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Effect of no tillage method and nitrogen fertilizer levels on maize (*Zea mays* L.) yield under conditions of southern part of Lorestan province in Iran

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ABSTRACT

An experiment was conducted to study on effects of no tillage and nitrogen fertilizer levels on yield of maize (*Zea mays* L.) under south of Lorestan province climatic conditions in 2012. The experiment was carried out as split-plot based on randomized complete block design in three replications. Residue management using different tillage methods as main plot with four levels and nitrogen fertilizer levels four levels as subplots were applied. Results showed that the management of residues using different tillage methods had a high significant effect ($p < 0.01$) on plant number per m^2 and ear length, and a significant effect ($p < 0.05$) on ear number per m^2 , thousand grain weight, grain yield, leaf area and biological yield. Furthermore, N-fertilizer levels had significant effect on ear number per m^2 , ear length, grains number per row, grain yield, leaf area, leaf area index, biological yield and harvest index. Interaction effects of residue management and nitrogen fertilizer had significant effect on ear number per m^2 , ear length, grain yield, leaf area and biological yield. According to the results of this study, no-tillage method with using 103.5 kg/ha of nitrogen is suggested to be used in the region.

Key words: Grain yield, N-fertilizer, tillage method, wheat, yield components

INTRODUCTION

Maize (*Zea mays* L.) can be planted after the harvest of winter crops, in warm or temperate regions of Iran such as Lorestan province. Farmers in these areas, usually burning crop residue such as wheat for faster soil preparation. Although soil preparation in fields with burned crop residues is faster and pests or diseases can be controlled, but disadvantages resulting from burning is much greater than its benefits [2].

Residue management (tillage system) and nitrogen fertilizer management are needed to improve maize production [2]. Recently conservation tillage is emphasized for soil water conservation, fuel energy saving, and erosion control [1]. Research has shown that efficient agronomic management contains fertilizer management. This is an important issue since all of the farmers use fertilizer [8].

Crop residues are an important resource as a source nutrient for crop production and affecting physical, chemical, and biological functions of soil and properties and water and soil quality. Crop residue management operations should be selected to increasing crop yields with a minimum adverse effect on the environment .

Numerous investigations had been performed on effects of residue management and nitrogen fertilizer levels on yield maize [2, 1, 5, 4]. For example, Najafinezhad, et al. [8] studied on the effect of various tillage practices

(Conventional tillage, Reduced tillage and Minimum tillage) on grain yield of maize and reported that reduced tillage and conventional tillage treatments had the highest grain yield of corn.

The objectives of this research were to investigate the effects of different residue management, nitrogen fertilizer levels and their interaction effects upon yield and its components in maize under the climatic conditions of Lorestan regions of Iran.

MATERIALS AND METHODS

Field experiments were conducted at Poldokhtar, Lorestan province of Iran (latitude 33°9' N, longitude 47°42' and 660 m above sea level) during the cropping season 2012. The soil texture was silt clay loam with pH = 7.7, EC = 0.75 dS/m.

The experiment was carried out as split-plot based on randomized complete block design in three replications. The main plots (24×30 meter) were four tillage systems include: (I) burning of wheat residues and preparing the soil surface then disk operations twice vertically and planting pneumatic row crop planter (Conventional method), (II) preparing the soil surface and disk operations three times then planting using pneumatic equipment (save at least 30% of wheat residues: Reduced tillage method), (III) preparing the soil surface and chisel then pneumatic planting using pneumatic equipment (save at least 30% of wheat residues: Conservation tillage method) and (IV) sowing directly (save at least 100% of wheat residues: No-tillage method). The subplots (6×30 meter) were seven nitrogen fertilizer levels: (I) 300 kg/ha urea fertilizer (138 kg/h N), (II) 225 kg/ha urea fertilizer (103.5 kg/h N), (III) 150 kg/ha urea fertilizer (69 kg/h N) and (IV) no used fertilizer.

Maize variety single cross 704 was planted at a depth of 3-5 cm in rows with 75 cm apart with plant to plant distance of 20cm in July 2012.

