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Full Length Research Paper

The effects of tillage system and plant density on yield and yield components of corn (*Zea mays L.*) varieties in North of Iran

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In order to investigate the effect of tillage system and plant density on grain yield component in three varieties of corn, an experimental design, random complete block in a split factorial was used. Treatments arrangement was in quadruplicate in north of Iran in 2010. Main plot was subjected to tillage system in three levels: 1. Conventional system (CT). 2. Conservation system (RT) - chisel plough and multitiller. 3. No-tillage system (NT). Other factors were plant density in three levels (65000, 75000 and 85000 plant/ha) and three varieties of corn (500, 540, L.cv.sc 370). The results indicated that the grain yield and biological yield, which were affected by tillage system did not show any significant difference, while the grain yield and biological yield, which were affected by plant density and varieties showed significant difference. With the increase of density from 65000 to 85000 plants/ha, grain yield and biological yield decreased, respectively by an amount of 18.79 and 19.06. The reason for that was the decrease of some yield components, such as 1000 seeds weight, the number of grain in each row and the number of ear.

Key words: Corn, tillage system, density, variety, yield and yield component.

INTRODUCTION

Corn (*Zea mays L.*) is the most important grain forage crop in Iran. The average grain yield of corn is more than 8 ton/he and it increase annually. In order to optimize the use of moisture, nutrients and solar radiation, corn seeds must be planted under optimum density and tillage system. Intensive production of field crops practiced until recently to achieve high yields required intensive tillage and application of other high-technology inputs. This concept, however, implies a number of problems, among which relationship between product quality and quantity are in the foreground, along with increase crop production which shows an important ecological sustainability. Above all, farmers approach production in terms of the cost effectiveness of the applied system (Kisic et al., 2010). The traditional, conventional soil tillage, with all its advantages for crops grown, has also some adverse side effect, mainly in the domain of physical, chemical and biological complex of soil fertility, which intensifies soil degradation (Basic et al., 2004) and environmental pollution (Kisic et al., 2005). Possible solutions to these problems lie in the domain of soil tillage, that is, in the concept of more or less reduced tillage, which encompasses the so-called conversion, minimal, rational, or no-till systems (Barkerde et al., 2006). These systems can be defined as tilling practices with the number of treatments reduced by a certain percentage (Barkas et al., 2008). Different concepts of reduced tillage have appeared in order to solve problems of soil erosion induced by water and wind, storage of water in arid regions to prevent underground water pollution and to reduce climatic stress impact (Barkas et al., 2009), as well as to reduce energy consumption,

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Table 1. Weather condition in experiment site during corn growth stages.

Variable	May	June	July	August	September	October	November	December
Minimum tem. (°C)	13.6	18.2	22	21.4	19.4	15.7	11.5	4.9
Maximum tem. (°C)	22	26.7	31.4	29.2	28.2	25.3	21.1	14.6
Evaporation (mm)	93.7	166.6	136.3	199.7	187.1	142.6	87.4	81.5
Precipitation (mm)	35.2	29.6	0.1	56.4	171.9	84.4	173.5	81.9

primarily of crude oil and its derivates. Current area under reduced tillage is not negligible. There are 95 million hectares under no-tillage system in the world; 35% are in the USA, 22% in Brazil, 15% in Argentina, and 14% in Australia. Regarding the application of no-tillage technology, 96% of areas are in the two Americas, while only 4% are in the rest of the world. In European countries, reduced tillage has not been accepted to the extent that it could be realistically expected in view of their agro-ecological conditions. This is partly due to different approaches given to the concept of soil tillage as well as an encumbrance of tradition. Selection of desired density has too much effect on herbal yield component. So with the selection of desired plant density, appropriate yield can be produced. Corn is among the least tolerant of crops to high plant population density. Crop growth rate is directly related to the amount of radiation intercepted by the crop. Therefore, the response of grain yield to narrow rows can be analyse in terms of the effect on the amount of radiation intercepted at the critical periods for kernel set. In some cases, full radiation interception during these periods may not be achieved with wide rows. Andrade et al. (2002) found that corn yield response to decreased row spacing was negatively correlated to radiation interception at pollination time with the wider spacing. Akman (2002) stated that plant height and ear yield of sweet corn increased as the plant density increased, but ear length, ear diameter and filled ear length decreased in high plant density. Raising of corn plant population from 5333 to 88888 plants he significantly increased the fresh ear yield. Akbar et al. (1996) reported that the best sowing density in corn was 100000 plants he. It can be inferred that with the increase of plant density, light that reaches the bottom of canopy is increased and rivalry between plant organs for more absorption of radiation increases and on the other hand, destruction of light-auxin does not take place, so the collection of these factors can cause growth in interned length and growth of ear and ear height. This experiment was conducted to determine the best plant density and tillage system for modern long term maturity of corn variety in the North of Iran.

