S*	C*				
BS*	56.7	11.78	17.37	14.2	SL*	1.67	2.20	0.10

BS*= Bare soil, CS*= Coarse Sand, FS*= Fine Sand, S* = Silt, C*=Clay, SL*= Sandy Loam, BD*= Bulk density.

Table (2). Monthly means meteorological records during 2019 and calculated wind erosivity factors for Wadi El Raml area, NWCZ, Egypt.

Month	Temperature (°C)	Wind speed (m/s)	Rainfall (mm)
January	12.08	4.97	16.50
February	13.04	4.07	26.50
March	14.97	4.11	16.25
April	17.61	4.24	3.50
May	18.77	3.78	0.00
June	25.09	4.04	0.00
July	27.08	4.11	0.00
August	27.24	3.19	0.00
September	25.71	3.52	0.00
October	23.56	5.72	106.25
November	20.03	4.20	0.00
December	15.36	4.16	50.50
Total			219.50
Mean	20.04	4.18	
Erosivity factor of wind or climatic factor (C%)		1.64	

The machine carried out the study treatments as follows: MT treatment using all units of machine where, tillage unit used at 10 cm tillage depth and sowing wheat crop seeds by planting unit in one pass. NT treatment used planting unit only without tillage unit. CT treatment using traditional chisel plow seven blades at 20 cm tillage depth to make two perpendicular passes after that in another pass using planting unit only in study machine

without tillage unit for sowing wheat seeds. The forward speed of tractor was fixed about 4.5 km/h for all treatments.

Study Parameters

Theoretical field capacity, actual field capacity and field efficiency were calculated by equations mentioned by Kepner et al. (1978). Pulling force was measured by hydraulic dynamometer which, coupled between the two tractors with the attaching the machine to estimate its draught force. A considerable number of readings were taken at a time interval 10 seconds to obtain an accurate average of draught force. The hitch was always adjusted in order to keep the line of pull as horizontal as possible. Fuel consumption per unit time was determined accurately by measuring the volume of fuel consumed during operation time. It was calculated using the fuel meter equipment, which calibrated prior.

Soil erodibility factor I, was calculated according to Schwab et al. (1993). Big Spring Number Eight samplers (BSNE) were used to measure the soil loss rate in each treatment described by Fryrear (1986). Samples of eroded materials were collected at four heights from soil surface 0.1, 0.5, 0.75 and 1 m. It collected at 6 periods during 2018-2019. The mass/ height data at each cluster were analyzed using exponential and power equations as attained by Fryrear and Saleh (1993). The equation for each cluster and for each measurement period was integrated to determine total mass being transported by wind from the soil surface to a height of 0.2 m (exponential equation) and between 0.2 and 2 m (power equation) (Fryrear, 1995). Meteorological records presented in table (2) by NCEI (2019). Climatic erosivity factor (C) is expressed as: $C = 386 U^3 / (PE)^2$, where: U is the average annual wind velocity at 9.15 m from soil surface (ms^{-1}) and PE is the precipitation effectiveness index of Thornthwaite (1948). The PE index calculated by the following equation: $PE = 3.16 \sum (Pi / (1.8 Ti + 22))^{10/9}$, where: Pi is monthly precipitation (mm), and T_i is average monthly air temperature ($^{\circ}C$). was calculated according to Woodruff and Siddoway (1965). Surface soil sample (0-5 cm) randomly taken from each treatment. Non-erodible fractions percentage > 0.84 mm was determined according to USDA, SCS (1988). Particle size distribution, bulk density (BD), organic matter content (OM) and total nitrogen (TN) were determined using the relevant standard methods described by Jackson (1973) and Klute (1986). Soil erodibility (I) was calculated for the surface soil (0-5 cm) based on the regression equation between soil erodibility and percentage of dry soil fraction >0.84 mm was determined as follows: $I = 525 \times 2.718^{-0.4F}$, where: F is the percentage of non-erodible fractions > 0.84 mm according to Schwab et al. (1993). The Enrichment Ratio (ER) was calculated as the following equation: $ER = Ce/Co$

Where, C_e is the concentration of nutrient in the sediment, and C_o is the concentration of soil nutrients in the bare soil according to Are et al. (2011).