Effect of tillage systems and N-fertilizer were measured on some traits including plant number per m² (PN), ear number per m² (EN), ear length (EL), row number per ear (RNE), grains number per row (GNR), thousand grains weight (TGW), grain yield (GY), leaf area (LA), leaf area index (LAI), biological yield (BY) and harvest index (HI). Analysis of variance and mean comparison using Duncan's multiple range test ($\alpha = 0.05$), were performed by MSTAT-C statistical software. Excel software was used for drawing graphs.

RESULTS AND DISCUSSION

Statistical analyses of the data regarding to each trait is considering separately as following. Residue management and Nitrogen fertilizer interactions that was significant statistically were studied also.

Plant number per m² (PN): Residue management had a significant effect on PN trait but residue treatments had non-significant effect on this trait (Table 1). Comparison of means for PN trait revealed that reduced tillage and conservation tillage produced maximum plant number per m² (Table 2).

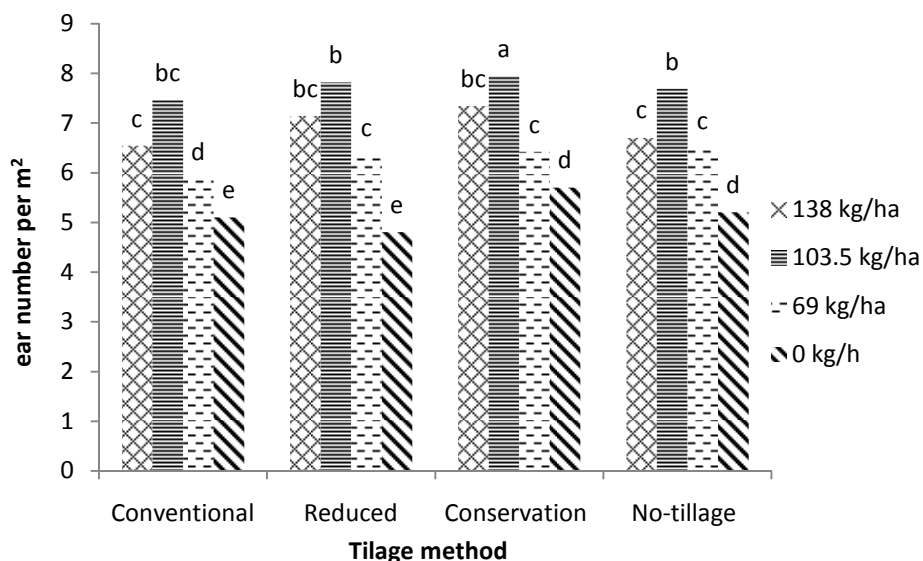


Figure 1- Mean comparison of residue management and nitrogen fertilizer management interaction effects for ear number per m² (EN) in maize

Ear number per m² (EN): Results showed that tillage treatments, residue management and their interaction effects had a significant effect ($p < 0.05$) on Ear number per m² (Table 1). Tillage treatments and residue management interaction effects mean comparisons for EN trait (Figure 1), revealed the conservation tillage method with 138 kg/ha N-fertilizer was the highest (7.94 ear number per m²).

Ear length (EL): The results of analysis of variance showed that residue management, nitrogen fertilizer levels and their interaction effects were significantly difference for the Ear length (EL) variable. The highest ear length were related to the no-tillage with 138 kg/h N-fertilizer, no-tillage with 103.5 kg/ha N-fertilizer and conservation tillage with 138 kg/ha N-fertilizer treatments with 16, 15.8 and 15.9 cm, respectively (Figure 2).