MATERIALS AND METHODS

The study was conducted at the Research Center of Agricultural and Resource Mazandaran, Qarakheil, Qaemshahr, Iran (36 27 N. 52 51 E) in 2010. The weather in this zone has an annual temperature of 23°C and receives annual rainfall of 600 to 700 mm from May to December. Weather condition in the experiment site is summarized in (Table 1). The soil analysis shows that the soil type was classified as clay loam. Some of its properties are as follows: 43, 32 and 25 g/kg clay, silt and sand, respectively; organic matter, 1.18 g/kg; pH, 7.4; 0.28, 35.8 and 250 available N, P and K, respectively. Before seeding, soil available N, P and K were determined for depths (0 to 30 cm).

This experiment was laid out in split-factorial on the basis of randomized completely block design with four replication tillage system in three levels (No-tillage system, conventional tillage – plough, disk harrow, seedbeds preparation implement and conservation tillage – chisel plough, multitiller). Other factors were plant density in three levels (65000, 75000 and 85000 plant/ha) and three varieties of corn (500, 540 and L.cv.sc 370).

Tillage systems include:

1. No-tillage system (NT)
2. Conventional tillage – plough, disk harrow, seedbed preparation implement (CT)
3. Conservation tillage – chisel plough, multitiller (RT)

The previous crop at the site was wheat. The plot size (experimental unit) was 6 by 7 m. The plot was overplanted and hand-thinned to achieve the desired plant densities. NPK fertilizers were applied according to yield potentials and soil test level (P and K) to the site. Fertilizer used as N. P. .K (200-100-100) were made from urea, triple super phosphate and potassium sulfate. The experimental site received 92 Kg N ha broadcast after plowing (before planting) and a further 46 kg N ha splitted in half and side dressed for 35 and 40 days after planting (at the fifth leaf stage). Hand weeding was practiced to control weeds. Ten plants (excluding border plants) were randomly selected from each plot prior to harvesting in an area of 7 m^2 and the moisture content was adjusted to 14%. All statistical tests were done using statically analysed system (SAS, Institute, 1996) and mean values were compared by Duncan (1984), Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Tillage system

Tillage system has a significant effect on biological yield and harvest index at 0.01 probability level. Also tillage system had significant effect on number of leaf at 0.05 probability level (Table 4). The highest harvest index was obtained in no-tillage system and the lowest harvest index was obtained in conventional tillage (CT) (Table 5). The highest biological yield was obtained in conventional tillage (CT) (Table 5). The highest number of leaf was obtained in conservation tillage (RT), but the lowest number of leaf was obtained in no-tillage system (NT)

Table 2. Main square effects of tillage system, plant density and varieties on ear length, number of rows in ear, number of grain/row, number of ear and ear diameter.

Source of variation	Df	Ear length	Number of rows per ear	Number of grain/row	Number of ear	Ear diameter
Replicate	3	1.65	3.19	16.88	0.01	9.64*
Tillage system (A)	2	7.55	0.12	16.79	0.01	1.46
Error	6	3.15	1.27	9.31	0.01	1.68
Plant density (B)	2	21.83**	1.25	70.52**	0.02	26.88**
A×B	4	0.93	0.45	4.81	0.01	3.92
Varieties	2	259.52**	136.13**	915.51**	0.03**	910.37**
A×C	4	0.64	0.28	3.43	0.01	2.71
B×C	4	4.46**	0.60	14.51	0.01	20.49*
A×B×C	8	1.95	0.95	6.29	0.01	9.16
Error	72	1.34	0.57	7.37	0.01	7.19
%C.V.	-	7.52	5.18	9.71	7.73	6.46

*, ** significant at 0.05 and 0.01 probability level.

Table 3. Main comparison effects of tillage system, plant density and varieties on ear length, number of rows in ear, number of grain/row, number of ear and ear diameter.

