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ORIGINAL ARTICLE

Evaluating the Effects of Different Methods of Supplying Nitrogen Fertilizer on Wheat yield

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ABSTRACT
To evaluate the split and the rates of nitrogen fertilizer on wheat yield, a study was conducted in crop year 2013-2014 at Agricultural Research Station of Islamic Azad University of Karaj in factorial way in a complete randomized block design with four replications. The treatments of this experiment included, three levels 200, 300 and 400 kg urea per hectare and covered sulphurous nitrogen split at three 200, 300 and 400 kg per hectare levels. Application of nitrogen fertilizer treatments on biomass features, grain yield, spike per square meter and the number of grains per spike in the probability of one percent of Duncan test became significant and the mentioned treatment became significant on grain weight at the 5% level of probability and on the rest of the features had no significance and between the rest of the features there was no significant difference. Treatment of various types of nitrogen fertilizer on biomass features, grain yield, spike per square meter, number of seeds per plant, grain weight and plant height in Duncan's multiple range test became significant at one percent level. Analysis of variance of yield components showed that nitrogen fertilizer treatment had no significant effect on all traits. This is while in various treatment of different types of nitrogen fertilizer on features the diameter of the second node, length of the second node and length of the third node the nodes at 1% of Duncan's multiple range test has become significant, and had no significant l effect on the remaining characters. Moreover, variance analysis table of the components shows that in the interaction between treatments only the length of the node three at one percent probability level has been significant.
Keywords: *impact assessment, nitrogen split, wheat, yield, Duncan*

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INTRODUCTION

Wheat is one of the country's strategic products and provides over 45 percent of protein and 55 percent of calories needed by people in our country. The area under wheat cultivation in Iran is 6.4 million hectares and of the land under wheat cultivation in the country, 36% is under water wheat cultivation and the rest 64% is allocated to rain-fed wheat [6]. Nitrogen is the main nutrient requirements of the wheat and managing its use is of great importance to be successful in increasing the production of wheat grain and wheat proteins. Nitrogen use efficiency is greatly affected by the amount, frequency (split) of consumption, source, time and method of use. The use of nitrogen in one goes causes the loss of this important nutrient and decreases its efficacy and causes contamination of underground water. Split application of nitrogen fertilizer (two to four) in addition to increasing performance improves grain quality [8]. Nitrogen is the most important fertilizer that affects grain yield and protein content of wheat [2]. Wheat needs nitrogen at different stages of its growth. Thus, using nitrogen fertilizer to the extent necessary and in time is important for this product [5]. Nitrogen application compared with control treatment increased tiller number, biomass, yield and components of wheat yield [4]. Late use of nitrogen in form of solution spray (providing storage nitrogen for wheat after emergence of cluster) increases grain protein, without the need for high use of nitrogen fertilizers. Dynamics and high mobility of nitrogen in the soil has made use time of particular importance for success in the production of grain and protein. Therefore, taking into account economic and environmental factors, one can return performance to the maximum amount possible with less losses. These goals can be achieved through appropriate procedures of consumption, consumption time and split application of nitrogen fertilizer during growing

periods. At the time of split of nitrogen consumption, the amount of fertilizer use and its time should be considered, and avoid unnecessary consumption of fertilizers in the stage of vegetative growth leading to plant lodging and yield reduction. With nitrogen consumption in a growth stage of the plant that has a set of active roots to absorb nitrogen fertilizer, one can stop waste of nitrogen through leaching as nitrate and sublimation [1]. Attention to this issue not only stops wasting funds of the farmer, but also prevents contamination of underground water or well water and other water supplies. Since the best time of nitrogen consumption is close to the time of maximum need according to wheat physiology of growth, so to prevent nitrogen leaching losses, it is better to use nitrogen in split diets. The results of [7] have demonstrated that nitrogen fertilizer use in the pollen and graining time increases the quality of grain. Reviews of [3] suggest the important role of nitrogen during the growing season on grain quality and quantity of the products and performance in parallel. In studying the effect of split application of nitrogen fertilizer on wheat yield in Ahvaz, [9] stated that the two-stage method of splitting (50 percent at planting and 50% at stem elongation stage) is economically more appropriate. Therefore, this study was presented to increase nitrogen use efficiency in order to achieve maximum yield potential of wheat in Karaj.

MATERIALS AND METHOD

This experiment was done in factorial form in form of complete randomized blocks with four replications at Research Farm of Islamic Azad University of Karaj. The treatments of this experiment included, three levels 200, 300 and 400 kg urea per hectare and covered sulphurous nitrogen split at three 200, 300 and 400 kg per hectare levels that will be applied by considering net fertilizer absorption coefficient to land as is shown in the table below.

