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Original Research Article



## Some agricultural practices for improving the productivity of moderately sodic soil II: wheat yield, nutrient status, and economic potentiality

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### Abstract

To evaluate the effect of some agricultural practices, namely, tillage systems (shallow and subsoiling), gypsum application (0.0, 4.76 and 9.52 t/ha), and farmyard manure (FYM) application (0.0, 11.9, 23.8 and 35.7 m<sup>3</sup>/ha) on grain and/or straw yields, nutrient status and economic potentiality of wheat grown on moderately sodic soil, two successive seasons of 2015/2016 and 2016/2017 were carried out at Agricultural Farm of Sids Station, ARC, Egypt. The main results can be summarized as follow: Highest values of grain and/or straw yields, N, P, and K concentrations, and uptake of both grain and straw were recorded under subsoiling tillage, 9.52 t/ha gypsum or 35.7 m<sup>3</sup>/ha FYM than other treatments. Considering the economic analysis, the treatment of zero or 4.76 t/ha gypsum plus 35.7 m<sup>3</sup>/ha FYM under subsoiling operation resulted in the highest net return of wheat production. Therefore, under moderately sodic soil, it could be concluded to use subsoiling tillage and add 4.76 t/ha gypsum and 35.7 m<sup>3</sup>/ha FYM to attain maximum economic productivity of wheat.

**Keywords** Agricultural practices, Farmyard manure, Straw yields, Wheat production

### Introduction

After maize and rice, wheat is the third cereal crop all over the world, but in human dietary intake, it is the second after rice as the main food crop. It supplies about 20 % of food calories for world people (Hamouda et al., 2015), whereas in Egypt it provides about 37 and 40 % of total calories and protein for the people, respectively. Wheat is used for making bread, pastas as well as other bakery products, therefore it consider the main source of nutrients for the world population. Also in Egypt, wheat straw is the main source of animal feeding. The total grain yield of wheat reached about a million tons, which cover only about 60 % of local consumption demand. Therefore, the policy of the Egyptian Governorate aimed to increase wheat production by increasing the lands cultivated by wheat as well as improving the cultural practices for maximizing wheat yield such as growing high yielding varieties, tillage process, fertilization, elimination soil problems such as salinity and alkalinity, etc. Tillage systems are a cultural practice widely used all over the world with several different modifications aimed to, prepare seedbeds that are elevated above the land surface of the field.

Tillage defined as mechanical operations of the soil for plant growing resulted in various purposes such as improving soil temperature, infiltration rate, soil salinity and pH, and soil organic matter (Strudley et al., 2008). There are many factors used to choose the kind of tillage, such as climate, crops, labor-intensive management, fertility, water management, water, and wind erosion control. Irshad et al. (2017) mentioned that tillage can classify into two types: conventional tillage and conservation tillage. They added conventional tillage aims to keep the plant residues and manures soil surface, however conservation tillage is concerned with the preparation of seedbed that contains residue mulch and enhanced the roughness of soil surface. Furthermore, Li et al. (2020) stated that due to subsoil compaction resulting from long-term conventional tillage which is harmful to soil properties and plant growth, the use of deep tillage has a beneficial effect on these problems. They pointed out that deep tillage improved soil bulk density and soil porosity, increased soil water capacity, and aboveground biomass. Many workers stated the positive effect of subsoiling

tillage on soil properties and crop production (Jiao et al., 2017; Soltanabadi et al., 2018; Tahir et al. 2018; Wang et al., 2019).

Due to its cheaper, gypsum considers the most important amendment for sodic soil. Abdel-Fattah (2011) reported that gypsum application improved physical soil properties, such as pH, EC, ESP, bulk density as well as increased hydraulic conductivity and infiltration ratio. Also, Genaidy (2011) mentioned that added gypsum before crops planting in slightly to moderately sodic soil resulted in a positive effect on crop production, which mainly due to its amelioration effect, e.g. improved various physicochemical characters and promotive nutrient uptake. Wong et al. (2009), Chaudhary et al. (2015), Genedy et al. (2018) El-Sheref et al. (2019), and Abbas and Hussain (2020) stated that gypsum application increased wheat productivity and nutrient absorption by plant roots.

Organic manure has a favorable effect in sustaining soil properties and fertility by supplying plants with nutrients and improving soil physical properties. Youssef et al. (2020) indicated that farmyard manure application has many advances, such as increases in nutrient uptake, enhancing soil biological activity as well as improved chemical and physical soil properties. In addition, Ayyat (2017) mentioned that farmyard manure as an organic application resulted in enhanced nutrient release, has a positive effect on microorganisms and earthworms activity, improved root growth, and can control some plant diseases. Many investigators stated the beneficial effect of treated wheat plant with organic manure on nutrient uptake and yields Ali et al. (2009a), Shah et al. (2013) and Galal et al. (2017) for nutrient status and yields as well as Ali et al. (2009b) Genedy et al. (2018), and Hussain (2020) for wheat productivity.

The objective of this work is aimed to evaluate the response of wheat yields, nutrient uptake, and some economic parameters of wheat productivity to the application of gypsum and farmyard manure under two tillage systems, i.e., shallow and subsoiling tillage and their interaction.

### Materials and methods

Two field experiments were conducted at the Sids Agricultural Research Station Farm, ARC, Beni-Suef Governorate, Egypt (Lat. 29°04' N, Long. 31°06' E and 30.4 m above sea level) in two successive seasons of 2015/2016 and 2016/2017 to study the effect of gypsum (0.0, 4.76 and 9.52 t/ha) and farmyard manure (0.0, 11.9, 23.8 and 35.7 m<sup>3</sup>/ha) under two tillage systems (shallow and subsoiling) on wheat yield, nutrient status, and some economic measurements. A surface soil sample (0-30 cm depth) was taken before planting to determine soil physical and chemical properties according to A.O.A.C. (1990) and listed in Table 1.

The experimental design was split-split in four replications in complete randomized blocks. The tillage treatments were located in the main plot. The gypsum levels were arranged in sub-plots, while farmyard manure treatments were applied in sub-sub plots. The conventional tillage (T<sub>1</sub>) for wheat was done by using two passes of a disc, while sub-soiler (about 90 cm

depth) represented the subsoiling tillage (T<sub>2</sub>). Representative samples of farmyard manure used in the two seasons were taken to determine its chemical properties according to A.O.A.C. (1990) and listed in Table 2.

