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Effect of Some Seed Bed Preparation Systems on Wheat Yield Under Raised Bed-Mechanical Drilling Method

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ABSTRACT

This study aimed to good seedbed preparation systems and the best sowing methods on some varieties of wheat. The main experiments were carried out three seed bed preparation systems, three sowing methods and three varieties of wheat. The results showed that best preparation systems were ploughing the land with T3, moldboard plough followed by chisel plough (2passes)followed by rotary followed by land leveler(mb+2ch+R+Ll). The maximum germination percent recorded 94.5% for seeds before sowing and manual method (broadcasting).The greater average of height of wheat stem was 99cm of Gemiza11 under T3(mb+2ch+R+Ll) and drilling on raised bed. Whereas the greater average number of spike per m^2 was 403.6 for Gemiza9 above conditions. The productivity increased of 15.6 and 24.5 % when sowing by drilling on raised bed compared to drilling on surface and manual broadcasting, respectively under different preparation, the highest varieties in response to sowing on raised beds were Gemiza11,Gemiza9 and Misr1 its productivity reached 4.14, 3.77 and 3.2ton/fed, respectively. The lowest energy per unit of production was 20.7 kWh/ton using modified seed drill under T1 chisel plough (2passes) followed by land leveler(2ch +Ll) with Gemiza11. Finally, it is recommended to apply the modified seed drill on raised bed under T3(mb+2ch+R+Ll) for Gemiza11variety.

Keywords: preparation system - wheat- raised bed- seed drill

INTRODUCTION

Seedbed preparation techniques for conservation sowing should be selected to best suit the site conditions: The goals of seedbed preparation are to retain the maximum amount of soil moisture, control competing vegetation, improve grain to soil and allow for the proper seeding depth, germination and emergence of the species to be seeded in the conservation sowing . Loren *et al.*(2011) showed that most seeds simply require water, oxygen, and favorable temperatures for germination. And also she showed that local tile and simple blade harrows are manual tolls used for soil loosning. A raised bed sowing system with a number of defined rows planted on top of the bed with furrow irrigation was found to overcome these disadvantages the benefits of raised bed. Sowing system with furrow irrigation compared with conventional flat sowing with flood irrigation. Freeman, *et al.*(2007)investigated seeding effects of furrow and bed sowing using the distance of 60 and 75cm sowing at the whole area of field (furrow and bed) would be the best sowing treatment and increased the amount of yield compared with flat sowing . Also, they found that the maximum number of spikes per m2was achieved 234 in bed sowing system and the minimum was achieved 210 in conventional sowing system. And the highest number of spikelet per spike and grain yield 17.27 and1.06 ton/fed, respectively were produced from bed sowing system. El-Awady *et al.*(2000) found that the forward speed of 2.18km/h gave grain yield of wheat 3.45 and 3.51ton/fed, and the otherwise forward speed of 5.46km/h gave 3.14 and 3.21 ton/fed for mechanical and pneumatic seed-drill, respectively . Hesham *et al.* (2020)studied the effect of sowing methods on wheat yield and water productivity. Higher yields, water savings, and water productivities were achieved with raised furrows or beds under normal salinity. To improve yield under normal salinity conditions, raised beds are the recommended sowing method. Abdul Majeed *et al.* (2015) studied that conventional flat sowing is commonly used for growing wheat and the crop is irrigated by flood irrigation, but it leads to ineffective use of applied nitrogen owing to poor aeration and leaching and volatilization losses. The practice also results in greater crop lodging, lower water use efficiency, and crusting of the soil surface. In contrast, bed sowing of wheat not only saves water but improves fertilizer use efficiency and grain yield. Three years of pooled data from this study showed that wheat sowing on beds produced 15.06% higher grain yield than flat sowing at the same nitrogen rate. Subhash *et al.*(2017) founded that the sowing on raised beds, save irrigation water by 20-40% , reduce cost of irrigation, Save fertilizer N by 25% ,save up to 40% diesel in permanent bed sowing reduce seed requirement by 25%, reduce cost of cultivation by 20%and higher input use efficiency.

The aim of this research is to identified the best methods for the process of preparing the soil which achieve the highest wheat yield under raised bed-mechanical drilling using a modified seed drill.