R\#	# 1	# 2	# 3	# 4	# 5	# 6	# 7	# 8	# 9	# 10	# 11	# 12	# 13
R1	N0	N1L1	N1L2	N2L1	N2L2	N3L1	N3L2	N4L1	N4L2	N5L1	N5L2	N6L1	N6L2
R2	N6L2	N6L1	N5L2	N5L1	N4L2	N4L1	N3L2	N3L1	N2L2	N2L1	N1L2	N1L1	N0
R3	N4L1	N4L2	N5L1	N5L2	N6L1	N6L2	N0	N1L1	N1L2	N2L1	N2L2	N3L1	N3L2
R4	N1L1	N4L1	N1L2	N4L2	N0	N2L1	N5L1	N6L2	N3L2	N6L1	N3L1	N5L2	N2L2

N0: control group
N1: 46%Urea - 200 kilograms per hectare
N2: 46% Urea - 300 kilograms per hectare
N3: 46% Urea - 400 kilograms per hectare
N4: 35% SCU - 200 kilograms per hectare
N5: 35% SCU - 300 kilograms per hectare L1: split in 2 phases
N6: 35% SCU - 400 kilograms per hectare L2: split in 3 phases
First irrigation was done immediately after planting on November 13, 2013. The first section of fertilizer for treatments L1 and L2 was given on November 13, 2013 while planting, irrigation and the second section of fertilizer for treatments L1 and L2 were done on April 4, 2014, at 8-leaf stage, the third section of fertilizer of L2 treatments was given in hyacinth phase on May 5, 2014.
One hundred fifty kg of ammonium phosphate fertilizer per hectare had been given to land before planting. Use of chemical fertilizers was calculated and used based on soil test results (Table 1).

Table 1: Physico-chemical analysis of the experiment soil

Soil depth	Silt percent	Percentage of clay	Percentage of sand	PH	Texture	The electrical conductivity Mm Mouse cm	Saturation	Total nitrogen	Organic carbon content
0-30	54	20	26	7.8	Sandy clay loam	1.43	91.44	0.01	1.17

Data analysis using SAS 9.1 software and drawing graphs using Excel software and for comparing the effects of each treatment, Duncan test will be used .

RESULTS AND DISCUSSION

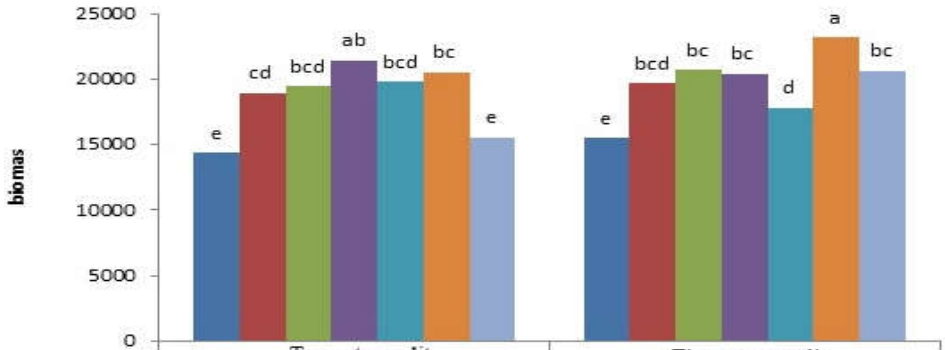
Analysis of variance for spring wheat yield components showed that split use of nitrogen fertilizer on biomass, grain yield, spike-square meters and the number of grains per spike in the level of 1% Duncan test is significant, and it is significant on the weight of a thousand seed at 5% level.

Various sources of nitrogen fertilizer in Duncan's multiple range test was significant at the one percent level on biomass, grain yield, spike per square meter, number of seeds per plant, one thousand grain weight and plant height. The interaction between nitrogen fertilizer sources and application of nitrogen fertilizer on biomass, harvest index, and number of grains per spike in the probability has become significant at 5% level of Duncan's multiple range test (Table 2).