**Table 1. Physico-chemical characteristics analysis of soil before sowing**

Characteristics	1 <sup>st</sup> season	2 <sup>nd</sup> season
Particle size distributions %:		
Coarse sand	0.36	0.55
Fine sand	18.73	15.17
Silt	29.12	31.09
Clay	51.79	53.19
Textural class	Clay	Clay
ESP (%)	14.70	14.35
Field capacity (%)	44.31	46.15
Available water (%)	22.72	21.22
Wilting point (%)	21.59	24.93
pH (1:2.5 soil-water suspension)	8.43	8.45
EC (dSm <sup>-1</sup> ), 1:5 soil-water extraction	1.42	1.49
Total carbonate (mg/g)	11.1	15.7
Organic matter (mg/g)	10.6	10.5
Available N mg/kg soil	19.35	21.27
Available P mg/kg soil	12.14	13.39
Available K mg/kg soil	176.4	186.1

**Table 2. Some chemical analysis of FYM used in the experiments in both growing seasons**

Chemical properties	2015/2016	2016/2017
EC (1:15, soil-water extraction)	5.90	6.20
Organic carbon (mg/g)	169.0	184.0
Organic matter (mg/g)	291.4	317.2
Total N (mg/g)	16.2	17.4
Total P (mg/g)	3.3	3.6
Total K (mg/g)	14.0	14.4
C/N ratio	10:1	11:1

Grains of Beni Suef 5 of wheat were planted on 15 and 20 November at rate of 142.8 kg/ha for the two studied seasons, respectively in plots (4 x 5.25 m = 21 m<sup>2</sup> = 1/476 ha) in 15 cm between rows. All plots fertilized with 178.5 kg N/ha as urea (46.0 % N), 54.74 kg P<sub>2</sub>O<sub>5</sub>/ha as mono-calcium superphosphate (15.5% P<sub>2</sub>O<sub>5</sub>) and 57.12 kg K/ha as potassium sulphate (48 % K<sub>2</sub>O). The recommended cultural practices for wheat were done as in the district.

At harvest ten wheat plants were randomly taken to determine plant height, number of spikes/m<sup>2</sup>, number of

grains/spike, and 1000-grain weight. Also, grain and straw yields were determined for each plot and converted to ton/ha. Samples from grains and straw were randomly taken from each plot to determine N, P, and K concentrations in both grains and straw. N, P and K uptake in grains and/or straw were calculated by multiplying the nutrient concentration by grain or straw yields. Also, protein content in grains was calculated by multiplying nitrogen concentration by 5.70.

Some economic measurements, i.e., total gross parameters; total net return and beneficial cost ratio were estimated as follow:

- Total gross return (L.E/ha.) = Total grain or straw yield x its price.
- Total net return (L.E/ha.) = Total gross return – total cultivation cost.
- Beneficial cost ratio =  $\frac{\text{Total gross return}}{\text{Total cultivation cost}}$ .

The total cultivation cost of wheat during the growing season was determined as the sum of land rent, land preparation; except tillage processes, irrigations, fertilizers, and cost of weed, insect, and fungi control as well as the cost of grains and straw harvest. Also, the cost of the studied factors, i.e., tillage, gypsum, and farmyard manure were estimated.

The results were subjected to statistical analysis according to the method described by [Snedecor and Cochran \(1980\)](#). The differences between the studied treatments were compared by using LSD at a 5 % level of probability.

## Results and discussion

### Yield potentiality

The data of wheat yield potentiality in terms of grain yield, straw yield, and biological yield as affected by tillage system as well as gypsum and farmyard manure application were given [Table 3](#). The main effect of tillage indicates that subsoiling tillage produced grain, straw and biological yields surpassed that due to shallow one by about 3.4, 3.9, and 3.7 % in the first season. The corresponding increasing in the second season were 2.9, 2.5, and 2.7 % in the abovementioned order. The promotive effect of deep tillage on wheat yields was mainly due to the positive effect of subsoiling on soil properties and soil fertility, which in turn improved wheat growth. These results are in line with those obtained by [Hammel \(1995\)](#) and [Alam et al. \(2014\)](#) who found that deeper tillage increased wheat grain and straw yields than a shallow one.

With regard to the main effect of gypsum, the data clearly show that wheat yields were gradually increased as gypsum levels increased. Comparing with no gypsum, added 9.52t gypsum/ha increased grain, straw and biological yields by about 8.5, 6.5 and 7.3 % in the first season and 7.8, 7.5, and 7.7 % in the second one. The beneficial effect of gypsum on wheat productivity is mainly due to its positive effect on improving physical and chemical soil properties, in turn, enhanced wheat growth ([Table 6](#)), consequently increasing

grain and/or straw yields. These results were confirmed by many investigators such as [Gelderman et al. \(2004\)](#), [Taha et al. \(2010\)](#), [Genaidy \(2011\)](#), [Bello \(2012\)](#), [Genedy et al. \(2018\)](#), and [El-Sheref et al. \(2019\)](#) who reported that gypsum application had a positive effect on wheat productivity, especially under slightly or moderately saline soil. As for the main effect of farmyard manure, the obtained results show that wheat grain and/or straw were positively responded to FYM application. It is obvious to notice that wheat productivity was increased as FYM levels increased. The augmentation in wheat yields caused by organic manure application may be explained by the effect of organic manure on amelioration soil properties and fertility which enhanced wheat vegetative growth as discussed formerly. The results achieved from this research were confirmed to those established by many workers such as [Ali et al. \(2009a\)](#), [Shah et al. \(2010\)](#), [Taha et al. \(2010\)](#), [Shah et al. \(2013\)](#), [Irshad et al. \(2017\)](#), [Galal et al. \(2017\)](#) and [Genedy et al. \(2018\)](#) who stated that added FYM to wheat resulted in enhanced its grains and straw yields.

Concerning the response of wheat yields to the interaction between any two factors or among them, the data show that grain, straw, and biological yields were significantly affected by these interactions. Mixed gypsum with organic manure enhanced its effect on wheat productivity, especially under subsoiling tillage. In general, the maximum wheat productivity was produced for the treatment of subsoiling + 9.52 t/ha gypsum + 35.7 m<sup>3</sup>/ha FYM (7.081, 10.384, and 17.465 t/ha) in the first season and 7.363, 10.436, and 17.819 t/ha in the second one for grain, straw, and biological yields, respectively). On the other hand, the treatment of shallow tillage without both gypsum and FYM recorded the lowest abovementioned yield potentiality (5.238, 8.132, and 13.371 in the first season and 5.539, 8.249, and 13.818 t/ha in the second one, respectively). These results are similar to those obtained by [Ghafoor et al. \(2001\)](#), [Choudhary et al. \(2004\)](#), [Wong et al. \(2009\)](#), and [Genedy et al. \(2018\)](#) who mentioned that physical and chemical soil properties are improved due to mixed of gypsum with FYM as soil remediation for sustainable soil usage and crop production.

### Nutrients status

The data in [Tables 4, 5, and 6](#) represent the effect of tillage systems, gypsum, and FYM application on nutrients status of wheat expressed as N, P, and K uptake and protein yield in wheat grains; N, P, and K uptake in wheat straw and total N, P and K. As for the main effect of tillage, the data reveal that N, P and K uptake in grains and/or straw, as well as total N, P and K uptake, were significantly affected by tillage operation, where subsoiling tillage recorded the highest values of it. The increments in N, P and K uptake and protein yield in grains and total N, P and K in wheat plant were 7.0, 7.9, 5.4 and 7.0 and 7.1, 11.4 and 5.6 % due to deep tillage when compared with shallow one in the first season, respectively. Same trends were obtained in the second season.