RESULTS AND DISCUSSION

1. Meteorological Data of El Raml Area

According to the data of monthly means of meteorological data during 2019 in table (2), the mean daily average air temperature was 20°C. High air temperature prevails from June to October. The summer is the hottest season and is virtually dry. Annual rainfall reached 219.50 mm. Most of it occurred from October to March. The average of monthly wind speed was 4.18 m s⁻¹. Generally, highest wind speed occurred during the period from March to July and included the khamassien wind period. Fryrear et al. (2008) and Afifi and Gad (2011) stated that the average wind speed ranged between 3.8 to 5.2 m s⁻¹. The prevailing wind direction is mostly from the northwest. It is about 75% of the windy day's recorded warm dusts storms. Days with dust storms mostly occurred during October and January. The climatic erosivity factor was 1.64. Sharkawy (2006) stated that climatic erosivity factor greater than 1 in the Mediterranean area is related to inadequate rainfall and high temperature.

2. Main Soil Properties

Main soil properties of the 0-20 cm of the experimental site are given in table (3). The texture is sandy loam and soil bulk density (BD) for CT, MT and NT was 1.43, 1.57, 1.64 Mg m⁻³, respectively, regardless of the other treatments. The soil is low in soil organic matter (SOM) and total nitrogen (TN). Results of the different treatments of the study show decreases caused by tillage. Average values were 1.39, 1.54, 1.51 Mg m⁻³ for CT, MT and NT, respectively. Wassif et al. (2014) and Rai et al. (2018) stated that conservation tillage needed 2 to 3 years to improve soil quality. Sauer et al. (1990), Fabrizzi et al. (2005) and Rai et al. (2018) stated that continuous use of NT and MT would necessitate a change to temporary CT to correct soil problems. Table (3) shows response to treatments regarding BD, SOM and TN. Manuring decreased BD and SOM by average of 6 g kg⁻¹ and TN by average of 0.4 g kg⁻¹. The effect of mulching was positive. With reference to the increase in the rate of SOM and TN for one growing season was a slight increase. Saavedra et al. (2007), Dendooven et al. (2012) and Wassif et al. (2014) stated that by mulching using rice straw causes positive effect to soil fertility parameters. Therefore, conservation tillage enhances soil fertility especially organic matter content.

Table (3). Some soil properties surface layer (0-20 cm) for the studied treatment at Wadi El-Ramal, NWCZ, Egypt.

Tillage type	Treatment		BD (Mg m ⁻³)	SOM	TN
	Organic manure (m ³ ha ⁻¹)	Mulch by rice straw (%)		(g kg ⁻¹)	
CT*	Without	Without	1.43	3.29	0.02
		60	1.41	3.29	0.03
	30	Without	1.39	5.10	0.03
		60	1.33	6.00	0.03
MT*	Without	Without	1.57	3.60	0.30
		60	1.48	4.90	0.50
	30	Without	1.46	7.80	0.60
		60	1.53	8.80	0.60
NT*	Without	Without	1.64	4.10	0.50
		60	1.52	6.80	0.50
	30	Without	1.56	8.50	0.60
		60	1.6	9.90	0.90

CT*= Conventional tillage, MT*= Minimum tillage, NT*= No tillage, BD*= Bulk density, SOM = soil organic matter, TN= Total nitrogen.

3. Wind Erosion Hazards

Soil loss by wind erosion (Table 4) was determined at different heights using BSNE sampler. It was affected by the treatments and decreased with increasing height above the soil surface. Eroded materials fitted the power and exponential decay mass-height profile, which was reported as most appropriate for arid and semi-arid regions (Ali et al., 2011). During the period from January to June, the mass of transported materials was higher than the other periods due to the response to high intensity of wind. This is due prevalence of the strong El-KHAMASN wind, which prevails in such period. The transported soil mass via wind in Sept. – Dec. period was much lower as compared with the other periods. This is due to, a decreasing both air temperature and wind speed. There was less vegetative cover due to wheat harvest. Soil mass transported by wind in the spring season was characterized by high relative drift potential values as compared with the other months for most of the season. These results agree with those by El-Flah (2009), Ali et

al. (2011) and Wassif et al. (2013), who emphasized the importance of soil loss of sandy soils due to wind erosion. Concerning of the mass of soil loss ($\text{kg m}^{-2} \text{ year}^{-1}$). The highest loss occurred in the bare soil. Application of organic manure on/or mulching can decrease soil loss.

4. Soil Loss

Soil loss values ($\text{kg m}^{-2} \text{ y}^{-1}$) are given in table (4). Highest loss was about 420 recorded in the bare non-cultivated bare soil (BS). Values for non-manured, non-mulched, tillage treatments were the highest in CT, and the lowest in NT treatments: losses ($\text{kg m}^{-2} \text{ y}^{-1}$) of about 275, 221 and 173 were shown in the CT, MT and NT treatments, respectively.