Table 2- Analysis of variance for wheat yield components

Sources of changes	Degrees of freedom	Biomass	grain performance	Harvest index	The number of spikes per square meter	The number of grains per spike	the weight of one thousand seeds	Plant length	Spike length	Diameter of spike
Repetition	3	560432.8ns	5228577.2ns	13.38ns	7226.30ns	1.61ns	4.04ns	71.39**	5.03*	2.21ns
Split application of fertilizer	1	17721900.1**	48876671.5**	6.92ns	46389.33**	78.32**	64.17*	26.23ns	73.0ns	0.00094ns
Nitrogen fertilizers	6	40384093.0**	19371040.3**	353.33**	12624.91**	114.35**	147.43**	94.65**	0.61ns	2.92ns
Interaction	6	10820353.1**	3730130.5ns	145.16**	7452.43ns	49.81**	15.84ns	86.30*	2.37ns	2.53ns
error	39	0.61569688	1997620.1	24.58	3703.44	6.2	12.65	22.12	1.31	3.24
Coefficient variation	-	6.54	17.55	12.44	12.61	6.54	8.8	4.59	13.46	15.6

ns,.*,: Non-significant Significant at 5% and 1% probability levels, respectively**



	Two- step split	Three- step split
Control	14365.6	15508
N2 200	18972.2	19666.7
N2 300	19441.7	20680.6
N2 400	21444.4	20402.8
Nsu 200	19791.7	17833.3
Nsu 300	20486.1	23230.6
Nsu 400	15583.3	20637.5

Figure 1. Changes in interactions and split application of nitrogen fertilizer on wheat biomass yield

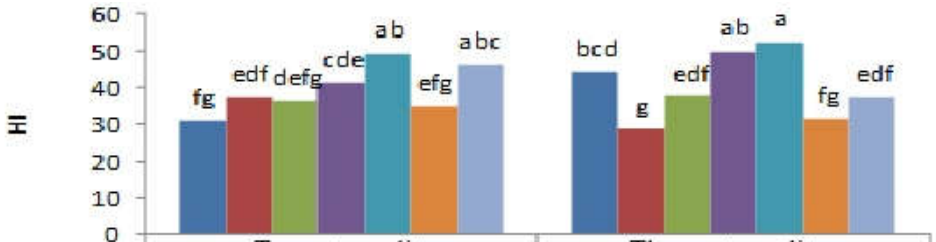
Biomass

As is seen in the plot of the mutual change effects of different types of nitrogen fertilizer with split application on wheat biomass yield, nitrogen fertilizer with a combination of sulfur fertilizer 300 kg in three-stage split has had the highest biomass yield with an average of 23230.6 kg per hectare on wheat and was placed in grouping of Duncan test.

Looking at the chart above, three-stage nitrogen fertilizer split has greater impact on biomass compared to two-step split. The two-step split in the highest rate of nitrogen fertilizer with sulfur compounds at a rate of 400 kg per hectare with an average of 15583.3 kg ha minimal has the least impact on biomass yield in spring wheat and this average is placed in group e of Duncan test at 5% likelihood .

Thus, as Figure 1 shows, the recommended treatment is three-split nitrogen fertilizer at a rate of 300 kg per hectare with sulfur compounds. This is while the increase of fertilizer more than 300 kilograms reduces the amount of biomass in spring wheat.

As the plot of the interaction of different types of nitrogen fertilizer and fertilizer splitting on the harvest index shows, the nitrogen fertilizer with a combination of sulfur fertilizer 200 kg in three-stage split into manure highest biomass yield with an average of 328.52 kg per hectare on wheat was in group a in Duncan test . Looking at the chart above, generally, split three-stage nitrogen fertilizer compared to two-step split biomass has shown the greatest impact. This is while three-stage split with 200 kg nitrogen ha with an average of 548.28 kg ha has the least effect on wheat harvest index in spring and this average is in group g of Duncan test at 5% probability level. Thus, as Figure 1 results show, the recommended treatment is three-stage split of nitrogen fertilizer at a rate of 200 kg per hectare with sulfur compounds. This is while an increase of more than 200 kilograms of fertilizer reduces the amount of biomass in spring wheat. Among two-stage split treatments, 200 kg treatment of nitrogen per hectare with sulfur has the highest yield with an average of 49.348 kg than other treatments.



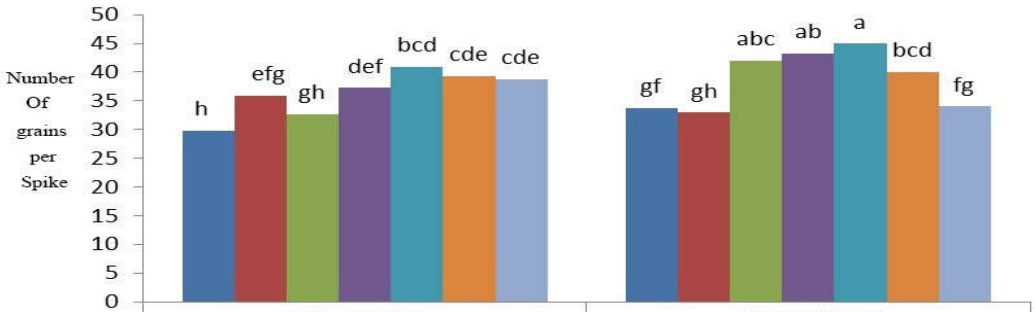
	Two- step split	Three- step split
Control	30.633	44.133
N2 200	37.488	28.548
N2 300	36.355	37.583
N2 400	41.458	50.023
Nsu 200	49.348	52.328
Nsu 300	34.86	31.485
Nsu 400	46.348	37.313