**Table 3. Yield measurements of wheat as affected by gypsum and FYM application under different tillage systems**

Treatments			2015/2016			2016/2017		
Tillage	Gypsum (t/ha)	FYM (m <sup>3</sup> /ha)	Grain yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)	Grain yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)
Shallow	Gypsum (0.0)	0.0	5.238	8.132	13.370	5.569	8.249	13.818
		11.9	5.883	9.189	15.072	5.986	8.811	14.796
		23.8	6.029	9.234	15.263	6.326	9.127	15.453
		35.7	6.178	9.384	15.562	6.474	9.472	15.946
	Mean		5.832	8.985	14.817	6.089	8.915	15.004
	Gypsum (4.76)	0.0	5.798	8.844	14.642	5.876	8.739	14.615
		11.9	6.021	9.201	15.222	6.309	9.418	15.727
		23.8	6.321	9.446	15.767	6.712	9.882	16.593
		35.7	6.619	9.556	16.175	7.083	10.039	17.122
	Mean		6.190	9.262	15.452	6.495	9.519	16.014
	Gypsum (9.52)	0.0	5.857	9.092	14.949	5.952	8.832	14.784
		11.9	6.010	9.444	15.454	6.488	9.665	16.153
		23.8	6.402	9.572	15.974	7.104	9.879	16.153
		35.7	6.712	9.906	16.618	7.166	10.044	17.210
	Mean		6.245	9.503	15.748	6.678	9.605	16.283
	Mean			6.089	9.250	15.339	6.420	9.346
Subsoiling	Gypsum (0.0)	0.0	5.548	8.454	14.002	5.838	8.594	14.432
		11.9	5.933	9.294	15.227	6.226	9.044	15.270
		23.8	6.119	9.558	15.677	6.628	9.342	15.970
		35.7	6.233	9.599	15.382	6.902	9.741	16.643
	Mean		5.958	9.226	15.184	6.399	9.180	15.579
	Gypsum (4.76)	0.0	5.926	9.130	15.056	5.869	9.044	14.913
		11.9	6.086	9.551	15.637	6.495	9.532	16.027
		23.8	6.507	9.891	16.398	6.907	9.903	16.810
		35.7	7.004	10.272	17.276	7.319	10.353	17.672
	Mean		6.381	9.711	16.092	6.648	9.708	16.356
	Gypsum (9.52)	0.0	5.988	9.199	15.187	5.976	9.282	15.258
		11.9	6.355	9.765	16.120	6.676	9.665	16.341
		23.8	6.771	10.213	16.984	7.095	10.046	17.141
		35.7	7.081	10.384	17.465	7.383	10.436	17.819
	Mean		6.549	9.890	16.439	6.783	9.857	16.640
	Mean			6.296	9.609	15.905	6.609	9.582
Mean of gypsum (t/ha)	0.0	5.895	9.106	15.001	6.244	9.048	15.291	
	4.76	6.285	9.486	15.771	6.571	9.614	16.185	
	9.52	6.397	9.697	16.094	6.730	9.731	16.461	
Mean of FYM (m <sup>3</sup> /ha)	0.0	5.726	8.808	14.534	5.847	8.790	14.637	
	11.9	6.048	9.407	15.455	6.363	9.356	15.719	
	23.8	6.358	9.652	16.010	6.795	9.697	16.492	
	35.7	6.638	9.850	16.488	7.054	10.014	17.069	
L.S.D at 0.05	A	0.014	0.068	0.082	0.022	0.089	0.068	
	B	0.027	0.052	0.081	0.011	0.060	0.068	
	AB	0.038	0.074	0.116	0.016	0.084	0.096	
	C	0.015	0.048	0.052	0.016	0.069	0.065	
	AC	0.021	0.068	0.074	0.022	0.097	0.092	
	BC	0.025	0.084	0.090	0.028	0.118	0.113	
ABC	0.036	0.118	0.127	0.039	0.167	0.160		

The positive effect of deep tillage in nutrient uptake may be due to subsoiling operations reduced the penetration resistance in soil, consequently improved root growth and nutrient absorption by crops [Rusu et al. \(2011\)](#) and [Moraru and Rusu \(2012\)](#). Moreover, [Alam et al. \(2014\)](#) reported that deep tillage improved nutrient uptake of wheat by increasing the root mass density of wheat. These results are in line with those obtained by [Taha et al. \(2010\)](#) and [Alam et al. \(2014\)](#).

season. Similar trends were obtained for the second season and wheat straw. The decline in soil pH resulting from gypsum application and the enhancement in soil fertility due to gypsum is a good explanation for its beneficial effect on the nutrient status of wheat. These findings are in harmony with those obtained by [Genaidy \(2011\)](#), [Genedy et al. \(2018\)](#), and [El-Sheref et al. \(2019\)](#) who stated that gypsum application to wheat plants enhanced its nutrient content in both grains and straw.

As for organic manure, the results show that irrespective of tillage and gypsum treatments, farmyard manure had a positive effect on nutrient adsorption in both grains and straw. The maximum nutrient uptake was recorded under using 35.7 t/ha FYM, where it enhanced N, P, and K uptake and protein in grains as well as total N, P, and K by about 22.6, 37.3, 32.5 and 22.6 and 23.0, 40.0 and 22.0 % over without manure, respectively in the first season. The same trends were obtained in the second season and wheat straw. The improvement in nutrient status could be attributed to chelated compounds resulting by FYM decomposition ([Ali et al., 2009b](#)). These results confirmed by many authors such as [Mekail et al. \(2006\)](#), [Shah et al. \(2013\)](#), and [Galal et al. \(2017\)](#).

Considering the effect of the interaction between treatments, the results show that nutrient status in wheat plants were significantly affected by the interaction between the studied factors. Gypsum application has a synergistic effect on the enhancement of nutrient status caused by organic manure under deep tillage. The relative increasing of N, P and K uptake and protein in grains and total N, P and K uptake due to incorporated gypsum with FYM under subsoiling tillage reached to 43.0, 64.9, 72.0 and 43.0 and 45.8, 72.2 and 46.6 % when compared with the treatment of without both gypsum and farmyard manure under shallow tillage.

