Biological Forum – An International Journal **8**(2): 297-304(2016)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

The Effect of Plant Density and Nitrogen Management on Yield and Quality of Durum Wheat Lines in Neishabour

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(Received 21 May, 2016, Accepted 28 September, 2016)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: To determine the appropriate density of durum wheat promising D-81-6 line, a split-factorial randomized complete block design with three replications was conducted during two growing seasons at Agricultural Research station of Neishabur. Plant densities of 400, 500 and 600 seeds per square meter devoted to the main plots and total of two fertilizer treatments of nitrogen fertilizer (including both the 138 and 184 kgha^{-1}) and five treatments of timing of nitrogen application in different growth Zadoks stages were assigned to the subplots. In this study traits such as grain and biological yield, grain weight, number of spikes per square meter, number of grains per spike and grain protein requirements were recorded. Analysis of variance showed that the effects of seed density on all traits except grain yield was not significant in the first year. While the effect of nitrogen fertilizer on all traits was not significant in the first year. Moreover, in case of grain and biological yield and number of ears per square meter there was no significant difference in terms of time of nitrogen application. In the second year significant differences were observed among all of traits such as grain yield, biological yield, grain weight, number of grains per spike and spike protein with the exception of seed density per square meter. nitrogen fertilizer could not make any significant difference in grain yield and number of grains per spike. Time of nitrogen application significantly affected grain yield, number of grains per spike and protein content. The results showed that the effect of year on all traits except biological yield and number of ears per square meter were significant ($p<0.05$). Effects of seed density on all of traits except grain yield, biological yield and seed protein content was significant, however its interaction with years was not significant. The effect of nitrogen fertilizer as well as its interaction with grain yield was significant ($p<0.05$). Interaction between seed density and nitrogen fertilizer on biological yield and number of grains per spike was significant. The effect of nitrogen fertilizer as well as its interaction with the only grain yield, number of grains per spike and grain protein content was significant. In general, changes in plant density in different years and their interactions with the amount and timing of nitrogen created new conditions for plants so that the seeds could affected from nitrogen in the plant tissue.

Keywords: Durum wheat, planting density, nitrogen management

INTRODUCTION

Durum wheat (*Triticum turgidum* L. var. Durum), considered one of the major field crops and only tetraploid wheat that occurs on a large scale cultivation. About five percent of the total acreage of durum wheat of the world allocated to it and the global production of about 7/36 million tons (Qadieh Zarinabadi and Ehsanzadeh, 2014). The wheat extraordinary physiological characteristics of this type of plants to produce a wide range of environments that adapting to climate and chemical and physical properties of wheat gluten ideal for many different food products is diversify (Arzani, 2004).

Plant density is one of the key factors instrumental in determining the ability of the crop in the use of resources. This is particularly wheat production because most systems are controlled agricultural crops, is of particular importance (Satorre, 1999). The desirable density of plants in the regions according to climate, soil, planting and figures can vary greatly, resulting in the relationship between density and yield will vary in different regions of seeding (Qi-Yuan *et al.* , 1994). More research into the effect of density on crop yield shows the performance range of the average density increases and then remains constant and only in very high densities will be significantly reduced (Ghorbani *et al*., 2010).

Most studies concerning the effect of density on crop yields show to limit the average increase performance density and then remains constant and only at very high density, its value will be significantly reduced (Garcia del Moral *et al*., 2003). But Schillinger (2005) reported that the concentration had no effect on spring wheat yield in rain fed conditions due to the spike and number of grains per spike. Number of ears per plant at low densities, reducing the amount of plants per unit area sustainably compensate.

Staggenborg *et al*., (2003) found that the optimum density of plants depends largely on environmental conditions during the growing season. Otteson *et al*., (2008) reported that increasing the number of plants per unit area and seed rate increase in low density, number of tillers per plant increased. Also, increasing seeding, increased the number of ears per square meter and performance of the main stem and tillers share decreased performance.