MATERIALS AND METHOD

The experiment was conducted at Kafer El- Hamam-Zagazig, Government El Sharqia During winter season of 2012-2013

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The soil of the experimental site was achieved in table (1).

Table 1. mechanical analysis and some physical properties of the experimental

Soil texture	Soil fraction, % clay	silt	sand	Depth, cm	Bulk density, gm/cm^3	Penetration resistance, kPa
clay	48.7	34.60	16.7	15	1.45	830

Wheat varieties

Three varieties of wheat were planted namely, Misr1, Gemiza11and Gemiza9

Tractors

The following tractors were used:

1. **Roman Universal 650-M:** It was specified as four cylinder, diesel engine and 55.14 kW engine power. It was used to pulling the chisel plough, the land leveler and the seed drill.
2. **Kubota 90LD:** It was specified as four cylinder, diesel engine, hydraulic system and 66.17 kW engine power. It was used to pulling the moldboard plough.
3. **Kubota 296LD:** It was specified as four cylinder, diesel engine, hydraulic system and 21.32 kW engine power. It was used to operate the rotary plough.

- The following ploughs were used:

1.**Chisel plough (ch):** mounted, 7tines and 1.50 m working width and 4.3 km/h forward speed.

2.**Moldboard plough (mb):** It was mounted with 3tines, 1.25m working width and 3.8 km/h forward speed.

3.**Rotary plough (R):** It was mounted of 1.25m working width and 3 km/h forward speed**.**

4.**Land leveler(Ll):** It was trailed of 3.05 m working width and 4 km/h forward speed.

- **Traditional seed drill** Tye Model were used in sowing grains wheat in surface and 5 km/h forward speed.
- **Modified seed drill** with inter row spaces of 15cm , operating width of 240cm used to drill grains at raised beds and 4 km/h forward speed.

The field experimental was carried out in an area of two feddans divided to 27 plots which all treatments were fertilized, irrigated and weed controlled according to the technical recommendations.

- **Three seed bed preparation systems**

T1: Two passes of chisel plough followed by land leveler (2ch +Ll)

T2: moldboard plow followed by two passes chisel plow followed by land leveler(mb+2ch +Ll)

T3: moldboard plow followed by two passes chisel plow followed by rotary plough followed by land leveler (mb+2ch+R+Ll)

- Three sowing methods

P1:drilling at raised bed

P2: traditional drilling

P3 :manual sowing by broadcasting

- Three varieties of wheat

V1: Misr 1variety

V2: Gemiza 11variety

V3: Gemiza 9 variety

Fig. (1) shows the shape of drilling wheat on raised bed sowing was used modified seed drill, bed sowing 120 cm from bottom to bottom of furrow and upper raised bed of 93 cm for each one with seven rows of plants, the distance between rows of 15cm and the height of beds was (12 – 15cm).

- Drilling on surface was used traditional seed drill which plant wheat on surface.
- Manual sowing was done by broadcasting wheat grains on the surface of the soil.

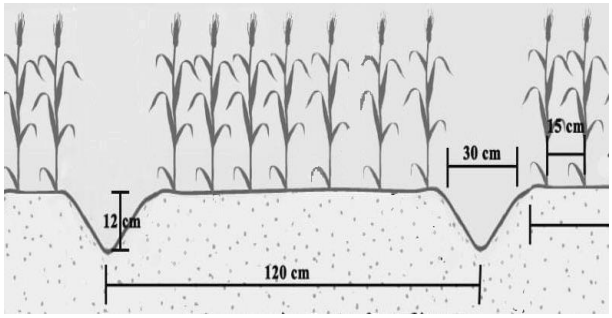

Fig. 1. Shape of drilling on raised bed sowing of wheat

Measurements

Soil bulk density

The bulk density was calculated using the following equation:

$$Pb = \frac{Mb}{Vb} \quad \text{.....(1)}$$

Where:

Pb is the bulk density(gm/cm^3), Mb over dry weight of the soil in the container (gm) and Vb is volume container (cm^3).

Soil penetration resistance

The required force to penetrate soil was determined using a penetrometer. Then, soil penetration resistance was

$$R = \frac{F}{A} \quad \text{.....(2)}$$

Where:

R is soil penetration resistance of soil compaction (kPa), F is force required to penetrate the soil (N) and A is projected area of penetrometer (cm^2).