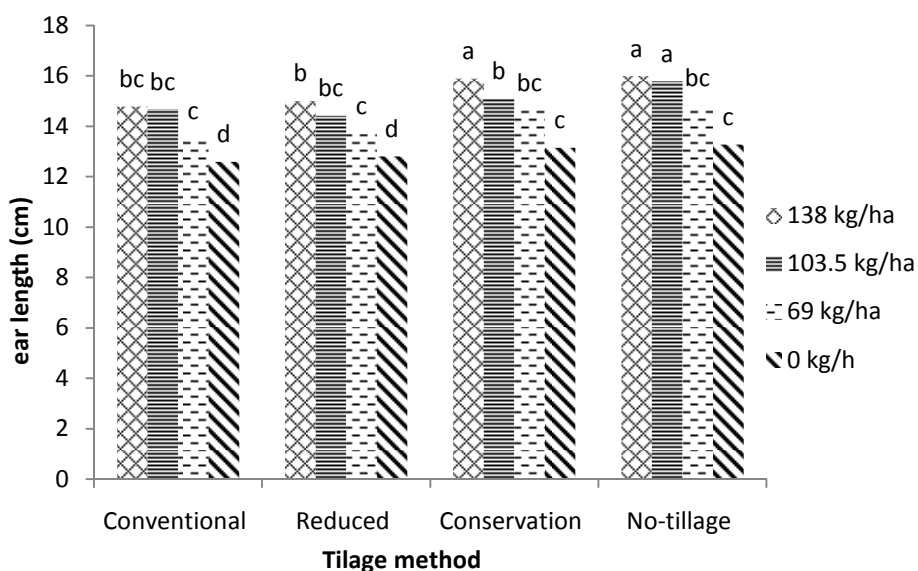


Figure 2- Mean comparison of residue management and nitrogen fertilizer management interaction effects for ear length (EL) in maize

Row number per ear (RNE): Analysis of variance (Table 1) showed that tillage method, residue management and their interaction effects have not significantly difference for row number per ear.

Grains number per row (GNR): This variable was significantly ($p < 0.05$) affected only by nitrogen fertilizer amount, but not affected by tillage method (Table 1). Second part of these results is agreement with findings of Najafinezhad, et al. [8] that reported grain number per row was not influenced significantly by different tillage practices. Mean comparisons for GNR revealed the differences between N-fertilizer levels. The highest GNR was in 138 kg/ha level of N-fertilizer (34.12) and no fertilizer usage treatment with 28.12 Grains per row was the lowest (Table 3).

Thousand grains weight (TGW): Results of variance analysis revealed the significant effect of residue management (tillage method) on thousand grains weight at the probability level of 0.05 (Table 1). This result is disagreement with Najafinezhad, et al. [8] that reported 1000-grain weight was not affected significantly by different tillage practices. Mean comparisons table (Table 2) revealed that no-tillage and conservation tillage methods had the highest thousand grains weight (269.37 gr and 266.14 gr respectively).

Grain yield (GY): Statistical analysis showed that residue management, nitrogen fertilizer levels and their interaction effects were significantly difference for the grain yield trait (Table 1). Furthermore, data analysis for interaction effects in grain yield (Figure 3) showed that no-tillage plus 138 kg/h N-fertilizer, no-tillage plus 103.5 kg/ha N-fertilizer and conservation tillage supplemented with 138 kg/ha N-fertilizer were the highest grain yield (5613 kg/ha, 5886 kg/ha and 5763 kg/ha respectively). These disagreement with results of Doren, et al. [9], Griffith, et al. [10] and Uri [11] that who reported that grain yield of maize decreased with reduced tillage.