Nitrogen fertilizer is the most important grain yield and protein content of wheat under the influence (Bly and Woodard, 2003). Campbell *et al*., (1990) reported that its broadcasting band application of nitrogen fertilizer increased compared with a protein content of wheat.

Nitrogen is used mainly before flowering plants absorbed and later during grain filling of grain-growing transferred. Photosynthesis during grain filling period spent most of the starch grains. Conditions affecting growth performance also affects the amount of protein. All the nitrogen required to maximize application performance and deliver the protein to an acceptable level during the growth period can increase growth and yield loss is severe. Nitrogen application after growth is done mainly with the aim of increasing protein. Due to late application of nitrogen and protein nitrogen content of plants depends on the amount of nitrogen (Brown *et al*., 2005).

Gooding and Davies (1992) showed that increasing the protein content and baking quality of wheat foliar application of urea fertilizer at flowering stage and after it enormous advantages over its application in the soil. Most of the nitrogen in the dry matter at heading and consequently increasing the harvest index (Sarandon and Gianibelli, 1990).

Winter wheat grain yield and biomass production compared to the amount and distribution of nitrogen fertilizer show different responses. Add nitrogen fertilizer in the spring in eight tests of 14 winter wheat was tested in the Canadian Arctic increased biomass production. Winter wheat is planted in Idaho in between usage and strip nitrogen from the yield difference was not significant (Harmoney and Thompson, 2005).

Sharif Al-Husseini and Ghasemzadeh (2009) study the reaction of two new varieties of durum wheat to split and Neishabur reported that the premises L fertilizer N split application of nitrogen fertilizer required four times before sowing, stem elongation, pollination and gradation in effect on grain quality was remarkable. One time foliar application of nitrogen fertilizer in the pollination stage effects and significant effect on grain yield and protein content of wheat varieties. Siadat and Fathi (2001) also examine the effect of split application of nitrogen fertilizer on wheat yield in Ahvaz that splitting a two-stage approach (50% at sowing and 50% at stem elongation stage) economically more appropriate.

Mousavi *et al* (2011) with a variety of methods to evaluate the effects of nitrogen fertilizer on wheat yield under irrigated conditions showed that split and integrated solutions while achieving good performance can be supply of nitrogen fertilizer savings.

The results indicate the important role of nitrogen during the growing season as well as durum wheat in grain quality and yield of the crop and on the basis of performance upgrades and the quality of durum wheat is subject to proper management of nitrogen (amount and timing of base fertilizer and top dressing) and provide the nitrogen needed by the plants during the growing period is applicable.

In this regard, grain protein content significantly correlated with soil available nitrogen to the need for proper nitrogen fertilizer application based plants to prove (Eckhoff, 2001). Study conducted in Montana showed that nitrogen top dressing at the end of the season when nitrogen levels before planting (basic) was enough, did not increase seed yield, while protein content increased by up to 2 percent (Westcott *et al*., 1997). While nitrogen in the mid-term growth of seed yield increased only when the basic nitrogen intake was lowest (Eckhoff, 2001). The farming operation is to increase the yield and quality are of considerable importance.

One of the problems farmers to determine the appropriate amount and timing of nitrogen application in order to enhance the quality and quantity of durum wheat is performance. However, regardless of type or source of nitrogen fertilizer after taking almost the bulk of nitrogen in the form of nitrate leaching, they are risk it and get out of the root zone and groundwater pollution and lack of use of the plant. The synchronization nitrogen requirement of the plants during the growing season, especially in the developmental stages of nitrogen uptake by plant roots quickly to stem the steep slope is increasing, should be studied. The aim of this study was to evaluate the effects of planting density, different amounts of time basal fertilizer and topdressing on yield and quality of D-81-6 lines of durum wheat in Neishabur region with moderate climate is executed.