Machine actual field capacity (AFC):

It is estimated as follows:

$$AFC = \frac{1}{ATT} \quad \text{.....(3)}$$

Where:

AFC is actual field capacity (fed/h) and ATT is the actual total time in hours required per fed.

Machine field efficiency (η_f):

It is estimated as follows:

$$\eta_f = \frac{AFC}{TFC} \times 100 \quad \text{.....(4)}$$

Where:

η_f is field efficiency (%) and TFC: is the theoretical field capacity, fed/h.

Germination percent

A sample of (100 grains) was germinated in laboratory and replicated three times before sowing in the soil and after flowing of seeds on the feeding system of seed drill.

Emergence percent

The number of plantings per meter of the row was counted for the sowing methods to determine the emergence percentage according to the following formula:

$$\text{Emergence percent},\% = \frac{\text{No. of germinated grains/m2}}{\text{No. of grains fallen/m2}} \times 100 \quad \text{.....(5)}$$

Plant characteristics

There are two characters were measured only. characters were measured at harvest which are average plant height in cm (stem length) measured from soil surface to the top of main stem and average number of spike/m^2.

Wheat yield

- Rate of decreasing productivity

Rdp= H p -L p/ H p ……(6)

Where:

Rdp is rate of decreasing productivity (%), H p is the highest productivity (Mg/fed) and L p is the lowest productivity(Mg/fed).

- Rate of increasing productivity

Rip= H p -L p/ L p ……(7)

Where:

Rip is rate of increasing productivity (%).

Power requirements

The total power consumed by the tractor during seed bed preparation and sowing operations, was calculated using the measured fuel consumption. The following formula was used to estimate power consumption by the tractors according to, (Hunt, 1983):

$$Power = Fc\left(\frac{1}{60 \times 60}\right) p_f \times LCV \times 427 \times \eta_{th} \times \eta_m \times \frac{1}{75} \times \frac{1}{1.36} (KW) \quad \text{.....(8)}$$

$$\text{.....(9)}$$

Where,

Fc = Fuel consumption, L/h;

p_f= Density of the fuel .

***LCV* = Lower calorific value of fuel (10000 kcaL/kg for diesel fuel);**

427 = Thermo - mechanical equivalent, kg. m / kcal,.

η_{th} = Thermal efficiency of engine.

η_m =Mechanical efficiency of engine.

Specific energy requirements

Energy requirements can be calculated by the following equation:

$$\text{Energy requirements (kW h/fed)} = \frac{\text{power required(kW)}}{\text{Actual field capacity}\left(\frac{\text{fed}}{\text{h}}\right)} \quad \text{.....(10)}$$

$$\text{Energy requirements per unit of production (kWh/ton)} = \frac{\text{Power required(kW)}}{\text{grain yield(ton/h)}} \quad \text{.....(11)}$$

RESULTS AND DISCUSSION

Machine measurements:

Actual field capacity and field efficiency

Data in table (1) showed that the actual field capacity and field efficiency varies according to tillage and sowing methods. The highest actual field capacity was 2fed/h at traditional seed drill and field efficiency was 85.4% at rotary plough, this due to the difference in forward speed and working width .

Energy requirements

Table (2) showed that the effect of seedbed preparation treatments and sowing methods on fuel consumption, power and energy requirements. The maximum energy value was 44.2kW.h/fed at land lever and the minimum energy value was 8.2kW.h/fed using traditional seed drill, this difference is due to the fuel consumption and actual field capacity.

Table 1. Actual field capacity and field efficiency of the used seed bed preparation and sowing machines.