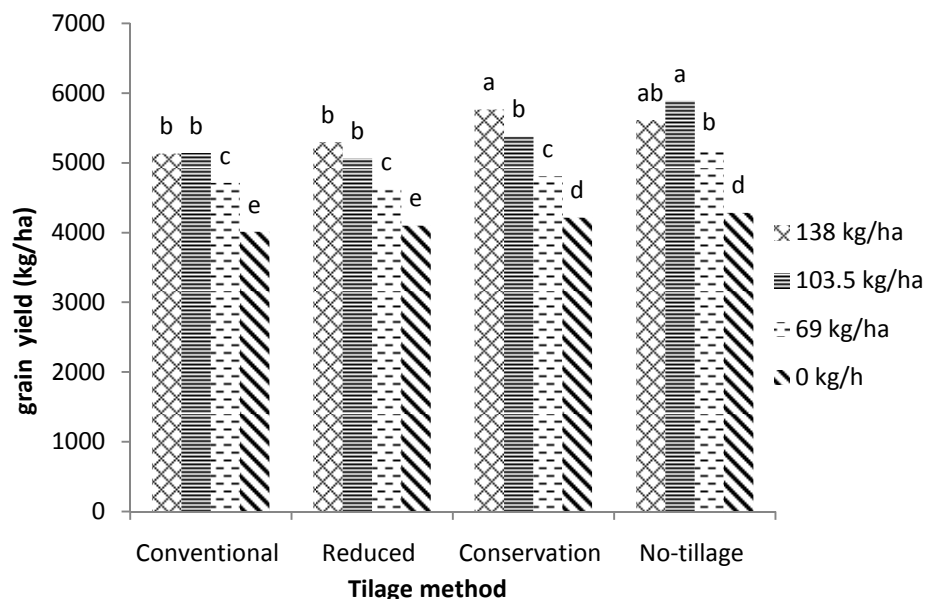


Figure 3- Mean comparison of residue management and nitrogen fertilizer management interaction effects for grain yield (GY) in maize

Leaf area (LA): Analysis of variation (Table 1) showed that residue management, nitrogen fertilizer levels and their interaction effects were statistically significant ($p < 0.05$) for the leaf area trait. The highest LA were related to no-tillage with 138 kg/h N-fertilizer (4208 cm^2), no-tillage with 103.5 kg/ha N-fertilizer (4598 cm^2) and conservation tillage with 103.5 kg/ha N-fertilizer (4120 cm^2) also (Figure 4).

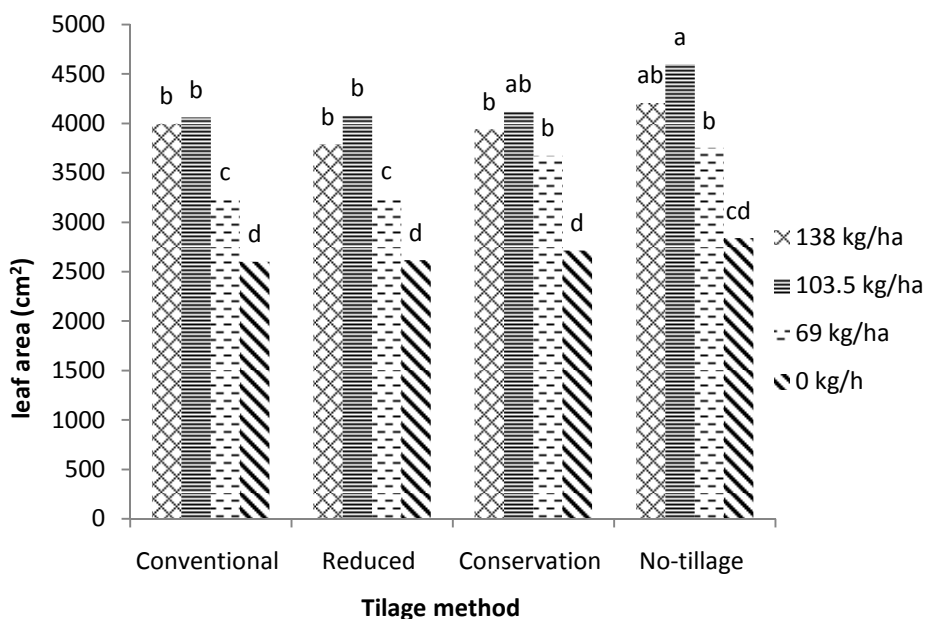


Figure 4- Mean comparison of residue management and nitrogen fertilizer management interaction effects for leaf area (LA) in maize

Leaf area index (LAI): Leaf area index was affected by N-fertilizer rate at 0.05 level of probability (Table 1). Mean comparisons (Table 2) revealed 138 and 103.5 kg/ha nitrogen levels (with 3.18 and 3.92 cm² respectively) were highest LAI rate (Table 3).