MATERIALS AND METHODS

To assess the need for the production of durum wheat crop and system optimization study to determine appropriate plant density and nitrogen management role of durum wheat lines with pedigree number -81-6.
Plata-1 / SNM // Plata 2010-2011 and 2011-2012 in Neishapur was conducted during the crop years. Neishabur city has a latitude and longitude as `48°, 58 eastern and` 12°, 26 north and an elevation of 1,350 meters above sea level. The annual rainfall in this area 241 mm and the average summer temperature is 29.8°C. Neishabour based classification system Domarten climate between the Mediterranean and semi-arid type of climate is located. The annual rainfall in this area 241 mm and the average summer temperature is 29.8°C. Nyshabour based classification system Domarten climate between the Mediterranean and semi-arid type of climate is located.

With regard to the interaction between the number of plants per unit area and nitrogen management (in terms of amount and timing of nitrogen application). The split-factorial in a randomized complete block design with three replications. So that plant densities of 400, 500 and 600 seeds per square meter in climate, the main plot of the effect of nitrogen fertilizer treatments included two levels of 138 and 184 kg per ha (respectively 300 and 400 kg. ha) and five fertilizer treatments resulting from the splitting of fertilizer nitrogen fertilizer use in sub plots were set forth in table 1. Growth stages were determined based on the scale Zadoks (Zadoks *et al*., 1974).
In order to run the tests, to prepare the land includes plow, disc, fertilizing based on soil, water and fertilizer recommendations according to the Research Institute of soil and irrigation water test results (Table 2 and 3), respectively.

Table 1: Timing of nitrogen application in different Zadoks growth stages of wheat.

Flowering GS51	Stem elongation GS32	Late tillering GS29	Planting time	No treatment
0	1/3	1/3	1/3	1
1/3	0	1/3	1/3	2
1/3	1/3	0	1/3	3
1/3	1/3	1/3	0	4
0	0	0	0	5

Table 2: Analysis of soil test execution.

Zn mg/kg	Clay (percent)	Silt (%)	Sand (%)	Potassium mg/kg	Phosphorus mg/kg	Organic carbon	Neutralizing) percent)	pH	EC (dS/m)	Fe mg/kg	Mn mg/kg	Cu mg/kg
0/46	26/4	43/0	30/6	225	5/2	0/5	14/2	7/9	1/3	2/7	6/20	1/80

Table 3: Details the implementation of testing irrigation water.

Sulfate	Cl^-	Bicarbonate	Carbonate	Na	Mg	Ca	pH	EC dS/m
Mg equivalents per liter								
1/3	1/4	3/3	-	2/9	1/4	1/5	7/9	0/65

In the place of performance tests (Agricultural Research Station Nishapur), base fertilizer nitrogen-based treatments done and then proceed to make the bed. The seeds disinfected with appropriate pesticides and based on the density studied (400, 500 and 600 seeds per square meter), the culture they work in each experimental unit using Wintersteiger linear dimensions 6 × 5/2 m (15 m. square). Each experimental unit of length 6 and 5/62 cm width was 5.2 meters, including four stacks. In the first year the main consumer and micro nutrients based on soil test consisted of 100 kg of super phosphate, potassium chloride, 75 kg and 50 kg zinc sulfate per hectare during planting. In the second year, furrow irrigation and use five times the original nutrients and micronutrients based on soil test and triple superphosphate 100 kg, 50 kg potassium chloride, 50 kg zinc sulfate per hectare as a baseline.
Before the final harvest the plant sample preparation 625/0 square meter (a meter long four line planting) of each of the units examined and yield components including grain weight, number of grains per spike, spike and number of grains per unit area were determined. Also before the harvest by removing the two sides stack and half a meter from the beginning of each experimental unit, the ultimate recovery test was conducted using the Combine. In this study traits such as grain yield, number of spikes per square meter, number of grains per spike, biological yield, grain weight and protein content are. Protein measured in the laboratory by Standard No. 105 ICC was performed.