### Economic analysis

Gross income, i.e., human labor costs (L.E./ha), machine labor costs (L.E./ha), variable costs (L.E./ha), total cultivation costs (L.E./ha), gross return (L.E./ha), net return (L.E./ha), return over variable costs (L.E./ha), beneficial cost ratio and product profit margin ratio (%) were calculated to represent the economic measurements for these studied factors. Table 7 represents the total cultivation cost of wheat production, whether the common costs or variable costs,

Put the main effect of gypsum into consideration, the data reveal that nutrient uptake was positively affected by gypsum application, where increasing gypsum levels resulted in a significant increase in nutrient status. The relative increments in N, P and K uptake and protein yield in grains as well as total N, P and K uptake in the wheat plant caused by 9.52 t/ha gypsum were 10.4, 12.7, 14.9 and 10.4 and 9.8, 11.4, and 8.2 % over without gypsum, respectively in the first

while Tables 8 and 9 show the effect of the studied variables on this economic analysis. In general, the obtained results indicate that the subsoiling system enhanced the studied economic measurements than the shallow one. The values of the abovementioned parameters owing to deep tillage were 3631.9 (L.E.), 2582.3 (L.E.), 10598.9 (L.E.), 21701.6 (L.E.), 25315.7 (L.E.), 3614.1 (L.E.), 14716.8 (L.E.), 1.17 and 14.14 %, while these values due to shallow one were 3542.2 (L.E.), 2461.3 (L.E.), 10122.9 (L.E.), 21225.6 (L.E.), 24477.3 (L.E.), 3251.6 (L.E.), 14354.3 (L.E.), 1.15 and 13.20 % in the first season, respectively. Similar results were obtained by [Megahed and Salleh \(2014\)](#). As for gypsum, the data reveal that human labor costs (L.E./ha), machine labor costs (L.E./ha), variable costs (L.E./ha), total cultivation costs (L.E./ha), gross return (L.E./ha), net return (L.E./ha), return over variable costs (L.E./ha), beneficial cost ratio and product profit margin ratio (%) was increased as gypsum levels increased up to 9.52 t/ha. The relative increments of these measurements due to added 9.52 t/ha gypsum were 3.2, 7.9, 15.9, 7.4, 7.5, 12.8, 2.8, 0.9, and 4.4% over without gypsum in the first season, respectively. The same trend was observed in the second season. Also, the data indicate that increasing organic manure levels were positively affected all studied economic measurements. Comparing with no manuring added 35.7 m<sup>3</sup>/ha FYM increased these parameters by about 4.5, 8.0, 20.3, 9.3, 14.7, 57.5, 10.8, 4.4 and 37.3%, respectively in the first season. The corresponding increments in the second season were 4.5, 8.2, 18.6, 8.5, 18.5, 67.4, 19.0, 9.1 and 40.5%. The data of the interaction clearly show that mixed 4.76 t/ha gypsum with 35.7 m<sup>3</sup>/ha FYM recorded the highest net return under subsoiling tillage, where the difference between them did not reached to the significant value.

Moreover, the T-Test analysis of some economic measurements, i.e., human labor cost (L.E./ha), machine labor costs (L.E./ha), variable cost (L.E./ha), total cost (L.E./ha), gross return (L.E./ha), net return (L.E./ha), return over variable costs (L.E./ha), beneficial cost ratio and product profit % are given in [Table 10](#). The data clearly confirmed the positive effect of subsoiling as well as gypsum and FYM application on these economic parameters. Similar results were obtained by [Ghoneim et al. \(2014\)](#).

**Table 4. N, P and K uptake (kg/ha) and protein yield (kg/ha) in grains as affected by gypsum and FYM application under different tillage systems**

Treatments			2015/2016				2016/2017			
Tillage	Gypsum (t/ha)	FYM (m <sup>3</sup> /ha)	N uptake	P uptake	K uptake	Protein yield	N uptake	P uptake	K uptake	Protein yield
Shallow	Gypsum (0.0)	0.0	108.96	19.749	17.286	621.063	111.38	22.053	18.935	634.889
		11.9	124.73	22.358	20.416	710.944	122.11	24.302	21.970	696.017
		23.8	122.98	24.114	23.512	700.998	134.11	27.202	25.178	764.439
		35.7	128.51	25.333	23.231	732.521	139.83	28.225	25.247	797.030
	mean		121.30	22.888	21.111	691.383	126.86	25.446	22.832	723.094
	Gypsum (4.76)	0.0	113.64	20.292	19.711	647.717	119.88	24.621	20.568	683.286
		11.9	125.25	24.086	21.677	713.897	136.28	26.499	23.976	776.811
		23.8	134.01	26.549	25.285	763.863	153.02	28.860	27.383	872.240
		35.7	137.67	28.461	25.151	784.723	151.57	30.881	27.977	863.970
	mean		127.64	24.847	22.956	727.550	140.19	27.715	24.976	799.077
	Gypsum (9.52)	0.0	117.14	21.087	19.328	667.719	123.81	23.810	20.835	705.715
		11.9	122.59	22.836	21.634	698.785	137.54	25.952	24.654	783.995
		23.8	135.73	25.609	24.328	773.642	156.29	31.259	28.062	890.879
		35.7	144.97	30.202	26.846	826.332	160.52	33.394	29.955	914.978
	mean		130.11	24.933	23.034	741.619	144.54	28.604	25.876	823.892
	Mean			126.35	24.233	22.367	720.184	137.20	27.255	24.561
Subsoiling	Gypsum (0.0)	0.0	113.18	21.082	18.307	645.097	120.27	23.353	19.966	685.514
		11.9	124.60	23.733	21.361	710.221	134.48	26.150	22.725	766.555
		23.8	132.17	25.088	22.028	753.369	148.47	28.502	25.188	846.302
		35.7	129.65	26.180	24.310	739.011	15.46	31.059	28.160	857.643
	Mean		124.90	24.021	25.501	711.924	138.42	27.266	24.010	789.003
	Gypsum (4.76)	0.0	120.89	21.334	20.742	689.098	124.42	23.476	21.011	709.219
		11.9	129.02	24.952	23.369	735.391	142.89	26.630	26.240	814.476
		23.8	148.36	27.979	24.726	845.640	161.62	31.080	27.765	921.224
		35.7	154.90	31.520	24.515	894.314	169.80	33.665	27.444	967.798
	Mean		138.79	26.446	23.338	791.111	149.68	28.713	25.616	853.179
	Gypsum (9.52)	0.0	122.16	23.353	20.658	696.293	126.69	24.502	21.515	722.161
		11.9	134.72	26.689	24.783	767.890	146.87	28.039	26.837	837.158
		23.8	154.38	29.117	28.439	879.972	164.60	29.798	30.861	938.213
		35.7	155.77	32.570	29.738	887.895	171.28	33.960	32.854	976.295
	mean		141.76	27.932	25.905	808.013	152.36	29.075	28.017	868.457
	Mean			135.15	26.133	23.581	770.349	146.82	28.351	25.881
Mean of gypsum (t/ha)	0.0	123.10	23.454	21.306	701.653	132.64	26.356	23.421	756.048	
	4.76	133.22	25.647	23.147	759.330	144.94	28.214	25.295	826.128	
	9.52	135.93	26.433	24.470	774.816	148.45	28.839	26.946	846.175	
Mean of FYM (m <sup>3</sup> /ha)	0.0	115.99	21.149	19.339	661.164	121.08	23.636	20.471	690.131	
	11.9	126.82	24.109	22.206	722.855	136.70	26.262	24.400	779.169	
	23.8	137.94	26.409	24.720	786.247	153.02	29.450	27.406	872.216	
	35.7	142.25	29.044	25.632	810.799	157.24	31.864	28.606	896.289	
L.S.D at 0.05	A	1.875	0.577	0.685	6.210	1.840	0.630	0.141	8.543	
	B	0.771	0.452	0.218	2.546	0.937	0.297	0.169	5.849	
	AB	1.090	0.639	0.308	3.601	1.325	0.420	0.240	8.272	
	C	0.671	0.441	0.229	5.321	0.507	0.245	0.193	3.002	
	AC	0.950	0.623	0.325	7.525	0.717	0.346	0.272	4.246	
	BC	1.163	0.763	0.398	9.216	0.878	0.424	0.334	5.200	
	ABC	1.644	1.080	0.562	13.034	1.242	0.599	0.472	7.354	