Soil losses in the conservation tillage of MT and NT types were lower than with CT, indicating the beneficial effect of such treatments (Murillo et al., 2004; Rai et al., 2018 and Lal, 2019). FAO (2019) mentioned that the principle factor for minimizing soil erosion is to maintain a cover of growing plants or organic and/or non-organic residues that protects soil surface from erosion. Hikmet et al. (2015) showed that, erosion is reduced by up to 50% using conservation tillage. Results of the current study show that the lowest values of about 35, 25 and 16 $\text{kg m}^{-2} \text{ y}^{-1}$ were obtained by the non-manured non-mulched CT, manured mulched MT and manured mulched NT, respectively. These results demonstrate the profound positive effect of organic manuring and mulching augmented by conservation tillage; when compared with the effect on bare soil, which caused highest loss, the afore-mentioned treatment decreased soil loss by about 96%. Sandy soils must be cultivated using NT or MT decrease soil erosion (Wassif et al., 2012 & 2013 and FAO (2019).

5. Hazards and Wind Erosion

The amount of soil mass transported by saltation mode (within ≈ 0.2 mm in diameter) represented an average 99% of total mass transported above the soil surface at bare soil and all tillage types. High discharge of suspended materials in the bare soil as compared with the other treatments is due to the ability of wind to carry fine particles from the top of soil (Table 4). Mulching straw residues decreased the amount of eroded materials by wind (Table 4). Morgan (1995) and Ali et al. (2011) reported that because of the roughness of soil surface caused by soil, stones, vegetation and other materials losses of soil material decrease significantly. Also, the tillage practices of CTWW, MTWW and NTWW led to decrease the annual discharge of soil loss by 65, 52.47 and 41.24%, respectively as compared to BS. On the other hand, it is clear that the conservation tillage practices are the lowest annual soil loss compared to conventional tillage practices.

Table (4). Soil loss values as affected by tillage type, organic manure and plant residue cover measured by BSNE samplers during the study period (Jan. to Dec. 2019).

Tillage type	Treatment		Period of soil loss sampling	Eroded materials (g cm ⁻²) at different heights above the soil surface (m)			Qsa*	Qsu*	Qt*
	Organic manure (m ³ /ha)	Mulch by rice straw (%)		0.1	0.5	1			
BS*	Without	Without	Jan. - Feb.	0.99	0.40	0.39	141.89	0.24	142.13
			March -April	0.39	0.27	0.26	57.76	0.12	57.88
			May -June	0.50	0.48	0.37	74.13	0.17	74.30
			July - Aug	0.00	0.00	0.00	0.00	0.00	0.00
			Sep. - Oct.	0.48	0.39	0.38	71.62	0.17	71.78
			Nov. -Dec.	0.50	0.45	0.42	74.09	0.18	74.28
			Annual	2.86	1.99	1.83	419.49	0.88	420.37
			Jan. - Feb.	0.79	0.20	0.19	117.51	0.14	117.65
			March -April	0.19	0.07	0.06	27.71	0.04	27.76
	Without	60	Jan. - Feb.	0.30	0.28	0.17	42.95	0.09	43.04
			March -April	0.00	0.00	0.00	0.00	0.00	0.00
			May -June	0.28	0.19	0.18	40.98	0.09	41.07
			July - Aug	0.28	0.19	0.18	40.98	0.09	41.07
			Sep. - Oct.	0.30	0.25	0.22	44.93	0.10	45.03
			Nov. - Dec.	0.30	0.25	0.22	44.93	0.10	45.03
			Annual	1.86	0.99	0.83	274.09	0.46	274.55
			Jan. - Feb.	0.59	0.14	0.13	82.80	0.10	82.90
			March -April	0.13	0.04	0.04	18.80	0.03	18.83
CT*	Without	60	Jan. - Feb.	0.16	0.07	0.06	23.70	0.04	23.74
			March -April	0.00	0.00	0.00	0.00	0.00	0.00
			May -June	0.11	0.11	0.11	16.80	0.04	16.84
			July - Aug	0.11	0.11	0.11	16.80	0.04	16.84
			Sep. - Oct.	0.10	0.07	0.06	15.10	0.03	15.13
			Nov. - Dec.	0.10	0.07	0.06	15.10	0.03	15.13
			Annual	1.10	0.43	0.40	157.20	0.24	157.44
			Jan. - Feb.	0.37	0.11	0.10	54.02	0.07	54.09
			March -April	0.10	0.02	0.02	13.74	0.02	13.76
	Without	30	Jan. - Feb.	0.14	0.06	0.03	21.30	0.03	21.33
			March -April	0.00	0.00	0.00	0.00	0.00	0.00
			May -June	0.05	0.05	0.05	7.43	0.02	7.45
			July - Aug	0.05	0.05	0.05	7.43	0.02	7.45
			Sep. - Oct.	0.05	0.05	0.04	7.50	0.02	7.52
			Nov. - Dec.	0.05	0.05	0.04	7.50	0.02	7.52
			Annual	0.70	0.28	0.23	104.00	0.15	104.15
			Jan. - Feb.	0.09	0.07	0.03	13.23	0.02	13.25
			March -April	0.07	0.01	0.01	10.31	0.01	10.32
Without	60	Jan. - Feb.	0.03	0.01	0.00	5.19	0.00	5.19	
		March -April	0.00	0.00	0.00	0.00	0.00	0.00	
		May -June	0.00	0.00	0.00	0.00	0.00	0.00	
		July - Aug	0.02	0.02	0.01	3.24	0.01	3.24	
		Sep. - Oct.	0.02	0.02	0.01	3.24	0.01	3.24	
		Nov. - Dec.	0.02	0.02	0.02	2.48	0.01	2.49	
Annual	0.23	0.12	0.07	34.45	0.04	34.49			