Biological yield (BY): Results of variation analysis showed significant effects ($p < 0.05$) of residue management, nitrogen fertilizer and their interaction effects on biological yield (Table 1). As shown in Figure 5, no-tillage and

conservation tillage methods with 138 kg/ha N-fertilizer had the best treatments for biological yield trait (13365 kg/ha and 13482 kg/ha respectively).

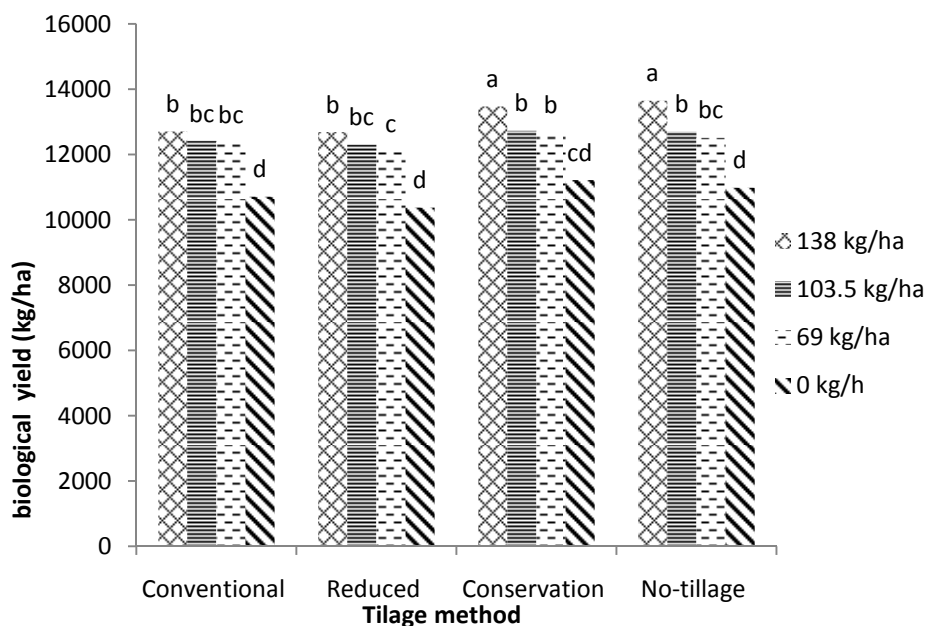


Figure 5- Mean comparison of residue management and nitrogen fertilizer management interaction effects for biological yield (BY) in maize

Table 1- Analysis of variance for yield and it's components under residue management (tillage system) and nitrogen fertilizer management in maize

SOV	df	Means squares (MS)										
		PN	EN	EL	RNE	GNR	TGW	GY	LA	LAI	BY	HI
Replication	2	0.13	0.24	0.16	0.38	11.32	393.40	1623482.4	113685.22	0.12	2564783.58	24.18
Residue management (R)	3	5.78**	4.10*	2.61**	0.78 ^{ns}	89.73 ^{ns}	8621.96*	7541263.7*	2697453.86*	1.62 ^{ns}	13426879.65*	163.19 ^{ns}
Error (R)	6	0.20	0.25	0.24	0.66	15.83	583.11	8751226.7	19824.39	0.31	1364216.54	34.52
Nitrogen fertilizer (N)	3	16.93 ^{ns}	6.72*	4.23*	0.23 ^{ns}	1.56*	439.70 ^{ns}	5122.0**	98231.81*	3.62*	148557.62*	1.68*
R×N	9	0.62 ^{ns}	0.66*	1.12*	0.19 ^{ns}	5.52 ^{ns}	851.34 ^{ns}	912237.7*	294873.27*	0.25 ^{ns}	1525477.66*	29.57 ^{ns}
Error (N)	24	2.49	0.98	1.547	0.35	2.19	672.98	551782.7	178242.54	0.22	1475326.94	27.68
Coefficient of Variation (CV) %		15.38	16.22	9.45	4.78	4.48	8.78	12.19	10.14	12.46	9.87	12.76