**Table 5. N, P and K uptake (kg/ha) in straw as affected by gypsum and FYM application under different tillage systems**

Treatments			2015 /2016			2016 /2017		
Tillage	Gypsum (t/ha)	FYM (m <sup>3</sup> /ha)	N Uptake	P uptake	K uptake	N uptake	P Uptake	K uptake
Shallow	Gypsum (0.0)	0.0	40.662	10.979	121.987	49.494	13.942	131.985
		11.9	49.621	14.704	142.433	54.627	15.507	145.378
		23.8	53.560	15.698	147.750	54.764	16.612	150.600
		35.7	56.306	16.891	154.843	56.834	17.429	156.295
	Mean		50.037	14.568	141.753	53.930	15.872	146.064
	Gypsum (4.76)	0.0	47.757	13.621	137.969	50.689	15.206	138.083
		11.9	50.606	15.826	147.217	57.448	18.081	150.683
		23.8	56.677	18.515	151.140	63.243	19.368	166.014
		35.7	57.334	19.111	156.713	60.233	20.881	172.668
	Mean		53.094	16.768	148.259	57.903	18.384	156.862
	Gypsum (9.52)	0.0	50.004	12.728	140.920	52.110	13.071	138.666
		11.9	52.886	15.110	151.101	57.991	17.011	158.509
		23.8	55.520	16.273	153.158	61.252	19.166	165.974
		35.7	59.433	18.821	163.442	60.262	20.288	165.719
	Mean		54.461	15.733	152.155	57.904	17.384	157.217
Mean			52.531	15.690	147.389	56.579	17.214	153.381
Subsoiling	Gypsum (0.0)	0.0	46.496	13.526	130.188	48.988	15.125	135.788
		11.9	52.976	15.801	148.702	51.551	16.460	146.513
		23.8	55.436	17.204	157.707	57.917	17.188	154.135
		35.7	59.51	19.198	161.255	60.396	20.261	163.655
	Mean		53.606	16.432	149.465	54.713	17.259	150.023
	Gypsum (4.76)	0.0	51.127	14.607	142.424	54.264	15.917	144.704
		11.9	55.395	16.810	152.815	59.098	17.919	156.323
		23.8	61.325	20.773	162.216	61.399	22.382	168.354
		35.7	62.660	20.955	172.571	65.224	21.120	178.072
	Mean		57.627	18.286	157.506	59.995	19.334	161.863
	Gypsum (9.52)	0.0	52.434	14.535	142.581	52.907	16.522	145.727
		11.9	55.661	17.576	156.242	57.025	17.783	156.575
		23.8	61.275	20.425	167.485	64.293	20.896	168.773
		35.7	62.304	20.353	174.450	62.618	20.456	175.330
	Mean		57.918	18.222	160.190	59.212	18.914	161.601
Mean			56.383	17.647	155.720	57.973	18.503	157.829
Mean of gypsum (t/ha)	0.0	51.821	15.500	145.608	54.321	16.566	148.043	
	4.76	55.360	17.527	152.883	58.950	18.860	159.362	
	9.52	56.189	16.978	156.172	58.557	18.149	159.409	
Mean of FYM (m <sup>3</sup> /ha)	0.0	48.080	13.332	136.011	51.408	14.964	139.159	
	11.9	52.857	15.971	149.752	56.290	17.127	152.330	
	23.8	57.299	18.148	156.577	60.478	19.269	162.308	
	35.7	59.591	19.221	163.879	60.928	20.073	168.623	
L.S.D at 0.05	A	1.976	0.285	3.330	0.869	1.113	0.961	
	B	1.473	0.135	1.002	0.556	0.053	1.100	
	AB	2.084	0.191	1.416	0.786	0.075	1.557	
	C	0.799	0.163	1.235	0.657	0.152	1.270	
	AC	1.130	0.232	1.746	0.929	0.215	1.795	
	BC	1.384	0.283	2.139	1.138	0.264	2.199	
ABC	1.957	0.385	3.025	1.610	0.372	3.109		