Table (4) Cont.

Tillage type	Treatment		Period of soil loss sampling	Eroded materials (g cm ⁻²) at different heights above the soil surface (m)			Qsa*	Qsu*	Qt*	
	Organic manure (m ³ ha ⁻¹)	Mulch by rice straw (%)		0.1	0.5	1				(kg m ⁻² y ⁻¹)
MT*	without	without	Jan. - Feb.	0.65	0.18	0.17	93.79	0.11	93.90	
			March -April	0.16	0.05	0.05	23.75	0.03	23.78	
			May -June	0.25	0.25	0.17	37.89	0.03	37.92	
			July - Aug	0.00	0.00	0.00	0.00	0.00	0.00	
			Sep. - Oct.	0.23	0.18	0.13	35.54	0.06	35.60	
			Nov. - Dec.	0.20	0.18	0.14	29.35	0.06	29.41	
			Annual	1.49	0.83	0.65	220.32	0.29	220.61	
		Without	60	Jan. - Feb.	0.54	0.12	0.12	78.90	0.10	79.00
	March -April			0.10	0.03	0.02	15.86	0.02	15.88	
	May -June			0.15	0.06	0.06	22.01	0.03	22.04	
	July - Aug			0.00	0.00	0.00	0.00	0.00	0.00	
	Sep. - Oct.			0.10	0.07	0.07	14.25	0.03	14.28	
Nov. - Dec.	0.06			0.06	0.06	9.15	0.02	9.17		
		Annual	0.95	0.35	0.33	140.17	0.20	140.37		
MT*			Jan. - Feb.	0.29	0.11	0.10	43.43	0.06	43.49	
			March -April	0.09	0.02	0.01	12.77	0.01	12.78	
			May -June	0.14	0.03	0.02	20.36	0.01	20.37	
			July - Aug	0.00	0.00	0.00	0.00	0.00	0.00	
			Sep. - Oct.	0.07	0.04	0.02	10.85	0.02	10.87	
			Nov. - Dec.	0.04	0.04	0.03	5.75	0.01	5.76	
		30		Annual	0.63	0.24	0.18	93.16	0.11	93.27
	Jan. - Feb.			0.07	0.06	0.03	10.34	0.02	10.36	
	March -April			0.05	0.01	0.01	8.12	0.01	8.13	
	May -June			0.01	0.01	0.00	1.46	0.00	1.46	
	July - Aug			0.00	0.00	0.00	0.00	0.00	0.00	
	Sep. - Oct.			0.02	0.01	0.01	2.80	0.01	2.81	
	60		Nov. - Dec.	0.02	0.01	0.01	2.18	0.00	2.18	
Annual			0.17	0.11	0.06	24.90	0.04	24.94		
Jan. - Feb.			0.60	0.17	0.15	84.46	0.11	84.57		
March -April			0.10	0.04	0.03	14.98	0.02	15.00		
May -June			0.24	0.16	0.17	35.23	0.07	35.30		
July - Aug			0.00	0.00	0.00	0.00	0.00	0.00		
NT*	Without		Sep. - Oct.	0.13	0.12	0.11	19.06	0.05	19.11	
			Nov. - Dec.	0.13	0.12	0.11	19.36	0.05	19.41	
			Annual	1.20	0.61	0.57	173.09	0.29	173.38	
			Jan. - Feb.	0.42	0.11	0.11	63.38	0.09	63.47	
			March -April	0.10	0.03	0.02	15.02	0.02	15.04	
			May -June	0.15	0.06	0.04	21.88	0.03	21.91	
		60		July - Aug	0.00	0.00	0.00	0.00	0.00	0.00
	Sep. - Oct.			0.06	0.06	0.06	9.47	0.02	9.49	
	Nov. - Dec.			0.06	0.05	0.05	8.37	0.02	8.39	