After the completion of data collection in the field and laboratory measurements to statistical analysis using SAS statistical software was compounded annually. Compare the means using Duncan's multiple range test was performed five percent.

RESULTS AND DISCUSSION

Analysis of variance in the first year (Table 4) indicate that a significant difference between biological yield, number of spikes per square meter, number of seeds per plant and seed density was no three percent protein. There is significant difference between all traits were observed in both treatment nitrogen. Moreover, between grain yield, biological yield and number of ears per square meter there was no significant difference in terms of time of nitrogen application. While the grain yield and grain weight of seed density difference was significant at three levels. Between grain weight, number of grains per spike and grain protein also significant differences were observed in terms of time of nitrogen application.

Table 4: Analysis of variance (mean square) grain yield, biological yield, grain weight, number of spikes per square meter, number of seeds per plant and seed protein content of durum wheat promising lines of D-81-6 run in the first year.

Protein content percent	The number of grains per spike	The number of spikes per square meter	the weight of one thousand seeds	Biological yield	grain performance	Degrees of freedom	Resource change
1.249 **	254.178 **	4150.277 ns	26.712 *	15694587.1 *	772027.9 ns	2	Replication
0.062 ns	60.044 ns	946.411 ns	51.977 **	6704816.2 ns	1452529.4 *	2	Seed density (A)
1.037	47.411	3658.044	23.808	28011119.8	136714.3	4	E1
0.150 ns	3.600 ns	11.377 ns	0.009 ns	786802.5 ns	121073.3 ns	1	Nitrogen (B)
0.161 **	86.817 *	11953.777 ns	29.273 **	7385946.0 ns	34166.2 ns	4	Time consumption (C)
0.143 ns	94.533 ns	252.077 ns	0.377 ns	74230.9 ns	118879.4 ns	2	B × A
0.425 **	30.517 ns	5933.786 ns	2.656 ns	8422303.9 ns	414774.8 ns	8	C × A
0.292 *	23.405 ns	7094.600 ns	10.091 ns	668973.8 ns	81526.5 ns	4	C × B
0.121 ns	42.838 ns	5335.592 ns	8.205 ns	3899482.2 ns	486213.9	8	C ×B × A
0.095	32.555	8401.48	5.872	4087656.8	444743.03	54	E2
2.59	10.47	16.75	6.14	11.02	9.83	Coefficient of variation (% CV)	

*and ns denote significant differences at 1%, 5% and an important loss without significant differences.

Table 5: Comparison of the mean effect of seed density, amount and timing of nitrogen fertilizer on the traits lines D-81-6 run in the first year.

Protein content	The number of grains per spike	The number of spikes per square meter	Grain weight (g)	Biological yield kg/ha)(	Grain yield (kg / ha)	Treatment
						Seed density (seeds per square meter)
11.9 a	54.9 a	547.23 a	40.4 a	18895 a	6846.3 a	400
11.8 a	55.7 a	541.60 a	40.0 a	18040 a	6960.1 a	500
11.9 a	52.9 a	552.83 a	37.9 b	18117 a	6535.1 b	600
						Nitrogen fertilizers (Kg per hectare)
11.8 a	54.3 a	546.87 a	39.47 a	18257.2 a	6743.8 a	138
11.9 a	54.7 a	547.58 a	39.45 a	18444.2 a	6817.2 a	184
						Time of nitrogen application *
11.9 a	54.3 ab	531.89 a	38.0 b	18896.8 a	6626.6 a	1
12.1 a	57.6 a	583.78 a	39.2 b	19007.3 a	6642.8 a	2
11.8 b	51.9 b	538.22 a	39.6 b	18102.4 ab	6921.2 a	3
12.0 a	53.2 b	562.67 a	39.0 b	18317.6 ab	6888.3 a	4
11.5 c	55.6 ab	519.56 a	41.5 a	14729.2 ab	6823.6 a	5

The timing of nitrogen application treatments shown in Table 1. *

The interaction showed that the effect of excluding the effects of seed density × time of nitrogen application and effect of the consumption values of N × time of nitrogen application the percentage of protein, none of the other effects were not significant. The results of comparison of the first year (Table 5) showed that by increasing the seeding density of up to 500 seeds per square meter, grain yield increased and then decreased significantly. The grain weight in high density (600 seeds per square meter) than low density (400 seeds per square meter) significantly decreased. Other traits of seed density was not affected.

