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Effect of fertigation on amount of protein, yield and yield components of corn

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Abstract

To study effect of furrow fertigation on amount of protein, yield and yield components of corn, a field experiment was conducted in Seed and Plant Improvement Institute of Karaj, Iran in the summer of 2012. The study design was a factorial design based on randomized complete block with 4 replication. First factor (N) includes three fertilizer levels of 60%, 80% and 100% recommended fertilizer value and the second factor (T) includes two split application fertilizer levels (four and three split application). The nitrogen required for the plant is provided by urea fertilizer and used along with water irrigation. Finally, these 6 treatments were compared with traditional fertilizer application method (Control). The results showed that treatment of 80% and 100% recommended fertilizer has not a significant difference with amount of protein. Therefore, 80% recommended fertilizer in four split application is recommended for increase of protein. The results in terms of yield of corn showed that 60% fertilizer in four split application has the most yield. In addition, the results showed that fertigation comparing method of surface fertilizer distribution increases yield and yield components. Therefore, fertigation is recommended as fertilizer management choice comparing traditional method of fertilizer distribution.

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Introduction

Whereas corn is very important in human and animal food program and considering to high power of corn production and high per capita use of this product in various countries, priority of agricultural researches is to study and find some approaches for qualitative and quantitative increase of corn and as a result, it feels more effort for more and economical production of this product (Cocks, 2003). Nitrogen is the most important high used food element that has a role in structure of various protein molecules, enzymes, co-enzymes, nucleic acids and cytochromes (Hassegawa *et al.*, 2008). Various tests showed that nitrogen affects on quality and quantity of corn. Many researchers have showed that nitrogen can increase protein of corn (Rending and Broadbent., 1979; Tsai *et al.*, 1990). In a study by Olike *et al.*, (1998), amount of protein of corn increased for all tested hybrids by increasing nitrogen fertilizer from zero to 120 Kg per hectares.

Corn as the third important grain of the world, is nitrogen fond plant that needs to nitrogen fertilizer to grow in case of being other conditions favorable. This case is more important in soils with low fertility. According to studies of Simpson *et al.*, (1989), lack of nitrogen at germination stage of corn, decrease number of rows in ear so that it can be its amends is not possible by using sufficient nitrogen at next step. Ears has a normal status in plants with lack of nitrogen but their end has not grain and the grains are simply separated (Anderson, 1984). Prasad and Singh (1990) observed that height of bush, length of ear, weight of one thousands corn, weight of ear and grain yield increase at various varieties of corn by increasing nitrogen. Sufficient distribution of nitrogen fertilizer plays an important role in yield of corn. Up to now, comprehensive researches have been performed about effect of nitrogen fertilizer installment on yield and yield components of corn and each research has been performed about different hybrids at different countries.

Vig (1986) gained the highest amount of yield components and production of corn by distribution of nitrogen at beginning of ear stage. Rhoads *et al.*, (1987) in a study about soil with light tissue concluded that using nitrogen fertilizer during growth season several times increased yield of corn than same amount use of fertilizer at one or two stage during growth season. Caraniwan (1990) concluded that height of bush and ear increased by more use and split application of nitrogen fertilizer. Sharma and Thakur (1995) reported that grain yield of early corn is very much when nitrogen fertilizer is equally used at cultivation stage, 8 leaves stage and pre tasseling stage, while Padmavathi and Gopalaswamy (1995) reported the most yield by basic 25% plus 50% at 8 leaves stage plus 25% at tasseling stage. Akbar *et al.*, (1999) reported that two third use of nitrogen fertilizer at planting time and one third at tasseling stage improved vegetative growth and natal growth of corn significantly. In modern agriculture, use of chemical fertilizers is inevitable as the best way if correct nutrition of the plant to improve qualitative and quantitative production of the plant. Researchers showed that qualitative and quantitative yield of corn can be increased by suitable selection of agricultural factors including correct use of nutrients (Kogbe and Adediran, 2003). Now, use of nitrogen fertilizer and water (Fertigation) is generalized at different methods of irrigation. In this method, there is possibility of low, repeated and split application of nutrients during growth period according to need of the plant. Also, invariable distribution of fertilizer on soil is possible during growth period. Results of research showed that fertigation increased yield and quality improvement of the product (Mousavifazl *et al.*, 2009). Hochmuth *et al.,* (1996) studying effect of fertigation on yield of strawberry in a loom sandy soil showed that there is more yield by using 25% to 50% use of fertilizer less than common methods of fertilizing. Dasberg and Or (1999) reported fertigation decreased loss of fertilizer and increased efficiency of its use. Lamm *et al.*, (1997) showed in a four years test by drip irrigation of corn that fertigation increased yield and water use efficiency three times more than surface distribution methods. Granberry *et al.*, (2000) also reported that more yield and better quality can be gained by using 20% to 50% less

fertilizer in fertigation method than common methods of fertilizing. According to results of Asadi's studies (2004), fertigation at Sprinkler irrigation, caused uniform distribution of fertilizer and increased efficiency of its use. Alizadeh *et al.*, (2009) reported that yield of corn is significantly affected by amount of irrigation and used fertilizer. Result of their studies showed that fertigation increases water and fertilizer use efficiency by providing possibility of split application fertilizer based on need of the plant during growth period.