		Annual	0.79	0.31	0.28	118.12	0.17	118.29
		Jan. - Feb.	0.19	0.07	0.05	27.80	0.03	27.83
		March -April	0.09	0.02	0.01	14.63	0.01	14.64
		May -June	0.11	0.01	0.01	16.89	0.01	16.90
	Without	July - Aug	0.00	0.00	0.00	0.00	0.00	0.00
		Sep. - Oct.	0.04	0.04	0.02	6.36	0.01	6.37
		Nov. - Dec.	0.03	0.03	0.03	4.10	0.01	4.11
30		Annual	0.46	0.16	0.11	69.78	0.07	69.85
		Jan. - Feb.	0.05	0.04	0.03	7.51	0.02	7.53
		March -April	0.03	0.01	0.01	3.68	0.00	3.68
		May -June	0.01	0.01	0.00	1.06	0.00	1.06
	60	July - Aug	0.00	0.00	0.00	0.00	0.00	0.00
		Sep. - Oct.	0.02	0.02	0.01	2.33	0.00	2.33
		Nov. - Dec.	0.01	0.01	0.01	1.65	0.00	1.65
		Annual	0.11	0.08	0.06	16.23	0.03	16.26

BS*= Bare soil, CT*= Conventional tillage, MT*= Minimum tillage, NT*= No tillage, Qsa*= Quantity of salted material, Qsu*= Quantity of suspended materials, Qt*= Quantity of total field soil loss.

6. Soil Erodibility Assessment

The soil erodibility of >0.84 mm particle diameter by wind varies (Table 5). It defines the resistance of soil to detachment and transport. Erodibility of the 0-5 cm surface ranges between 154.21 to 75.91 mg/ha/y for CTWW and NTOP, respectively. Erodibility of 140.20 mg ha⁻¹ y⁻¹ for the bare soil indicates that the soil is of moderate erodibility. The lowest erodibility was 75.91 in the manures mulch NT soil; i.e. low erodibility class (Wassif et al., 2013).

CT and MT led to increase soil erodibility index by averages of 9 and 1%, respectively. NT leads to reduction of soil loss by 60% with temperate climate or regions (Mhazo et al., 2016). Organic manuring decreased soil erodibility index (6.02 to 38.71%). Manuring combined with mulching could be decrease the erodibility by 7.00 to 45.42%. Therefore, no tillage in combination with organic manuring and mulching is the most effective treatment decreasing soil erosion (Derpsch et al., 2010 and Wassif et al., 2014).

7. Enrichment Ratio of Organic Matter and Total N

The enrichment ratios (ERs) of organic matter (SOM) and total nitrogen (TN) are shown in table (5). The SOM/TN ratio in eroded material depends on the soil properties and erosivity. Enrichment ratios (ERs) of OM and TN exceeded one in most treatment. They varied from 0.71 to 5.6 for SOM and from 0.41 to 8.64 for TN. Organic manuring and mulching increased SOM and TN in soil. Preferential removal of organic matter in soils reduces their organic matter (Lal, 2001; Ali et al., 2011 and Wassif et al., 2012). CT with manuring and mulching increased contents of organic matter and total N. This shows that measures may be taken in the future to combat the hazard of

wind erosion process. Results indicate that a major portion of the OM and TN content will be lost through eroded materials. These data agree with those of Ali et al. (2011), Wassif et al., 2012 and 2014 and Rai et al. (2018). Soil conservation may be achieved through reduction of soil detachment and its transport by agents of erosion. Long term use of conservation practices enhances soil fertility. Drinkwater and Snapp (2007) stated that low soil organic diminishes the ability of the soil to release nutrients. Saavedra et al. (2007) found higher organic matter content in soils under minimum tillage systems.