Equipments	Actual field capacity, fed/h	Field efficiency, %
Chisel plough (two passes)	0.6	42.3
Mould board plough	0.85	72.6
Rotary plough	0.76	85.4
land leveler	0.5	69.4
Traditional seed drill	2.0	70.2
Modified seed drill	1.7	74.2

Table 2. Power and energy requirements

Equipments	Fuel consumption, lit/h	Power requirement, kW	Energy requirement, kW.h/fed
Chisel plough (two passes)	6.8	17.68	22.1
Mould board plough	9.1	23.66	26.28
Rotary plough	3.8	9.88	14.97
land leveler	8.5	22.1	44.2
Seed drill	7.6	19.76	8.2
Developed Seed drill	8.1	21.06	12.39

Energy requirements per unit of production

Fig. (2) showed that the energy requirements per unit of production. The highest value was38.4kW.h/ton using traditional under T3(mb+2ch+R+Ll) at Misr variety. While the lowest value was 20.7kW.h/ton using modified seed drill under T1(2ch+Ll) at Gemiza11 variety. This is due to the productivity grains yield, seedbed preparation systems and sowing methods

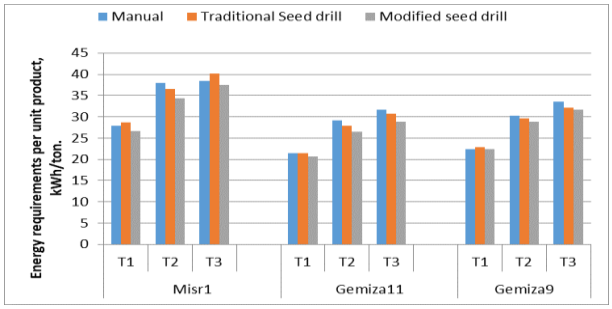

Fig. 2. The energy requirements per unit of production

Soil measurements

Bulk density

Effect of seed bed preparation systems on some soil physical properties.

The results in table (3) showed that when seedbed preparation, the bulk density generally decreased due to tillage (chisel and moldboard plough). It was less bulk density 1.26gm/cm^3 at T2 (mb+2ch + Ll). And it increased relatively using rotary plough due to the increase in soil softening. It also showed that the soil penetration resistance decreased with ploughing and increased when rotary plough was used in the T3(mb+2ch +R+ Ll) to increase the compaction of the soil and reduce the distances between the soil particles, thus increasing the amount of soil penetration.

Germination percent .

Sowing methods has a great effect on germination percent. The maximum germination percent of 94.5% for seeds before sowing and manual method. The germination percent decreased under traditional seed drill 93.3% , because of the friction between the grains and feeding system and fraction between grains with resulting in cracked grains.

Table 3. Effect of preparation systems on soil bulk density and soil penetration resistance.

Treatments	Soil bulk density, g/cm3	Soil penetration resistance(kpa)
T1	1.31	310
T2	1.26	242
T3	1.34	264

Emergence percent

Table(4) showed that the highest emergence was noticed under modified seed drill at T3(mb+2ch+R+Ll) for Gemiza11was 88.6%, this is due to excess water is drained to bottom of furrow far from of seeds, adjustable deep sowing and suitable seed bed preparation.

Table 4. Effect of preparation systems and sowing operations on emergence percent.

	Treatments	Emergence percent,%		
		Manual	Traditional seed drill	Modified seed drill
Misr1	T1	68.3	82.1	85.3
	T2	68.8	82.7	85.9
	T3	69.2	82.9	86.7
Gemiza11	T1	68.8	82.5	85.1
	T2	69.3	82.8	85.9
	T3	70.4	83.1	86.6
Gemiza9	T1	68.9	82.8	86.8
	T2	70.2	83.2	87.2
	T3	73.1	83.3	88.6

Crop measurements

-Average height of wheat stem

The data in table (5) showed that the effect of preparation systems and sowing operations on height of wheat stem. The maximum of average of height of wheat stem was 99cm for Gemiza11 variety under treatment 3 and drilling on raised bed, the minimum of average of height of wheat stem was 79cm for Misr1 variety under treatment 1 and manual sowing, this due to the good preparation systems and sowing method on raised bed where giving better ventilation for the plant exposed to the sun.