^{ns}, *, ** means non-significant, Significant at 0.05 and 0.01 level of probability, respectively

Table 2- Mean comparisons of residue management (tillage system) in maize

tillage system	PN (m ²)	EN (m ²)	EL (cm)	TGW (gr)	GY (kg/ha)	LA (cm ²)	BY (kg/ha)
Conventional tillage	6.92 b	4.86 c	13.94 b	241.51 b	4487.48b	3108.84b	12135b
Reduced tillage	7.84 a	5.54 b	13.87 b	242.25 b	4612.43b	3451.11ab	11936b
Conservation tillage	7.73a	6.32 a	15.21 a	266.14 a	5741.12a	3947.84a	13754a
No-tillage	5.89 c	5.31 b	15.44 a	269.37 a	5974.18a	4256.72a	13241a

Means followed by similar letters in each column are not significantly different

Table 3- Mean comparisons of nitrogen fertilizer levels in maize

N fertilizer (kg/ha)	EN (m ²)	EL (cm)	GNR	GY (kg/ha)	LA (cm ²)	LAI (cm ²)	BY (kg/ha)	HI (%)
138	5.52ab	15.42a	34.12a	5121ab	3952ab	3.18ab	13214a	42.16a
103.5	6.67a	15.08ab	32.82bc	5831a	4125a	3.92a	12442bc	38.57bc
69	5.18bc	14.47bc	32.20bc	4633c	3657b	2.86b	12354bc	36.18c
0	4.82c	13.97c	28.12d	4149d	3142c	2.31c	11612d	34.94d

Means followed by similar letters in each column are not significantly different

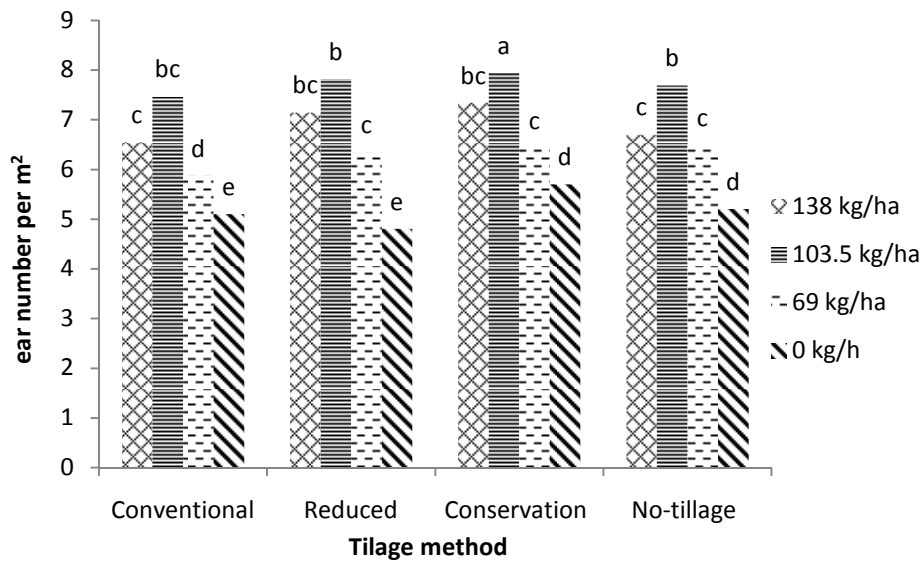


Figure 1- Mean comparison of residue management and nitrogen fertilizer management interaction effects for ear number per m² (EN) in maize