Treatments	Ear length (cm)	Number of rows per ear	Number of grain/row	Number of ear	Ear diameter (mm)
Tillage system					
(NT)	15.10 a	14.58a	27.56 a	0.99 a	41.60 a
(CT)	15.96 a	14.53 a	28.76 a	1.02 a	41.64 a
(RT)	15.24 a	14.65a	27.59 a	0.99 a	41.27 a
Plant density					
65000 plant/ha	16.16 a	14.80 a	29.13a	1.01 a	41.96 a
75000 plant/ha	15.52 a	15.51 a	28.36 b	1.01 a	42.05 a
85000 plant/ha	14.61a	14.46 a	28.41 b	0.97 b	40.51 b
Varieties					
L.cv.sc 370	13.62 c	12.81 c	22.65 c	1.03 a	35.77 c
L.cv.sc 500	14.16 b	16.67 a	28.57 b	1.00 ab	45.15 a
L.cv.sc 540	18.52 a	14.28 a	32.68 a	0.97 b	43.59 b

Means with similar letter(s) in each column are not significantly different at the 0.05 probability level according to Dancan's multiple rang test.

(Table 5). Ahmad (2007), in an experiment on the wheat plant, reported that the maximum wheat plant height resulted from minimum tillage (70 cm) and minimum wheat plant height resulted from no-tillage system (58 cm). Wang and partners (2006), in an experiment on wheat during 6 years with three tillage system concluded that average grain yield under tillage system was at least 8% more than the grain yield under conventional tillage system at 5% probability level. Tillage treatment had at least the highest yield (5604 ton/ha). Husnjak (2002) and partners, in an experiment there found that the highest yield of soybean in the first experimental year was achieved under CT system and the lowest under CP system. In all other experimental years, the highest yield of winter wheat and soybean was achieved under CM system, while the lowest under RT system.

Planting density

Plant density has a significant effect on grain yield, biological yield, 1000 seeds weight, number of grains/row, and ear length at 0.01 probability levels; also plant density had significant effect on plant height and number of ears/plant at 0.05 probability level (Table 2 and 4). The highest grain yield, biological yield and its lowest grain yield and biological yield was produced

Table 4. Main square effects of tillage system, plant density and varieties on plant height, number of leaf, 1000 seeds weight, grain yield, biological yield and harvest index.

Source of variation	Df	Plant height	Number of leaf	1000 seeds weight	Grain yield	Biological yield	Harvest index
Rep.	3	2787.79*	8.72**	1132.20	1.62	2.06	6.62
Tillage system (A)	2	1752.21	4.02	549.27	2.44	2.05	260.27**
Error	6	612.06	0.90	843.65	1.81	2.06	69.70
Plant density (B)	2	572.73*	0.14	7515.71**	10.28**	2.07**	50.76
A×B	4	183.86	0.77	1108.72	0.43	2.05	14.40
Varieties	2	14709.05**	9.84**	16806.37**	77.88**	2.09**	1045.79**
A×C	4	37.40	0.63	399.83	0.41	2.05	2.94
B×C	4	40.05	0.17	949.10	1.25	2.06	102.42*
A×B×C	8	37.00	0.23	1207.48	1.08	2.05	52.35
Error	72	167.50	0.36	936.79	0.77	2.06	41.45
%C.V.	-	7.18	4.44	10.37	17.05	19.88	13.33

*, ** significant at 0.05 and 0.01 probability level.

Table 5. Main comparison effects of tillage system, plant density and varieties on plant height, number of leaf, 1000 seeds weight, grain yield, biological yield and harvest index.

Treatments	Plant height (cm)	Number of leaf	1000 seeds weight (g)	Grain yield (t/ha)	Biological yield (t/ha)	Harvest index
Tillage system						
(NT)	172.9 a	13.13 b	290.6 a	4.98 a	9.98 b	51.21 a
(CT)	186.8 a	13.61 ab	297.5 a	5.45 a	12.11 a	45.76 b
(RT)	180.8 a	13.78 a	297.2 a	5.01 a	10.58 b	48.01 ab
Plant density						
65000 plant/ha	182.0 a	13.49 a	304.4 a	5.64 a	12.06 a	46.95 a
75000 plant/ha	182.9 a	13.46 a	302.5 a	5.21 b	10.85 b	49.18 a
85000 plant/ha	175.6 b	13.58 a	278.5 b	4.58 c	9.76 c	48.76 a
Varieties						
L.cv.sc 370	158.3 c	13.11 b	287.7 b	3.53 c	7.31 c	48.90 b
L.cv.sc 500	183.9 b	13.31 b	278.1 b	5.50 b	13.03 a	42.63 c
L.cv.sc 540	198.2 a	14.10 a	319.4 a	6.41 a	12.33 b	53.36 a

Means with similar letter(s) in each column are not significantly different at the 0.05 probability level according to Dancan's multiple rang test.

respectively in 65.000 and 85.000 plant/ha (Table 5). With an increase of density, 1000 seeds weight decreased so that the increase of density from 75000 to 85000 plants/ha, the weight of 1000 seeds had 7.9% reduction (table 5). The highest number of grain/row was obtained from the density of 65.000 Plant/ha and with increase of plant density, number of grain/row was decreased (Table 3). With the increase of density, the height of plant decreased so the lowest plant height and ear diameter were obtained from the density 85000 plants/ha (Table 5).