Posts with the same letters in each column show significant differences with each other, according to Duncan's multiple range test, not five percent.

Most studies concerning the effect of density on crop yields show that performance to the limit of the average density increases and then remains constant and only in very high density, its value will be significantly reduced (Garcia *et al*., 2003) in accordance with the results obtained in this test.

Van Herwaarden *et al*., (2003) also believe that the best density, which is the maximum density and increases performance in its seed is no more effect on performance

Giovanni *et al*. (2004) stated that more weight is under genetic control. Evans Studies (Ivans, 1990) is based on the weight of new wheat cultivars, plant density will not be affected. The findings with experiments on Jafari Haqiqi and colleagues (1998) reported that increased density is matched with decreased seed weight. Stacey (2003) reported that increasing the amount of seed to maturity, plant height reduction, reducing the number of tillers per plant due to increased water stress due to the reduction of nitrogen availability was associated with an increased density.

In this experiment, the effect of nitrogen rates was not statistically significant on all traits. The time of nitrogen application had significant effect on biological yield, grain weight, number of grains per spike and grain protein content, the maximum biological yield, number of grains per spike and protein percent in the second treatment (with1/3 split application of nitrogen fertilizer when planting, 1/3 late tillering and 1/3 flowering), respectively.

The results of the second year (Table 6) showed a statistically there is no significant difference between all traits such as grain yield, biological yield, grain weight, number of grains per spike and spike protein with the exception of seed density per square meter. Grain yield and number of grains per spike in the treatment of nitrogen fertilizer were significant. As well as grain yield, number of grains per spike and protein content in diets, time of nitrogen application were significant. The inconclusive outcome was different in the first year of the years of research that indicates to determine how soil nitrogen status of durum wheat seed at planting and during the growing season plays an important role in obtaining high yield.

Table 6: Analysis of variance (mean square) grain yield, biological yield, grain weight, number of spikes per square meter, number of seeds per plant and seed protein content D-81-6 lines in the second year.

Protein content percent	The number of grains per spike	The number of spikes per square meter	the weight of one thousand seeds	Biological yield	grain performance	Degrees of freedom	Resource change
1.998 **	67.589 ns	47017.911 **	6.513 ns	246636604 ns	4740811.6 **	2	Repeat
0.540 ns	88.673 ns	21818.611 **	17. 760 ns	104986165 ns	297128.1 ns	2	Seed density (A)
0.832	81.542	4609.428	3.518	78055567	6877949.4	4	The main error
0.024 ns	255.362 *	364.011 ns	0.880 ns	15489462 ns	10084845.9 **	1	Nitrogen (B)
0.986 **	196.448 *	4459.733 ns	15.885 ns	213598769 ns	39399920.9 **	4	Time-consuming) C(
0.012 ns	353.473 **	2237.878 ns	39.053 *	243782405 ns	2441653.9 ns	2	B × A
0.384 ns	58.074 ns	9072.750 *	2.128 ns	311507452 ns	1055981.0 ns	8	C × A
0.372 ns	94.953 ns	3885.011 ns	7.269 ns	101235178 ns	2180652.7 *	4	C × B
0.409 ns	63.758 ns	2527.211 ns	4.321 ns	164779450ns	1320758.2 ns	8	C ×B × A
0.216	60.249	4165.49	8.220	177463887	781178.3	54	Sub error
4.19	15.23	12.04	6.84	79.72	14.14	Coefficient of variation (% CV)	

**, * and ns denote significant differences at 1%, 5% and an important loss without significant differences.

Table 7: Mean comparisons of seed density, amount and timing of nitrogen fertilizer on the traits lines D-81-6 run in the second year.