**Table 6. Total N, P and K (kg/ha) as affected by gypsum and FYM application under different tillage systems**

Treatments			2015 /2016			2016 /2017		
Tillage	Gypsum (t/ha)	FYM (m <sup>3</sup> /ha)	N Total	P Total	K Total	N Total	P Total	K Total
Shallow	Gypsum (0.0)	0.0	149.621	30.728	139.273	160.878	35.995	150.921
		11.9	174.347	37.061	162.849	176.735	39.809	167.355
		23.8	176.541	39.813	171.262	188.876	43.814	175.778
		35.7	184.819	42.224	178.074	196.664	45.654	181.542
	Mean		171.331	37.456	162.866	180.788	41.318	168.896
	Gypsum (4.76)	0.0	161.393	33.913	157.680	170.563	39.827	158.649
		11.9	175.851	39.911	168.894	193.732	44.580	174.659
		23.8	190.688	45.064	176.425	216.268	48.228	193.397
		35.7	195.005	47.572	181.865	211.807	51.762	200.645
	Mean		180.734	41.615	171.216	198.092	44.100	181.837
	Gypsum (9.52)	0.0	167.147	33.815	160.248	175.920	36.880	159.500
		11.9	175.479	37.946	172.736	195.534	42.962	183.163
		23.8	191.246	41.882	177.486	217.547	50.425	194.036
		35.7	204.404	49.023	190.288	220.784	53.683	195.674
	Mean		184.569	40.666	175.190	202.446	45.988	183.093
	Mean			178.879	39.312	169.756	193.775	44.468
Subsoiling	Gypsum (0.0)	0.0	159.669	34.608	148.495	169.254	38.477	155.754
		11.9	177.577	39.534	170.063	186.034	42.610	169.238
		23.8	187.606	42.292	179.735	206.391	45.690	179.322
		35.7	189.162	45.377	185.565	210.860	51.321	191.815
	Mean		178.504	40.452	170.965	193.134	44.525	174.032
	Gypsum (4.76)	0.0	172.023	35.942	163.166	178.688	39.394	165.715
		11.9	184.410	41.762	176.184	201.988	44.549	182.563
		23.8	209.683	48.752	186.942	223.018	53.462	196.119
		35.7	219.557	52.475	197.086	235.013	54.785	205.516
	Mean		196.418	44.732	180.845	209.678	48.048	187.474
	Gypsum (9.52)	0.0	174.590	37.887	163.239	179.602	41.024	167.243
		11.9	190.379	44.266	181.025	203.895	45.822	183.412
		23.8	215.657	49.542	195.924	228.892	50.694	199.634
		35.7	218.075	52.923	204.188	233.897	54.416	208.183
	Mean		199.675	46.154	186.094	221.572	47.989	189.618
	Mean			191.532	43.780	179.301	201.794	46.854
Mean of gypsum (t/ha)	0.0	174.918	38.954	166.914	186.961	42.421	171.464	
	4.76	188.576	43.174	176.030	203.884	47.074	184.658	
	9.52	192.122	43.410	180.642	207.009	46.988	186.355	
Mean of FYM (m <sup>3</sup> /ha)	0.0	164.074	34.482	155.350	172.484	38.600	159.630	
	11.9	179.674	40.080	172.958	192.986	43.389	176.730	
	23.8	195.237	44.557	181.296	213.499	48.719	189.714	
	35.7	201.837	48.265	189.511	218.171	51.937	197.229	
L.S.D at 0.05	A	0.736	0.668	3.948	2.650	0.568	1.096	
	B	1.351	0.478	0.901	0.853	0.334	1.151	
	C	1.911	0.676	1.274	1.206	0.473	1.629	
	AB	1.236	0.446	1.300	0.809	0.279	1.355	
	AC	1.747	0.631	1.839	1.144	0.279	1.917	
	BC	2.140	0.773	2.253	1.402	0.383	2.348	
ABC	3.027	1.093	3.173	1.982	0.684	3.321		



**Table 7. Estimating guide of wheat crop costs**

Common Cost:	1 <sup>st</sup> season	2 <sup>nd</sup> season
Land rent	11102.7	11900
Land preparation	535.5	595
Seeds	714	833
Planting	357	476
Irrigation	1071	1190
Fertilizers	1666	1904
Weed Control	357	357
Harvesting	2023	2261
Threshing	952	1190
Total	18778.2	20706
Costs of Variables :		
Tillage system		
Shallow	714	833
Subsoiling	833	952
Gypsum (t/ha)		
0.0	0.0	0.0
4.76	785.4	1047.2
9.52	1523.2	2023
Farmyard manure (m <sup>3</sup> /ha)		
0.0	0.0	0.0
11.9	666.4	690.2
23.8	1285.2	1428
35.7	1904	1927.8

**Table 8. Some economic measurements of wheat production as affected by tillage system as well as gypsum and FYM application during 2015/2016**

Treatments			2015/2016								
Tillage	Gypsum. (t/ ha)	FYM (m <sup>3</sup> / ha)	Human labor costs (L.E./ha)	Machine labor costs (L.E./ha)	Variable costs (L.E./ha)	Total cultivation cost (L.E./ha)	Gross return (L.E./ha)	Net Return (L.E./ha)	Return over variable costs (L.E./ha)	Beneficial cost ratio	Product profit margin ratio (%)
Shallow	Gypsum (0.0)	0.0	3391.5	2261.0	8389.5	19492.2	21173.4	1681.2	12783.9	1.09	7.94
		11.9	3462.9	2332.4	9055.9	20158.6	23824.8	3666.2	14768.9	1.18	15.39
		23.8	3510.5	2380.0	9674.7	20777.4	24267.4	3490.0	14592.7	1.17	14.38
		35.7	3558.1	2451.4	10293.5	21396.2	24807.2	3411.0	14513.7	1.16	13.75
	Mean		3480.8	2356.2	9353.4	20456.1	23518.2	3062.1	14164.8	1.15	12.87
	Gypsum (4.67)	0.0	3462.9	2380.0	9174.9	20277.6	23308.8	3031.2	14133.9	1.15	13.00
		11.9	3534.3	2451.4	9841.3	20944.0	24220.8	3276.8	14379.5	1.16	13.53
		23.8	3581.9	2499.0	10460.1	21562.8	25256.6	3693.8	14796.5	1.17	14.63
		35.7	3629.5	2570.4	11078.9	22181.6	26179.0	3997.4	15100.1	1.18	15.27
	Mean		3552.2	2475.2	10138.8	21241.5	24741.3	3499.8	14602.5	1.17	14.11
	Gypsum (9.52)	0.0	3510.5	2451.4	9912.7	21015.4	23673.4	2658.0	13760.7	1.13	11.23
		11.9	3581.9	2522.8	10579.1	21681.8	24714.9	3033.1	14135.8	1.14	12.27
		23.8	3629.5	2594.2	11197.9	22300.6	25584.0	3283.4	14386.1	1.15	12.83
		35.7	3653.3	2641.8	11816.7	22919.4	26716.9	3797.5	14900.2	1.17	14.21
	Mean		3593.8	2552.6	10876.6	21979.3	25172.3	3193.0	14295.7	1.15	12.64
Mean		3542.2	2461.3	10122.9	21225.6	24477.3	3251.6	14354.3	1.15	13.20	
Subsoiling	Gypsum (0.0)	0.0	3481.5	2380.0	8865.5	19968.2	22296.8	2328.6	13431.3	1.12	10.44
		11.9	3552.9	2451.4	9531.9	20634.6	24048.5	3413.9	14516.6	1.17	14.20
		23.8	3600.5	2499.0	10150.7	21253.4	24779.6	3526.2	14628.9	1.17	14.23
		35.7	3648.1	2594.2	10769.5	21872.2	25131.8	3259.6	14362.3	1.15	12.97
	Mean		3570.8	2481.2	9829.4	20932.1	24064.2	3132.1	14234.8	1.15	12.96
	Gypsum (4.76)	0.0	3552.9	2499.0	9650.9	20753.6	23897.1	3143.5	14246.2	1.15	13.15
		11.9	3620.0	2594.2	10317.3	21420.0	24680.6	3260.6	14363.3	1.15	13.21
		23.8	3671.9	2618.0	10936.1	22038.8	26132.4	4093.6	15196.3	1.19	15.66
		35.7	3719.5	2689.4	11554.9	22657.6	27829.8	5172.2	16274.9	1.23	18.86
	Mean		3641.1	2600.2	10614.8	21717.5	25635.0	3917.5	15020.2	1.18	15.15
	Gypsum (9.52)	0.0	3600.5	2570.4	10388.7	21491.4	24125.6	2634.2	13736.9	1.12	10.92
		11.9	3671.9	2641.8	11055.1	22157.8	25605.0	3447.2	14549.9	1.16	13.46
		23.8	3719.5	2689.4	11673.9	22776.6	27129.1	4352.5	15455.2	1.19	16.04
		35.7	3743.3	2760.8	12292.7	23395.4	28132.6	4737.2	15839.9	1.20	16.84
	Mean		3683.8	2665.6	11352.6	22455.3	26248.1	3792.8	14895.5	1.17	14.32
Mean		3631.9	2582.3	10598.9	21701.6	25315.7	3614.1	14716.8	1.17	14.14	
Mean of Gypsum (t/ha)	0.0	3525.8	2418.7	9591.4	20694.1	23791.2	3097.1	14199.8	1.15	12.91	
	4.76	3596.6	2537.7	10376.8	21479.5	25188.1	3708.6	14811.3	1.17	14.63	
	9.52	3638.8	2609.1	11114.6	22217.3	25710.2	3492.9	14595.6	1.16	13.48	
Mean of FYM (m <sup>3</sup> /ha)	0.0	3500.0	2423.6	9397.0	20499.7	23079.2	2579.4	13682.1	1.13	11.12	
	11.9	3570.7	2499.0	10063.4	21166.1	24515.7	3349.6	14452.3	1.16	13.68	
	23.8	3619.0	2546.6	10682.2	21784.9	25524.9	3739.9	14842.6	1.17	14.63	
	35.7	3658.6	2618.0	11301.0	22403.7	26466.2	4062.5	15165.2	1.18	15.27	
L.S.D. at 0.05	A	7.66	54.70	123.39	123.39	7.58	122.29	122.29	0.007	0.55	
	B	6.31	30.45	202.00	202.00	4.96	202.41	202.41	0.011	0.84	
	AB	8.92	43.10	285.67	285.67	7.02	286.25	286.25	0.016	1.18	
	C	7.79	20.81	104.50	104.50	3.84	104.82	104.82	0.008	0.44	
	AC	11.03	29.43	147.79	147.79	5.43	148.24	148.24	0.010	0.62	
	BC	13.51	36.05	181.00	181.00	6.65	181.55	181.55	0.014	0.76	
ABC	19.10	50.98	255.97	255.97	9.41	256.76	256.76	0.015	1.08		