Shakarami and partners (2009), in investigating three plant density (7, 10 and 13 plant m^2) of corn recognized that the highest grain yield, harvest index, number of grain row and number of grain ear was produced in 10 plant m^2 and the highest biological yield obtained from 13 plant m^2. Kisic (2010) in the study of crop yield and plant density under different tillage systems found that the plant density and yields of maize, soybean, oilseed rape, winter wheat and spring barley point to the conclusion that high density crop (winter wheat, spring barley and oilseed rape) are suitable for growing under reduced tillage systems. Yield of low density spring crops (maize and soybean) obtained under the no tillage system are not satisfactory, especially in climatically extreme years. Tetio-Kagho and Gardner (1988) reported that with the increase of plant density, herbal density causes resonance rivalry between plants for absorption of environmental resources and so stem diameter which is affected decreases.

Effect of varieties

The corn varieties had significant effect on all the variable of this study at 0.01 probability level (Tables 2 and 4). The highest grain yield, harvest index, 1000seeds weight, ear length, number of grain/row, number of leaf, number of ear and plant height was obtained in L.cv.sc 540 variable; also the highest biological yield, was produced in L.cv.sc 540 variable (Tables 3 and 5). The highest number of ear and lowest number of rows per ear was obtained in L.cv.sc 370 variable (Table 3).

Hasan (2000) in an experiment with 8 varieties of corn in the densities of 48, 57 and 71 thousand plant/ha concluded that with the increase of density, ear length, ear diameter, the number of grain in each row, 100 seeds weight decreased and plant height, ear weight and grain yield increased. Radrikas and partners (2003) reported that yield and yield component of corn varieties in 2 densities of 55.000 and 110.000 plants/ha of 21 Hybrid single cross and 13 Inbreed line with a commercial witness were significantly affected by plant density (Rodrigues et al., 2003).

Interaction effects

The statistical analysis of the data shows that there were significant differences in harvest index, ear diameter and ear length due to different plant density × variable interactions. Interaction effect mean showed that there were no significant differences among varieties and density in different tillage system (Tables 2 and 4). Results show that the highest ear length was obtained in 65.000 plant/ha density in the case of L.cv.sc 540 variety while the lowest ear length was obtained in 85000 plant/ha density.

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REFERENCES

Ahmad T, Samara NH (2007). The effect of tillage practices on Barely production under rainfed conditions in Jordan. American-Eurasian. J. Agric Environ. Sci., 2(1): 75-79.

Akman Z (2002). Effect of tiller removing and plant density on ear yield of sweet corn (Zea mays sacharata sturt). Pak. J. Bio. Sci., 5(9): 906-908

Andrade FH, Calvino P, Cirilo A, Barbieri P (2002). Yield responses to narrow rows depend on increased radiation interception. Argon. J., 94: 975-980.

Duncan WG (1984). A theory to explain the relationship between corn population and grain yield. Crop Sci., 24: 1141-1145.

Husnjak S, Filipovic D, Kosutic S (2002). Influence of different tillage system on soil physical properties and crop yield. Rostlina Vyroba, 48(6): 249-254.

Kisic I, Basic F, Birkas M, Jurisic A, Bicanic V (2010). Crop Yiehd and Plant Density Tillage systems. Agriculturae Conspectus Scientificus, 75(1): 1-7.

Rodrigues R, Silva L, Mori E (2003). Baby corn single-cross hybrids yield in two plant densities. Crop Breeding, 3: 177-184.

Shakarami G, Rafiee M (2009). Response of Corn (Zea mays L.) to planting pattern and density in iran. American-Eurasian J. Agric. Environ. Sci., 5(1): 69-73.

Tetio-Kagho F, Gardner FP (1988). Response of maize to plant population. II: reproductive development on yield and yield adjustment. Agron. J., 80: 935-945.

Wang XB, Oenema O, Hoogmoed WB, Perdok UD, Cai DX (2006). Dust storm erosion and its impact on soil carbon and nitrogen losses in northern China, Catena, 66: 221-227.