Protein content percent	The number of grains per spike	The number of spikes per square meter	Grain weight (g)	Biological yield (kg / ha)	Grain yield (kg / ha)	Treatment
						Seed density (seeds per square meter)
11.2 a	52.2 a	505.90 b	42.2 a	15811 a	6136.0 a	400
11.1 a	51.7 a	557.73 a	42.5 a	18861 a	6285.6 a	500
10.9 a	48.9 a	544.73 ab	41.0 a	15458 a	6324.5 a	600
						Nitrogen fertilizer (kg ha)
11.1 a	49.3 b	538.13 a	42.00 a	16295 a	5914.0 b	138
11.1 a	52.6 a	534.11 a	41.80 a	17125 a	6583.4 a	184
						Time of nitrogen application *
10.9 bc	52.7 a	560.56 a	41.4 a	14475 a	6991.7 a	1
11.1 abc	52.9 a	520.44 a	42.7 a	14430 a	6806.0 a	2
11.4 a	50.9 a	534.28 a	42.6 a	17410 a	6709.2 a	3
11.2 ab	52.9 a	540.44 a	42.3 a	14777 a	7119.2 a	4
10.8 c	45.2 b	524.89 a	40.5 a	22459 a	3617.5 b	5

The timing of nitrogen application treatments shown in Table 1. *

The interaction showed that the effect of excluding the effects of seed density × amounts of nitrogen fertilizer on grain weight and number of grains per spike, the effects of seed density × time of nitrogen application on the spike per square meter and the effect of the consumption values of N × time of nitrogen application on grain yield, none of the other effects were not significant.

Comparing means in the second year (Table 7) showed that by increasing the seeding density of up to 500 seeds per square meter, number of spikes per square meter increased and then decreased. Other traits of seed density was not affected. High density often causes an increase in the number of spikes per unit area (Stougaard and Xue, 2004) and the number of spikes per unit area is generally the most important component of yield for wheat (Garcia *et al*., 2003).

In this study, the effect of nitrogen rates on grain yield and number of grains per spike only significant and increasing amount of nitrogen fertilizer significantly increased these traits. Time of nitrogen application had significant effect on grain yield and protein content was the maximum yield and protein, respectively, in the fourth treatment (Nitrogen fertilizer with split 1/3 in the late tillering at stem,1/3 elongation and 1/3 at flowering stage) and third (1/3with split application of nitrogen fertilizer when planting in early stem,1/3 elongation and1/3 at flowering stage) was observed.

Anaqli *et al* (2006) examined the effect of amount and timing of nitrogen on yield and yield components showed an increase of nitrogen application, grain yield significantly increased. The maximum yield of nitrogen fertilizer with split application at planting time, was at tillering and stem elongation stage. Increased grain yield higher levels of nitrogen because of its positive impact on the number of spikes per square meter and the number of grains per spike. Research has shown that nitrogenous fertilizers significantly increased the protein content, especially when the fertilizer is used to measure the functional requirements and the need to provide protein synthesis (Johnson and Mattern, 1987).

Bohrani and Tahmasebi Sarvestani (2005) The effect of nitrogen on the amount and timing of quantitative and qualitative characteristics of winter wheat showed that the increase in the amount of nitrogen application on yield and its components as well as the positive effect of the protein percent so that the consumption of 160 kg per hectare nitrogen and split it for two to three-stage application of the most appropriate management of nitrogen fertilizer to increase the yield and quality in wheat.