Therefore, our objective was to compare the effect of different amounts of fertilizer and split application fertilizer at sensitive stages of growth in fertigation method on protein, yield and yield components of corn and compare it with normal method of fertilizing.

Materials and methods

Experimental site

This research carried out in Seed and Plant Improvement Institute, in Karaj located at 48′, 35˚ latitude and 10′, 51˚ east longitude and 1312 meters above sea level, in crop year 2012-13.

Experimental design

The experimental design was A factorial based on randomized complete block design with 4 replicates. First factor (N) includes three fertilizer levels of 60%, 80% and 100% recommended fertilizer value and the second factor (T) includes two split application fertilizer levels (four and three split application). At four split application, amount of fertilizer is used at 4-6 leaves stage, 10 leaves stage, tasseling stage and insemination stage and also at three split application, amount of fertilizer is used at 4-6 leaves stage, 10 leaves stage, tasseling stage. Finally, these 6 treatments were compared with traditional fertilizer application method (Control). Control treatment is attributed to a treatment in which amount of fertilizer is applied according to custom of the region (400 Kg urea per hectare). In this treatment, the fertilizer was added in two equal split application by surface distribution method (50% before cultivation, and 50% at 4-6 leaves stage). Required nitrogen of the plant is provided by urea fertilizer and used along with water in treatments of fertigation. Triple super phosphate fertilizer was used in amount of 200 Kg per hectare in 10 centimeters depth of soil. The used seed was hybrid single cross 260 which was planted as 85000 density of bush per hectare. Fives furrows was considered for each treatment including three main furrows for harvest, two marginal furrows as border and two furrows for separation of each block. Distance of furrow banks is 75 cm and length of agricultural plot is about 120 meters. A 20- liter tank with a tap for fertilizer emission was used for injecting fertilizer to furrows. In this research, considering to tests of Abbasi *et al.*, (2008) and Alizadeh *et al.*, (2010) and also results of test of Playan and Faci (1997), the fertilizer was injected at the last 15 minutes of irrigation.

Measurements

100 grams of corn in each replication was selected and amount of total nitrogen of each sample was measured by Macrokejeldal to determine percent of protein of corn. Then, percent of protein was gained by product of percent of protein in stable factor of 6.25 (Nelson, Sommers, 1973). Yield components of corn including thousands seed weight, number of seeds in row and number of rows in ear were measured at final harvest by random sampling of 20 bushes. After removal of product, final grain yield was calculated for all treatments at 14% humidity.

Statistical analysis

Data were analyzed by MSTAT-C software and the averages were compared by Duncan test.

Results and discussion

Amount of protein

As seen in table (1), effect of nitrogen fertilizer and nitrogen split application on amount of protein of corn is significant at 1% level. The results showed that amount of protein of corn increases by increase of nitrogen fertilizer (table 2). Rending and Broadbent (1979) and Oike *et al.*, (1998) represented that amount of protein of corn increases for all tested

hybrids by increase of nitrogen. More split application of nitrogen increased protein of corn (table 2). Tsai *et al.,* (1990) found that if nitrogen is used at several stages, amount of protein of corn will be more than when nitrogen fertilizer is used at cultivation stage.

Table 1. Variance analysis of percent of protein of grain, yield and yield components of corn.

		Means of squares				
S.O.V	df	protein of grain	weight of one thousands seed	number of seeds in row	number of rows in ear	Grain yield
Replication	3	1.016	42.375	2.782	0.388	1.485
Amount of fertilizer	2	3.049**	229.542**	10.565^{ns}	0.602^{ns}	0.030^{ns}
Fertilizer split application	1	5.377**	63.375^{ns}	134.427**	8.882**	0.304^{ns}
Amount of fertilizer* Fertilizer split application	2	1.461**	114.875*	2.532^{ns}	0.672^{ns}	1.426^{ns}
Error	15	0.402	21.442	5.269	0.888	0.414
Total	23	-	-	-	-	-
C.V(%)	-	8.21	2.07	6.52	5.95	8.67

*, ** and ns: Significant at the 0.05 and 0.01 probability levels and non-significant, respectively.