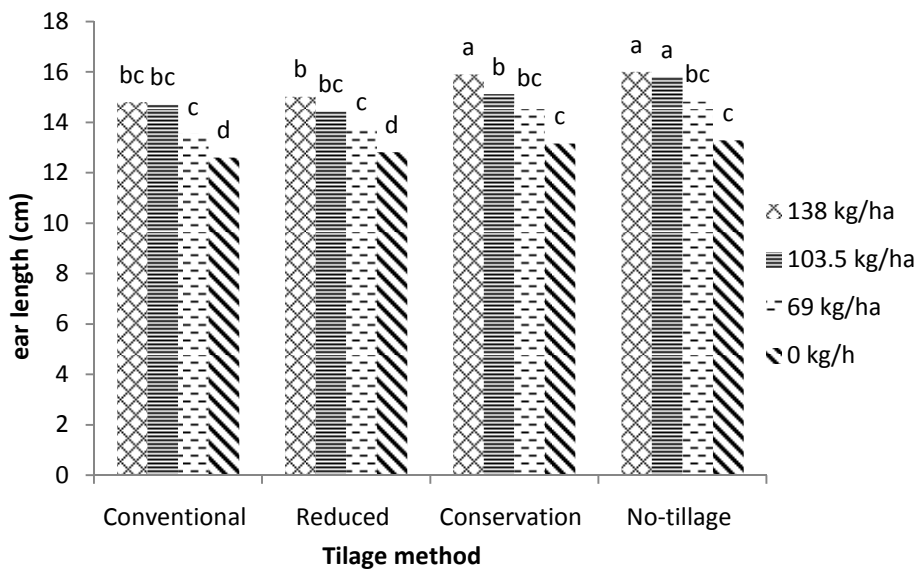


Figure 2- Mean comparison of residue management and nitrogen fertilizer management interaction effects for ear length (EL) in maize

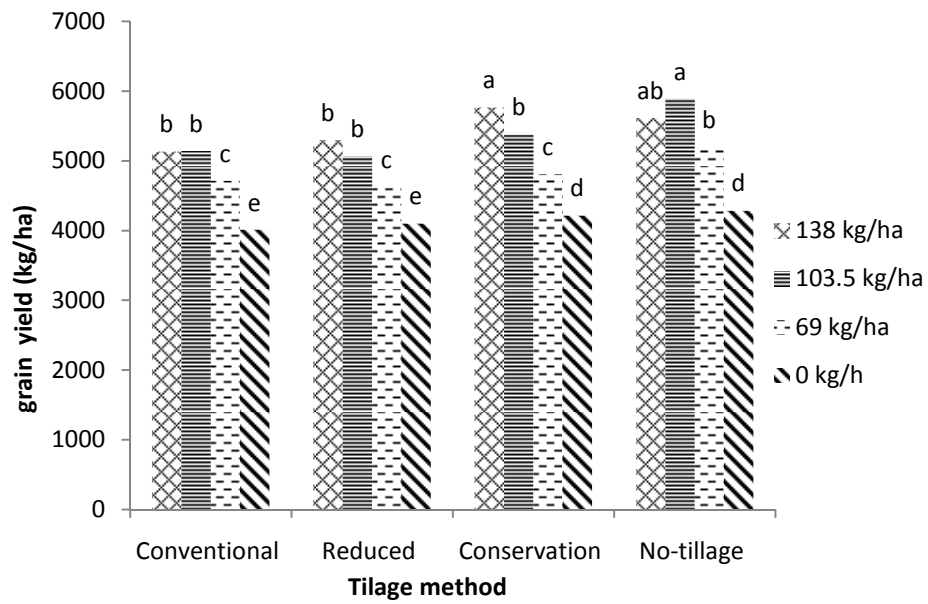


Figure 3- Mean comparison of residue management and nitrogen fertilizer management interaction effects for grain yield (GY) in maize