**Table 9. Some economic measurements of wheat production as affected by tillage system as well as gypsum and FYM application during 2016/2017**

Treatments			2016/2017								
Tillage	Gypsum. (t/ha)	FYM (m <sup>3</sup> /ha)	human labor costs (L.E./ha)	Machine labor costs (L.E./ha)	Variable costs (L.E./ha)	Total cultivation cost (L.E./ha)	Gross return (L.E./ha)	Net Return (L.E./ha)	Return over variable costs (L.E./ha)	Beneficial cost ratio	Product profit margin ratio (%)
Shallow	Gypsum (0.0)	0.0	4093.6	2689.4	9639.0	21539.0	26091.5	4552.5	16452.5	1.21	17.45
		11.9	4188.8	2796.5	10329.2	22229.2	27998.6	5769.4	17669.4	1.26	20.61
		23.8	4236.4	2832.2	11067.0	22967.0	29443.0	6476.0	18376.0	1.28	21.99
		35.7	4284.0	2927.4	11566.8	23466.8	30235.5	6768.7	18668.7	1.29	22.39
	Mean		4200.7	2811.4	10650.5	22550.5	28442.1	5891.6	17791.6	1.26	20.61
	Gypsum (4.76)	0.0	4188.8	2867.9	10686.2	22586.2	27558.3	4972.1	16872.1	1.22	18.04
		11.9	4284.0	2975.0	11376.4	23276.4	29617.0	6340.6	18240.6	1.27	21.41
		23.8	4093.6	3010.7	12114.2	24014.2	31396.0	7381.8	19281.8	1.31	23.51
		35.7	4379.2	3105.9	12614.0	24514.0	32821.2	8307.2	20207.2	1.34	25.31
	Mean		4295.9	2989.9	11697.7	23597.7	30348.1	6750.4	18650.4	1.29	22.07
	Gypsum (9.52)	0.0	4260.2	2975.0	11662.0	23562.0	27899.1	4337.1	16237.1	1.18	15.55
		11.9	4355.4	3082.1	12352.2	24252.2	30439.7	6187.5	18087.5	1.26	20.33
		23.8	4403.0	3117.8	13090.0	24990.0	32768.6	7778.6	19678.6	1.31	23.74
		35.7	4450.6	3213.0	13589.8	25489.8	33116.5	7626.7	19526.7	1.30	23.03
	Mean		4367.3	3096.9	12673.5	24573.5	31056.0	6482.5	18382.5	1.26	20.66
	Mean		4287.9	2966.1	11673.9	23573.9	29948.7	6374.8	18274.8	1.27	21.11
Subsoiling	Gypsum (0.0)	0.0	4212.6	2808.4	10115.0	22015.0	27223.6	5293.8	17193.8	1.24	19.13
		11.9	4307.8	2915.5	10805.2	22705.2	28702.8	6321.3	18221.3	1.26	20.89
		23.8	4379.2	2951.2	11543.0	23443.0	29885.7	7229.3	19129.3	1.28	21.56
		35.7	4403.0	3046.4	12042.8	23942.8	31038.5	7357.5	19257.5	1.30	22.86
	Mean		4325.7	2930.4	11126.5	23026.5	29212.7	6550.5	18450.5	1.26	21.11
	Gypsum (4.67)	0.0	4307.8	2986.9	11162.2	23062.2	27777.0	4714.8	16614.8	1.20	16.97
		11.9	4403.0	3094.0	11852.4	23752.4	30358.1	6605.7	18505.7	1.28	21.76
		23.8	4450.6	3129.7	12590.2	24490.2	32096.2	7606.0	19506.0	1.31	23.69
		35.7	4498.2	3224.9	13090.0	24990.0	33897.2	8907.2	20807.2	1.36	26.28
	Mean		4414.9	3108.9	12173.7	24073.7	31032.1	6958.4	18858.4	1.29	22.18
	Gypsum (9.52)	0.0	4379.2	3094.0	12138.0	24038.0	28342.2	4304.2	16204.2	1.18	15.19
		11.9	4474.4	3153.5	12828.2	24728.2	31571.4	6843.2	18743.2	1.28	21.68
		23.8	4522.0	3236.8	13566.0	25466.0	33274.8	7808.8	19708.8	1.31	23.47
		35.7	4569.6	3332.0	14065.8	25965.8	34291.0	8325.2	20225.2	1.32	24.30
	Mean		4486.3	3204.1	13149.5	25049.5	31869.9	6820.4	18720.4	1.27	21.15
	Mean		4408.9	3081.1	12149.9	24049.9	30704.9	6655.0	18555.0	1.28	21.48
Mean of Gypsum (t/ha)	0.0	4263.2	2870.9	10888.5	22788.5	28827.4	6038.9	17938.9	1.26	20.86	
	4.76	4355.4	3049.4	11935.7	23835.7	30690.1	6854.4	18754.4	1.29	22.12	
	9.52	4426.8	3150.5	12911.5	24811.5	31462.9	6651.4	18551.4	1.27	20.91	
Mean of FYM (m <sup>3</sup> /ha)	0.0	4240.4	2903.6	10900.4	22800.4	27481.9	4681.5	16581.5	1.21	17.10	
	11.9	4335.6	3002.8	11590.6	23490.6	29781.3	6290.7	18190.7	1.27	21.11	
	23.8	4387.1	3046.4	12437.2	24337.2	31661.8	7324.6	19224.6	1.30	23.10	
	35.7	4430.8	3141.6	12828.2	24728.2	32566.7	7838.5	19738.5	1.32	24.02	
L.S.D. at 0.05	A	16.29	15.01	204.25	203.31	7.758	207.02	207.93	0.011	0.65	
	B	13.28	11.10	58.57	58.77	2.38	59.32	59.13	0.003	0.18	
	AB	18.78	15.69	82.84	83.12	3.36	83.89	83.62	0.004	0.26	
	C	9.59	10.01	65.73	65.84	3.58	65.63	65.53	0.004	0.21	
	AC	13.61	14.15	92.96	93.11	5.07	92.82	92.67	0.005	0.29	
	BC	16.61	17.33	113.85	114.03	6.21	113.68	113.49	0.006	0.36	
	AB C	23.49	24.51	161.01	161.25	8.78	160.77	160.50	0.01	0.51	