8. Performance of Conservation Tillage Machine

The results in Fig. (3) show that as a general, tillage systems had a significant effect on performance of machine. The both fuel consumption rate and pulling force decreased at the tillage system (NT) about of (51% - 83%) for fuel consumption rate and about of (49% - 85%) for pulling force compared to the tillage systems (MT) and (CT) respectively. It also showed increasing in actual field capacity of the machine when using tillage system (NT) about of (30% - 229%) compared to the tillage systems (MT) and (CT), respectively. These results due to the tillage system (NT) used the planting unit only without tillage in conservation tillage machine (one pass). However, using planting and tillage units (at 10 cm tillage depth) in conservation agriculture machine (one pass) in the tillage system (MT), but using traditional chisel plow 7 blades (at 20 cm tillage depth) two passes, then sowing wheat crop seeds using planting unit in the conservation tillage machine in the tillage system (CT).

From the above mentioned the data with organic manuring and mulching caused non-significant effect on the machine performance. This is due to the fact that adding fertilizer and mulch did not show their effect on machine performance in the first season but its effect appears in the following seasons.

Table (5). Enrichment ratio of organic matter and total nitrogen of initial soil and eroded materials collected within the height from 0.1 m to 1.0 m above the soil surface, and soil erodibility before treated application of surface layer (0-5 cm) for different tillage types, Wadi El Raml (NWCZ) of Egypt.

Tillage type	Treatment		Sample type	O.M*		T.N*		Non - eroded fractions >0.84 mm (%)	Soil erodibility (Mg ha ⁻¹ y ⁻¹)
	Organic manure (m ³ ha ⁻¹)	Mulch by rice straw (%)		(%)	ER	(%)	ER		
BS*	Without	Without	Initial soil	0.22	5.629	0.01	8.64	37	140.20
			Eroded material	1.24		0.12			
CT*	Without	Without	Initial soil	0.33	3.401	0.02	3.87	30	154.21
			Eroded material	1.12		0.06			
		60	Initial soil	0.33	3.196	0.03	3.21	32	150.25
			Eroded material	1.05		0.09			
	30	Without	Initial soil	0.51	1.996	0.03	2.76	37	144.92
			Eroded material	1.02		0.08			
		60	Initial soil	0.60	1.616	0.03	2.12	38	142.72
			Eroded material	0.97		0.07			
MT*	Without	Without	Initial soil	0.36	2.995	0.03	1.55	39	141.37
			Eroded material	1.07		0.05			
		60	Initial soil	0.49	2.031	0.05	1.09	40	128.79
			Eroded material	1.00		0.06			
	30	Without	Initial soil	0.78	1.223	0.06	1.02	42	101.17
			Eroded material	0.96		0.06			
		60	Initial soil	0.88	0.970	0.06	0.91	45	99.00
			Eroded material	0.85		0.05			
NT*	Without	Without	Initial soil	0.41	2.449	0.05	0.63	38	139.09
			Eroded material	1.00		0.03			
		60	Initial soil	0.68	1.159	0.05	1.02	44	99.65
			Eroded Material	0.79		0.05			
	30	Without	Initial soil	0.85	0.865	0.06	0.83	47	85.24
			Eroded material	0.74		0.05			
		60	Initial soil	0.99	0.715	0.09	0.41	49	75.91
			Eroded material	0.71		0.04			

BS*= Bare soil, CT*= Conventional tillage, MT*= Minimum tillage, NT*= No tillage , O.M*= Organic Matter, T.N*= Total nitrogen