Weight of one thousands seeds

Effect of amount of nitrogen on this trait was significant at 1% level (table 1). Results show that increase of nitrogen from 60% to 80% of recommended fertilizer value increases weight of one thousands seeds significantly but 80% and 100% of recommended fertilizer value has not significant difference in terms of weight of one thousands seeds (table 2). Alizadeh Aghabagher (2012) showed that increase of nitrogen fertilizer from 60% to 80% of recommended fertilizer value increases weight of one thousands corn in fertigation method and also, 80% and 100% of recommended fertilizer value has not significant difference that is similar to results of this research. Comparing average of fertigation treatments, the most weight of one thousands seeds belongs to N_1T_1 (232.0 gr.) and the least one belongs to N_3T_1 (215.0 gr.) (table 3).

Table 2. Comparing average of simple effect Amounts of fertilizer and fertilizer split application on protein of grain, yield and yield components of corn.

	Means				
Treatment	Protein of grain (%)	weight of one thousands seeds (g)	number of seeds in row	number of rows in ear	Grain yield (t/ha)
Amounts of fertilizer					
N_1(100% recommended fertilizer)	8.44 a	228.1 a	38.8 a	15.5 a	7.45 a
N_2(80% recommended fertilizer)	7.41 b	225.3 a	35.9 a	16.0 a	7.35 a
N_3 (60% recommended fertilizer)	7.34 b	217.8 b	33.8 a	16.0 a	7.46 a
Fertilizer split application					
T_1(4 split application)	8.20 a	225.0 a	32.8 b	15.2 a	7.5 a
T_2 (3 split application)	7.26 b	222.0 a	37.6 a	16.5 a	7.3 a

Means in each column, followed by similar letter(s) not significantly different at 5% probability level.

Number of seeds in row and number of rows in ear

Effect of nitrogen and mutual effect of fertilizer and fertilizer split application is not significant on these two traits while effect of nitrogen split application on these two traits is significant (table 1). Results show that less split application of fertilizer increase number of rows in ear and number of seeds in row that is not similar to results of Alizadeh Aghabagher (2012). He reported that effect of nitrogen and nitrogen split application and mutual effect of both is not significant

on these two traits.

Grain yield

Effect of nitrogen and nitrogen split application and mutual effect of fertilizer and fertilizer split application is not significant on Grain yield at 1% possibility level (table 1). The results are not similar to results of Alizadeh *et al.*, (2009) and Alizadeh Aghabagher (2012).

Table 3. Comparing average of fertigation treatments and control.

	Means				
Treatment	Protein of grain (%)	Weight of one thousands seeds (g)	number of seeds in row	number of rows in ear	Grain yield (t/ha)
N_1T_1	8.95 a	232.0 a	34.0 bcd	15.2 b	7.17 a
N_1T_2	7.93 ab	224.3 bc	37.6 ab	15.8 ab	7.72 a
N_2T_1	8.29 ab	229.0 ab	33.0 cd	15.2 b	7.40 a
N_2T_2	6.52 c	221.5 cd	38.8 a	16.7 a	7.30 a
N_3T_1	7.37 bc	215.0 de	31.5 d	15.2 b	8.02 a
N_3T_2	7.31 bc	220.5 cd	36.2 abc	16.8 a	6.95 a
Control	8.82 a	209.3 e	36.0 abc	15.5 b	7.0 a

Means in each column, followed by similar letter(s) not significantly different at 5% probability level.

Alizadeh *et al.*, (2009) and Alizadeh Aghabagher (2012) studying effect of different amounts of nitrogen on yield of corn at fertigation method observed that increase of nitrogen increases yield of corn. Comparing averages of mutual effect of fertilizer and fertilizer split application at fertigation treatments showed that treatment of N_3T_1 with 8.02 tons per hectare and treatment of N_3T_2 with 6.95 tons per hectare had the most and the least yield of corn respectively (table 3).

Comparing averages of fertigation treatments and control

Results of variance analysis showed that there is significant difference of 5% between different treatments. Table 3 shows results of comparing average of studied traits between fertigation treatments and control according to Duncan test at 5% level. Results show that control treatment in terms of yield is less than all treatments of fertigation other than N_3T_2. In terms of weight of one thousands seeds, it is lower than all treatments of fertigation. Although, control treatment is set in one statistical group with treatment of N_1T_1 in terms of Amount of protein but as seen in table 3, its protein of corn is partly less than treatment of N_1T_1.

However, considering to classification of treatments and comparing average of control treatment and treatments of fertigation, control treatment using more fertilizer has less yield and yield components than fertigation method. Main reason of increase of yield in treatments of fertigation toward traditional method is to apply fertilizer split application based on need of plant and at times that plant needs more fertilizer. On the other hand, in fertigation method, fertilizer can be given in solution to plant that facilitate absorption of plant. In surface Distribution, farmers disseminate the required fertilizer of plant entirely in farm and more than 50% used fertilizer are lost (Wiesler, 1998).

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