**Table 10. T-Test between and shallow and subsoiling systems as well as between without and with high level of gypsum or farmyard manure application for some economic easements**

Average value of variables	2015/2016											
	Tillage				Gypsum (t/ha)				FYM (m <sup>3</sup> /ha)			
	Shallow <sup>(1)</sup>	Subsoiling	The amount of change (L.E)	T-Test between them	Without	9.52 ton/ha	The amount of change (L.E)	T-Test between them	Without	35.7 m <sup>3</sup> /ha	The amount of change (L.E)	T-Test between them
Human labor cost (L.E./ha)	3542.2	3631.9	90	4.89(**)	3525.5	3638.8	113.3	5.17(**)	3500.0	3658.6	158.6	7.17(**)
Machine labor costs (L.E./ha)	2461.3	2582.3	121	4.52(**)	2418.7	2609.1	190.4	6.31(**)	2423.6	2618.0	194.4	5.25(**)
Variable cost (L.E./ha)	10122.9	10598.9	476	2.07(*)	9591.4	11114.6	1523.2	6.73 (**)	9397.0	11301.0	1904	8.05(**)
Total cost (L.E./ha)	21225.6	21701.6	476	2.07(*)	20694.1	22217.3	1523.2	5.83(**)	20499.7	22403.7	1904	8.05(**)
Gross return (L.E./ha)	24477.3	25315.7	838.4	2.28(*)	23791.2	25710.2	1919	6.73(**)	23079.2	26466.2	3387	8.63(**)
Net return (L.E./ha)	3251.6	3614.1	362.5	2.08(*)	3097.1	3492.9	395.8	1.89 <sup>(1)</sup>	2579.4	4062.5	1483.1	6.78(**)
Return over variable costs (L.E./ha)	14354.3	14716.8	362.5	2.08(*)	13961.8	14357.6	395.8	1.89 <sup>(1)</sup>	13682.1	15165.2	1483.1	6.98(**)
Beneficial cost ratio	1.15	1.17	0.02	1.70 <sup>(1)</sup>	1.15	1.16	0.01	0.84 <sup>(1)</sup>	1.13	1.18	0.05	6.08 <sup>(1)</sup>
Product profit margin ratio % <sup>(2)</sup>	13.20%	14.32%	1.12%	4.80 <sup>(1)</sup>	12.91%	13.48%	0.57	0.82 <sup>(1)</sup>	11.11%	15.27%	4.16%	6.10 <sup>(1)</sup>
Average value of variables	2016/2017											
	Tillage				Gypsum (t/ha)				FYM (m <sup>3</sup> /ha)			
	Shallow <sup>(1)</sup>	Subsoiling	The amount of change (L.E)	T-Test between them	Without	9.52 ton/ha	The amount of change (L.E)	T-Test between them	Without	35.7 m <sup>3</sup> /ha	The amount of change (L.E)	T-Test between them
Human labor cost (L.E./ha)	4287.9	4408.9	121	5.20(**)	4263.2	4426.8	163.6	5.82 (**)	4240.4	4430.8	190.4	6.0(**)
Machine labor costs (L.E./ha)	2966.1	3081.1	115	3.30(**)	2870.9	3150.5	279.6	9.06(**)	2903.4	3141.6	238.2	5.2(**)
Variable cost (L.E./ha)	11673.9	12149.9	476	0.52 <sup>(1)</sup>	10888.5	12911.5	2023	8.81(**)	10900.4	12828.2	1927.8	6.45(**)
Total cost (L.E./ha)	23573.9	24049.7	476	0.52 <sup>(1)</sup>	22788.5	24811.5	2023	8.81(**)	22800.4	24728.2	1927.8	6.45(**)
Gross return (L.E./ha)	29948.7	30704.9	756	2.14 <sup>(1)</sup>	28827.4	31462.9	2635.5	4.68(*)	27481.9	32566.7	5084.8	12.88(**)
Net return (L.E./ha)	6374.8	6654.9	280	10.20 <sup>(1)</sup>	6038.9	6651.4	612.5	1.74 <sup>(1)</sup>	4681.5	7838.5	3157	15.54(**)
Return over variable costs (L.E./ha)	18121.1	18473.9	280	2.81 <sup>(1)</sup>	17938.9	18551.4	612.5	1.74 <sup>(1)</sup>	16581.5	19738.5	3157	15.54(**)
Beneficial cost ratio	1.27	1.28	0.01	2.82 <sup>(1)</sup>	1.26	1.27	0.01	0.06 <sup>(1)</sup>	1.21	1.32	0.11	13.8(**)
Product profit margin ratio % <sup>(2)</sup>	21.11%	21.48%	0.37%	2.8 <sup>(1)</sup>	20.86%	20.91%	0.05%	0.20 <sup>(1)</sup>	17.05%	24.02%	6.97%	13.9(**)

1- The amount of change between the two levels= Subsoiling- Shallow.

2- Product profit% = ( Net return / Total return) x 100.

## Conclusions

From the results of this investigation, it could be recommended to use subsoiling tillage and apply 9.52 t/ha gypsum + 35.7 m<sup>3</sup>/ha farmyard manure to maximizing yields of wheat grown in moderately sodic soil. In economic view, it could be recommended to add 4.76 t/ha gypsum + 35.7 m<sup>3</sup>/ha FYM under subsoiling tillage to attain the highest net return of wheat productivity grown in moderately sodic soil.

## Conflict of Interest

The author hereby declares no conflict of interest.

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