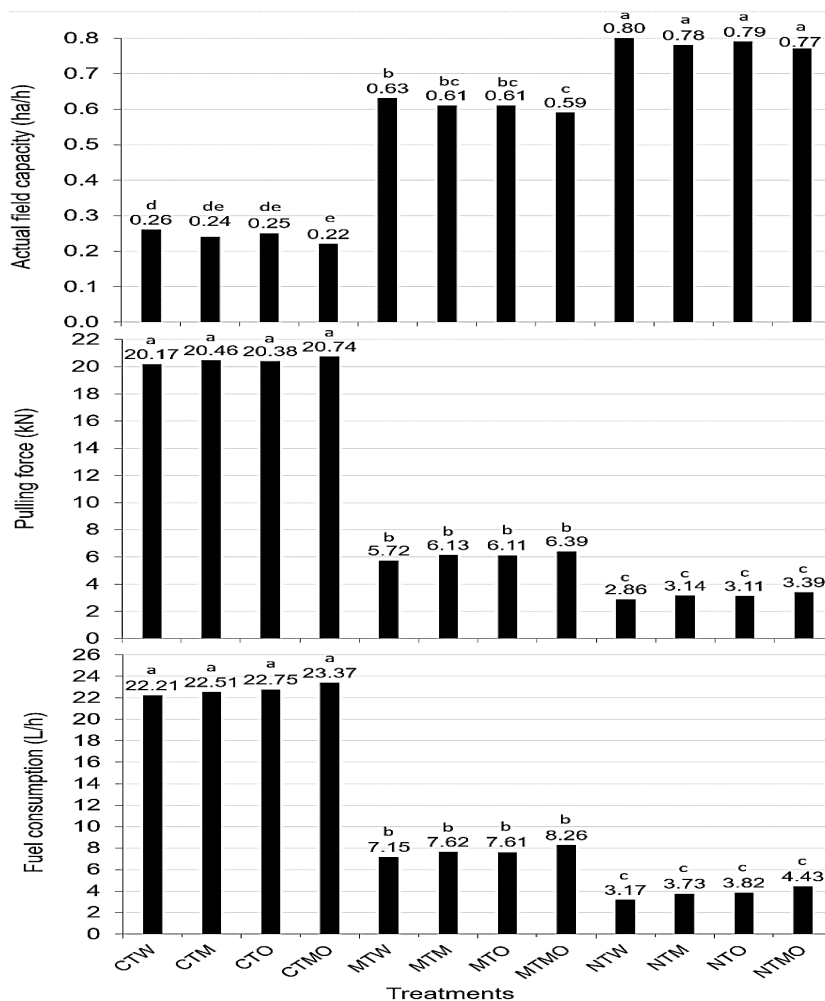


Fig. (3). Effect of tillage systems conventional tillage (CTW), minimum tillage (MTW) and no-tillage (NTW) without additions, conventional tillage (CTM), minimum tillage (MTM), and no tillage (NTM) with added mulching 60% of rice straw. Conventional tillage (CTO), minimum tillage (MTO) and no tillage (NTO) with added organic manure rate 30 m³ ha⁻¹. Conventional tillage (CTMO), minimum tillage (MTMO) and no tillage (NTMO) with added mulching 60% of rice straw and organic manure rate 30 m³ ha⁻¹. Fuel consumption (L/h), pulling force (kN) and actual field capacity of machine (ha/h). Values followed by different letters are significantly different at $p < 0.05$ according to the LSD test. LSD for: fuel consumption = 0.976, pulling force = 0.558 and actual field capacity = 0.0252.

9. Treatments and Wheat Yield

Data in table (6) show that conservation tillage with organic manuring and mulching caused positive response to yield of grains as well as straw. Yields (Mg ha⁻¹) of grains + straw ranged between 4.75 (NT with neither manuring nor mulching) to 9.72 (NT with manuring and mulching). Yields of grains as well as those of straw responded as those of grains + straw. Percent increase due to CT with mulching, and those MT with mulching surpassed the yield of non-till mulched one by 36 and 10%, respectively. On the other hand, the CT and MT manured surpassed their NT counterpart by 37 and 17%, respectively. Positive effect of CT treatments may be due to enhancement of aeration. Quinton and Catt (2004) and Wassif et al. (2014) concluded that MT, shallow tillage using a tine cultivator conserves organic matter and promotes aggregation. Goddard et al. (2008) found that yields under CT decreased by 5 to 15% over a period of ten years. Murillo et al. (2004) showed that the long-term, conservation tillage can be beneficial for soil fertility. The obtained results show that, long term conservation tillage practices are needed to achieve food security and sustainable agriculture. Wassif et al. (2014) and Rai et al. (2018) stated that reduced labor is obtained by conservation tillage practices and can help in climate change adaptation.

Table (6). yield of wheat as affected by tillage type, organic manure and plant residue as soil cover percent at Wadi El Raml area NWCZ, Egypt.

Tillage type	Treatments		Wheat yield		
	Organic manure (m ³ ha ⁻¹)	Mulch by rice straw (%)	Grain yield (Mg ha ⁻¹)	Straw yield (Mg ha ⁻¹)	Biological yield (grain + straw) (Mg ha ⁻¹)
*CT	Without	Without	2.58 ^d	3.70 ^e	6.28 ^d
		60	3.09 ^c	4.28 ^{cd}	7.37 ^c
	30	Without	3.46 ^b	5.11 ^b	8.57 ^b
*MT	Without	60	3.91 ^a	5.81 ^a	9.72 ^a
		Without	2.08 ^f	3.17 ^f	5.25 ^e
	30	60	2.38 ^{de}	3.60 ^e	5.98 ^d
*NT	Without	Without	2.94 ^c	4.37 ^c	7.31 ^c
		60	3.48 ^b	5.14 ^b	8.62 ^b
	30	Without	1.85 ^f	2.90 ^e	4.75 ^f
*NT	Without	60	2.12 ^{ef}	3.31 ^f	5.43 ^e
		30	Without	2.51 ^d	3.73 ^e
		60	3.07 ^c	4.15 ^d	7.22 ^c