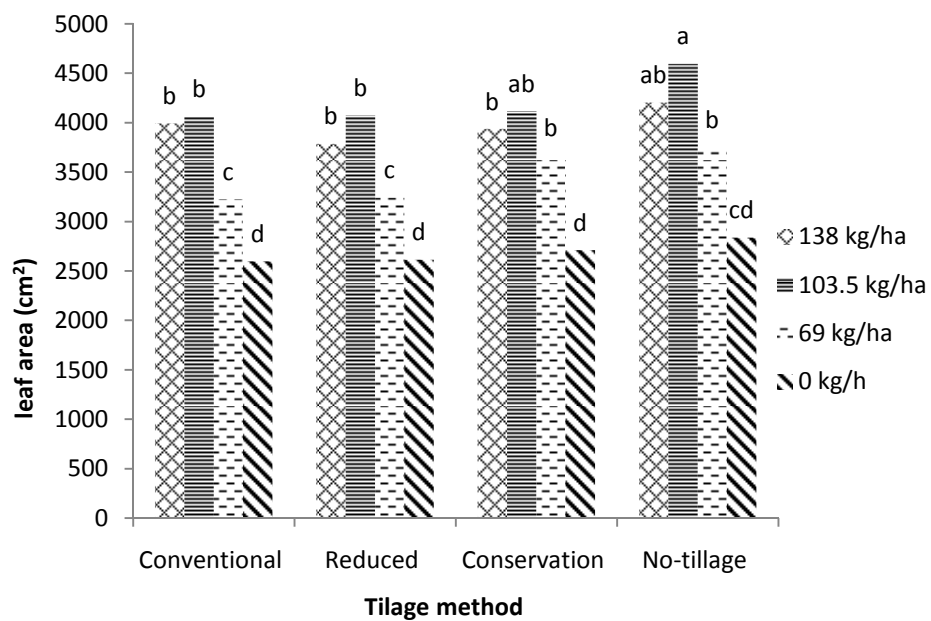


Figure 4- Mean comparison of residue management and nitrogen fertilizer management interaction effects for leaf area (LA) in maize

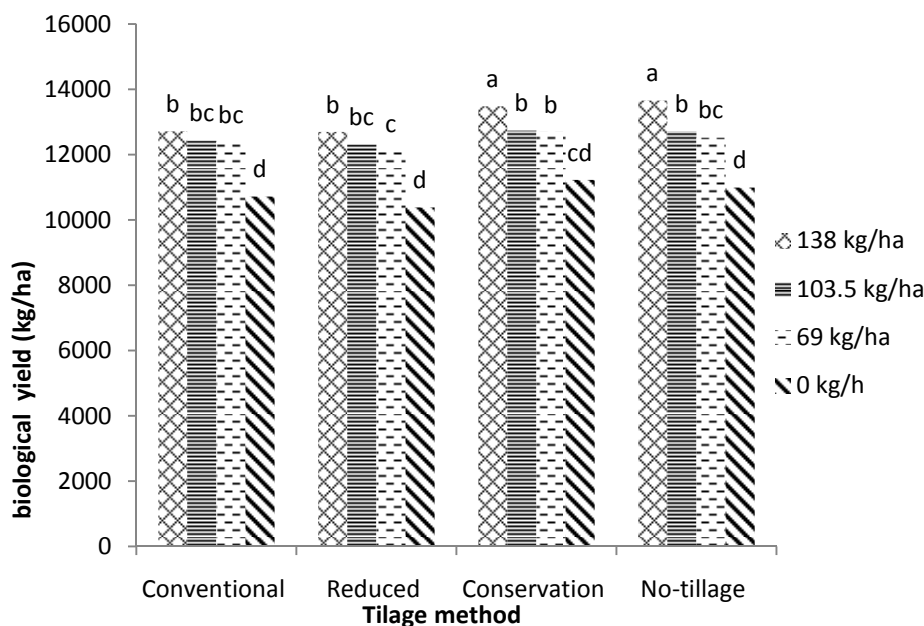


Figure 5- Mean comparison of residue management and nitrogen fertilizer management interaction effects for biological yield (BY) in maize

Harvest index (HI): Nitrogen fertilizer had a significant ($p < 0.05$) effect on harvest index (Table 1). The highest HI was related to using of 138 kg/ha N-fertilizer with 42.16 %. Furthermore, the HI variable decreased with reduction in using N-fertilizer (Table 3).

Since most of important traits in this investigation had been revealed high rates in no-tillage method with using 103.5 kg/ha of nitrogen, this treatment is suggested to be used in the region.

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