Figure 2. Change interactions and split application of nitrogen fertilizers on the Harvest index

The number of grains per spike

Split application of nitrogen fertilizer plot interactions on the number of grains per spike showed that treatment with 200 kg N ha sulfur compounds in split three-step has the greatest impact on the spike in average grain with an average of 44.95 that is in group a of in Duncan test at 5% likelihood. Therefore, as can be seen in the diagram, by increase in the amount of fertilizer, the amount of seeds per ear gradually reduces, which have less steep in two-step split than in two-step split. And in two-step split treatment of 200 kg of nitrogen with sulfur compounds with an average of 40.933 seed is the best treatment.

This is while the control group has the lowest number of grains per spike and in grouping of Duncan; it is in the last group. As the chart shows, nitrogen fertilizers had a positive effect on the number of grains per spike.



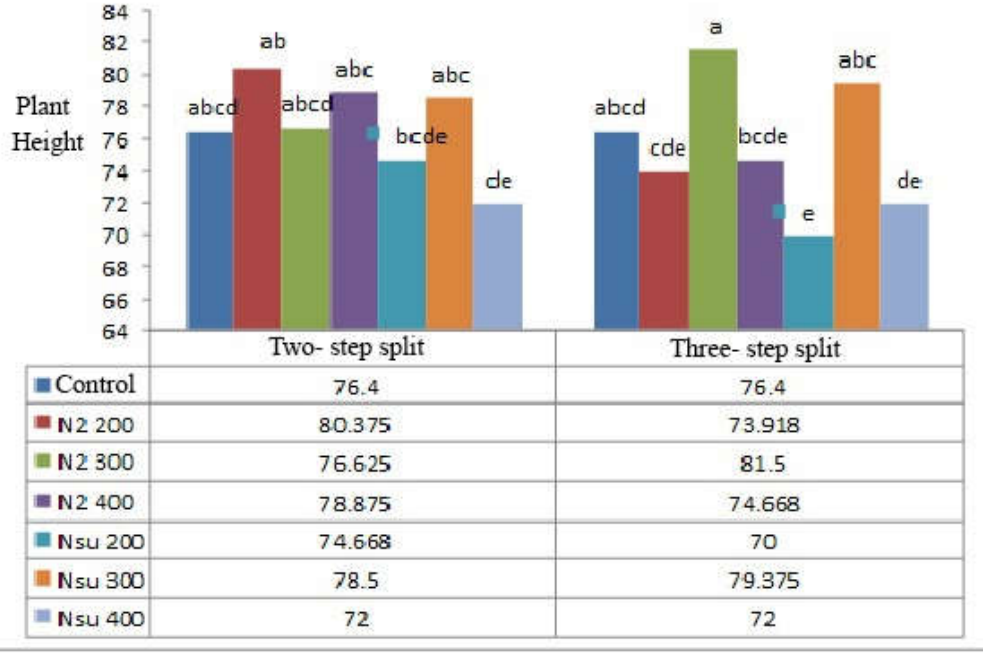
	Two- step split	Three- step split
Control	29.75	33.75
N2 200	35.868	32.913
N2 300	32.6	42.04
N2 400	37.218	43.208
Nsu 200	40.933	44.95
Nsu 300	39.278	40.05

Chart 3. Changes in interactions of nitrogen and fertilizer splitting on the number of grains per spike

Plant height

As the plot interactions with split application of nitrogen fertilizer on the plant indicates, treatment with 300 kg nitrogen in three-stage split has the greatest impact on the plant length with an average of 81.5 and this treatment is in group a in Duncan's grouping at 5% likelihood. Thus, as can be seen in Figure 4, an increase in the amount of fertilizer reduces plant height. These results have less steep in two-stage split compared to two-step split. And in two-step split in treatment of 200 kg of nitrogen fertilizer with an average of 80.375 is the best treatment.

This is while; 200 kg treatment of nitrogen with sulfur compounds in three-stage split has the least plant length and placed in the last group in grouping of Duncan.



	Two- step split	Three- step split
Control	76.4	76.4
N2 200	80.375	73.918
N2 300	76.625	81.5
N2 400	78.875	74.668
Nsu 200	74.668	70
Nsu 300	78.5	79.375
Nsu 400	72	72

Figure 4. Changes in interactions and split application of nitrogen fertilizer on the plant height

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