L.S.D. at significant level 0.05 for grain= 0.2794, straw= 0.1632 and biological= 0.3484
 CT= Conventional tillage, MT= Min-tillage, NT= No-tillage

CONCLUSION

The most effective treatment was manured and mulched MT and NT (conservation tillage). Such treatments can improve the SOM content and mitigate wind erosion hazards and reduce dust in the air and increase soil fertility. High wheat yields were obtained with adding organic manures in combination with mulching. On fields treated with conservation tillage, soil fertility was builds and degradation decreases. The study recommends that long term conservation tillage practices at Wadi El Raml are needed to confirm these results and encourage farmers to cultivate their soils with cereal crops using this system.

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التأثير الكمي للانجراف بالرياح على محتوى المادة العضوية بالتربة تحت ممارسات الإدارة المختلفة، وادي الرمل، الساحل الشمالي الغربي، مصر

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يعد انجراف التربة بالرياح إحدى عمليات تدهور الأراضي في منطقة الساحل الشمالي الغربي (NWCZ) في مصر. تم تقييمه في ظروف زراعة محصول القمح على تربة طميية رملية في وادي الرمل في ٢٠١٨/٢٠١٩. تم تقييم ثلاث معاملات حرث بدون حراثة (NT) والحد الأدنى من الحراثة (MT) والحراثة التقليدية (CT) مع أو بدون السماد العضوي (٣٠ م^٢ هكتار^{-١}) مع أو بدون تغطية قش الأرز الذي يغطي ٦٠٪ من سطح التربة. تهدف الدراسة إلى تقييم تأثير انجراف التربة بالرياح على محصول القمح وعلى محتوى المادة العضوية في التربة (SOM) في ممارسات الحراثة المختلفة في الزراعة المطرية في وادي الرمل في منطقة الساحل الشمالي الغربي. ارتبطت القيمة الأعلى للكثافة الظاهرية مع NT. سجلت قيم فاقد التربة للانجراف بالرياح حوالي ٢٧٥ و ٢٢١ و ١٧٣ كجم م^{-٢} سنة^{-١} في المعاملات CT و MT و NT بالترتيب. متوسط قيم قابلية التربة للانجراف وفاقد التربة للانجراف من المادة العضوية والنيتروجين الكلي كانت أعلى قيمة في الأراضي الأولية والتي بدون معاملة BS. فاقد التربة للانجراف للأراضي الأولية BS كانت ذات قيم مرتفعة بالمقارنة بالأراضي المعاملة، حيث كانت أعلى قيمة للفق ٢٧٥ كجم م^{-٢} سنة^{-١} للأراضي المعاملة بالحراثة التقليدية وبدون إضافات سماد أو تغطية CT وكانت أقل قيمة للفق ١٦ كجم م^{-٢} سنة^{-١} في الأراضي المعاملة بالحراثة NT وبالسماد العضوي (٣٠ م^٢ هكتار^{-١}) والتغطية بقش الأرز الذي يغطي ٦٠٪ من سطح التربة. تم الحصول على أعلى محصول من القمح للأراضي المعاملة بالحراثة التقليدية CT بإضافة السماد العضوي (٣٠ م^٢ هكتار^{-١}) وتغطية بقش الأرز الذي يغطي ٦٠٪ من سطح التربة. أظهرت نتائج هذه الدراسة أن استخدام 30 م^٣/هكتار من السماد العضوي و ٦٠٪ من التغطية بقش الأرز في كل نوع حرث أدى إلى تحسين محتوى التربة من المادة العضوية وتقليل فاقد التربة بالانجراف بالرياح. وأكدت هذه الدراسة على فوائد الحراثة الحافظة مثل تحسين الكثافة الظاهرية كدليل لجودة التربة مما يحافظ عليها من التدهور، كما يحدث مع الحراثة التقليدية. أوضحت الدراسة أيضًا على الاستمرار في استخدام الحراثة الحافظة في زراعة محاصيل الحبوب لمدة أكثر من موسم واحد تحت ظروف الزراعة المطرية بمصر لزيادة التربة من محتواها من المادة العضوية وزيادة الإنتاجية بالمقارنة بالزراعة التقليدية للوصول إلى الإنتاج الزراعي المستدام.