Table 5. Effect of preparation systems and sowing operations on plant characteristics

		T1		T2		T3	
Variety	Sowing operation	Average of height,cm	No. spike/ m^2	Average of height,cm	No. spike /m^2	Average of height,cm	No. spike /m^2
Misr1	Drilling on raised bed	84	370	85.5	382.3	90.8	393.6
	Drilling on surface	82	341.1	83.5	352.6	88	363.3
	Manual sowing	79	325.8	80	340.1	82	346.2
Gemiza11	Drilling on raised bed	86	380.7	92	385.3	99	395.9
	Drilling on surface	84	363.3	89	375.4	96	380.2
	Manual sowing	83	328.2	85	342.3	90	354.6
Gemiza9	Drilling on raised bed	89.4	391.2	94	395.1	98.1	403.6
	Drilling on surface	86	375.5	90	390.8	91.6	397.3
	Manual sowing	80.2	336.2	87	352.3	88.6	360.4

- Average number of spike per m^2

Data showed that in table (5) the effect of preparation systems and sowing method s on average number of spike per m^2.The greater average number of spike per m^2 was 417 for Gemiza9 under T 3(mb+2ch+R+Ll) and drilling on raised bed, the minimum of average of average no. of spike per $m^2$was 325.8 for Misr1 variety under T1and manual sowing, this is due to the good preparation systems and drilling on raised bed where encouraging roots to penetrate and deeping to mention fertilizer elements requirements, the plant exposed to the sun lead to increase photosynthesis.

Wheat yield (grain and straw).

Grain yield

This data in Fig.(3)evidenced that drilling on raised bed effects on the grain yield over all other sowing methods. The highest of grain yield of wheat was 4.14 ton/fed for Gemiza11 when using drilling on raised bed sowing under T3(mb+2ch+R+Ll)and the lowest of grain yield of wheat was 2.38 ton/fed for Misr1 when using manual sowing under T1(2ch+Ll). It might be due to uniformity distribution of plants on field, increasing of tillers and weight of grains per spike.

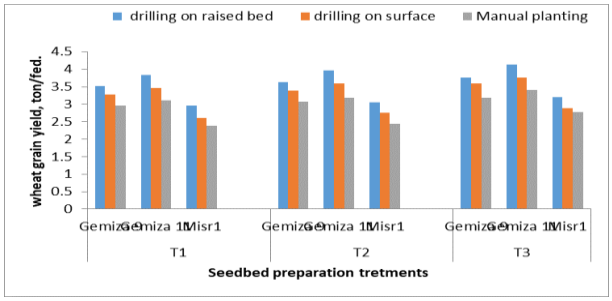

Fig.3. Effect of seed bed preparation systems and sowing methods on wheat grain yield

Wheat staw

This data in Fig.(4)evidenced that drilling on raised bed effects on the grain yield over all other sowing methods. The highest of straw yield of wheat was 5.58 ton/fed for Gemiza11 when using drilling on raised bed sowing under T3(mb+2ch+R+Ll)and the lowest of straw yield of wheat was 2.74 ton/fed for Misr1 when using manual sowing under T1(2ch+Ll). It might be due to uniformity distribution of plants on field and increasing of tillers.

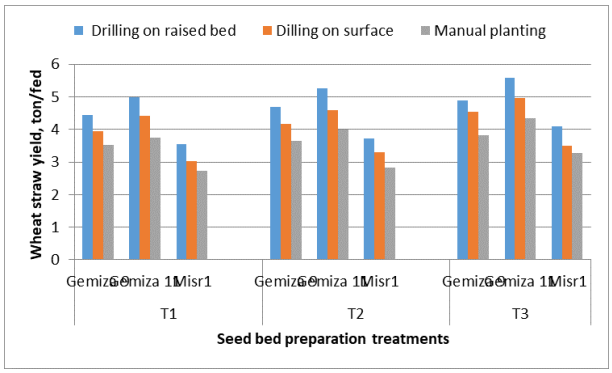

Fig. 4. Effect of seed bed preparation systems and sowing methods on wheat grain yield

The rate of decreasing, % in productivity

Results in table(6) showed that the effect seedbed preparation treatments on the productivity of some wheat varieties, as the largest rate of decreasing in the productivity of Misr 1was 14.1% at T1(2ch+Ll) when treated under the manual sowing compared to T3 (mb+2ch+R+Ll).

Table 6. The rate of decreasing, % in productivity compared to T3(mb+2ch+R+Ll) under different varieties.