Analysis of variance (Table 8) showed that the effect of year on all traits except biological yield and number of ears per square meter were significant at the one percent level. The effects of seed density on all traits except grain yield, biological yield and protein content was significant. But none of the attributes of the interaction with year was not significant. The effect of nitrogen fertilizer as well as its interaction with the grain yield was significant at the one percent level. The interaction between seed density and nitrogen fertilizer on biological yield and number of grains per spike was significant.

The effect of nitrogen fertilizer as well as its interaction with the only grain yield, number of grains per spike and grain protein content was significant. Among other interactions, just different amounts of N × time interaction between the consumption of protein, grain and seed density × time interaction effect of nitrogen fertilizer × grain protein year, the interaction between seed density × nitrogen fertilizer amounts ×time interaction effect of nitrogen fertilizer on yield and seed density × amounts of nitrogen fertilizer × time-consuming N × year were significant on grain protein content. Note that the interaction of four years, density, amount and timing of nitrogen application had significant effect on grain protein content was significant. So we can say that the change in density in different years and their interactions with the amount and timing of nitrogen created new conditions for plants the use of nitrogen in the plant tissue was effective grain and grain protein content fluctuated. It seems that indirectly affect protein content in grain yield, biological yield and number of spikes per square meter, which closed this reaction varies with weather conditions and years of management. Thus, when it is supposed to increase the protein content could be used to fertilizer application in the later stages of plant growth.

Posts with the same letters in each column show significant differences with each other, according to Duncan's multiple range test, not five percent.

Table 8: The combined analysis (mean square) grain yield, biological yield, grain weight, number of spikes per square meter, number of seeds per plant and seed protein content D-81-6 lines in the two-year project.

Protein content percent	The number of grains per spike	The number of spikes per square meter	the weight of one thousand seeds	Biological yield	grain performance	Degrees of freedom	Resource change
26.742**	568.889 **	5544.45 ns	268.889 **	121110733 ns	12726505.8 **	1	Year
1.623	169.883	25584.09	16.613	131165595	2756419.7	4	Repeat (years)
0.258 ns	141.834 *	10279.70 **	63.428 **	42880153 ns	583963.2 ns	2	Seed density (A)
0.344 ns	6.883 ns	12485.32 ns	6.309 ns	68810828 ns	1165694.3 ns	2	A×Y
0.934	64.476	4133.74	13.663	53033343	3507331.8	8	error
0.027 ns	159.801ns	123.34 ns	0.533 ns	11629142 ns	6207951.0 **	1	Nitrogen (B)
0.147 ns	99.161 ns	252.05 ns	0.355 ns	4647123 ns	3997968.2 **	1	B×Y
0.072 ns	287.883 **	516.34 ns	22.815 ns	117722097 *	1156332.8 ns	2	B × A
0.083 ns	160.123 *	1973.62 ns	16.615 ns	126134539 ns	1404200.4 ns	2	Y × B × A
1.456 **	129.980 *	5715.50 ns	12.025 ns	73932349 ns	19214270.1 **	4	Time consumption (C)
0.405 *	64.113 ns	1317.95 ns	7.541 ns	54639553 ns	822239.8 ns	4	C × B
0.691**	153.285 *	10698.01 ns	33.133 ns	147052366 ns	20527311.9 **	4	C×Y
0.234 ns	48.038 ns	6507.74 ns	1.642 ns	157888148 ns	401885.5 ns	8	C × A
0.574 **	40.553 ns	8498.79 ns	3.142 ns	162041608 ns	1068870.3 ns	8	Y × C × A
0.172 ns	69.284 ns	3339.82 ns	3.035 ns	80186557 ns	1419097.4 *	8	C ×B × A
0.325 *	42.957 ns	6235.87 ns	9.601ns	74749783 ns	738562.9 ns	12	Y × C ×B × A
0.155 ns	46.402	6283.48	7.046	90775772	612960.7	108	error
3.06	12.92	14.63	6.52	54.35	12.02	Coefficient of variation (% CV)	

and ns denote significant differences at 1%, 5% and no differences are significant. **, *

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