Variety	Sowing methods	T1	T2
Misr1	Drilling on raised bed	7.2	4.4
	Drilling on surface	9.7	4.5
	Manual sowing	14.1	4.7
Gemiza11	Drilling on raised bed	7.5	4.3
	Drilling on surface	7.9	5.5
	Manual sowing	8.8	4.7
Gemiza9	Drilling on raised bed	6.6	3.7
	Drilling on surface	8.9	5.8
	Manual sowing	6.9	3.5

The rate of increasing in productivity

Table(7) showed that the effect drilling on raised bed sowing using modified seed drill on productivity compared to other sowing methods, the results indicated that the grain yield was greater than the manual sowing at a rate of 24.5% for Gemiza11.

Table 7.The rate of increasing, % in productivity compared to drilling on raised bed under different varieties.

Variety	Treatments	Drilling on surface	Manual sowing
Misr1	T1	15.6	24.4
	T2	13.8	13.4
	T3	13.9	15.2
Gemiza11	T1	10.4	23.5
	T2	11.2	24.5
	T3	9.8	21.7
Gemiza9	T1	7.6	18.9
	T2	7.4	18.2
	T3	5.0	18.5

CONCLUSION

- The conclusion of this study can be summarized as follows points :

The optimum seed bed preparation system was usedT3 (moldboard plough followed by chisel plough (2 passes) followed by rotary plough followed by land leveler), which giving high emergence percent and productivity of wheat yield to all varieties (Gemiza9, Gemiza11 and Misr1)

-The raised bed-mechanical drilling using the modified seed drill was the best sowing method that lead to increase the wheat productivity (grains and straw) to all varieties.

- The highest response varieties was Gemiza11under raised bed -mechanical drilling method achieved the highest grain and straw yield of 4.14 and 5.58 ton/fed, respectively.
- The lowest Specific energy requirements value of 20.7kW.h/ton was achieved using chisel plough (2 passes) followed by land leveler under raised bed -mechanical drilling using Gemiza11 variety

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تأثير بعض نظم إعداد مرقد البذرة على إنتاج القمح تحت طريقة التسطير الآلي على مصاطب

عمر عبداللطيف عمر و سها جمال عبد الحميد

معهد بحوث الهندسة الزراعية – مركز البحوث الزراعية

يهدف البحث إلى دراسة أفضل نظم لإعداد مرقد البذرة وطرق الزراعة للحصول على أعلى إنتاج لأصناف القمح. ثلاث مستويات لمعاملة إعداد التربة- محراث حفار (وجهين متعامدين) يعقبهما تسوية التربة بالقصابية التقليدي- محراث حفار (وجهين متعامدين) متبوعًا بمحراث قلاب يعقبهما تسوية التربة بالقصابية التقليدي- محراث حفار (وجهين متعامدين) متبوعًا بمحراث قلاب متبوعًا بالدورانى يعقبهما تسوية التربة بالقصابية التقليديثلاث طرق زراعةالزراعة بالتسطير علي مصاطب باستخدام آلة التسطير المعدلة الزراعة الآلية التقليدية بالسطارةالزراعة اليدوية وهي نثر الحبوب يدويا. ثلاث أصناف لمحصول القمح :وهم مصر1, جميزة 11 ,جميزة9. أظهرت النتائج أن أفضل طرق الإعداد كانت حرث الأرض باستخدام المحراث الحفار (وجهين متعامدين)متبوعًا بمحراث قلاب متبوعًا بالدورانى يعقبهما تسوية التربة بالقصابية التقليدية والتى أعطت أعلى إنتاجية لمحصول القمح (حبوب وتبن) للأصناف مصر1, جميزة 11 ,جميزة9 . وكانت طريقة الزراعة تسطير على مصاطب بالسطارة المعدلة افضل الطرق للحصول على أعلى إنتاجية لأصناف القمح المستخدمة تحت جميع معاملات الإعداد. وكانت أعلى الأصناف استجابة للتسطير على مصاطب هو صنف جميزة11حيث بلغ إنتاجه 4.14, 5,58 طن / فدان حبوب وتبن على التوالى ، وكانت أقل قيمة لمتطلبات الطاقة النوعية 20,7كيلو وات.ساعة / طن حبوب للصنف جميزة11 مع الزراعة بالتسطير على مصاطب باستخدام آلة التسطير المعدلة.