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Influence of Nitrogen Fertilization on Traits Related to Lodging and Yield in Bread Wheat Genotypes

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Abstract

The study was carried out during 2017/2018 and 2018/2019 seasons at the Exp. Farm of Assiut University, to Evaluate 20 bread wheat genotypes (*Triticum aestivum* L) for traits related to lodging resistance and yield under different levels of nitrogen fertilization *i.e.* 50, 75 and 100 kg N/fed.

The results could be summarized as follow:

- There were highly significant differences among the studied genotypes, levels of nitrogen and genotypes x nitrogen interaction traits related to lodging.
- Plant height was positively and high significantly correlated with the second internode length under all nitrogen levels, while it was negatively highly significantly correlated with second internode diameter with an increase nitrogen levels.
- The mean plant height and length of second internode over all genotypes increased as nitrogen rate increased up to 100 kg N/fed.
- Increasing nitrogen rate up to 75 kg/fed. led to significant increase in the stem diameter, dry weight/unit and internode length. However, adding more nitrogen fertilizer showed negative effect on the above mentioned traits.
- The lodging percentage increased with the increase of nitrogen rate. The causes of lodging differed from cultivar to another.
- The grain yield significantly increased with the increase of nitrogen rate up to 100 kg/fed.
- Results showed that the genotype Sakha 93 was the best for lodging percentage.

Keywords: *Evaluation, wheat genotypes, Lodging, Nitrogen fertilizer*.

Introduction

Wheat is the world's most important cereal crop that excels all other cereal crops both in area and production. Besides wheat provides nutrition to most of the world population and is well adapted to a wide range of environmental conditions (Vamshikrishna *et al.*, 2013 and Olga *et al*., 2018). Moreover, wheat is the strategic cereal crop not only in Egypt, but also all over the world. In Egypt, wheat is ranking the first among winter cereal crops (Galal *et al*., 2016). Wheat grains are the main source of calories and protein in the most developing countries including Egypt. In addition, the wheat straw is the main source of fodder for animal feed to support the rapidly developing animal production (Galal *et al.*, 2016 and Bayisa 2019).

The cultivated area of wheat in Egypt during 2018 season was about 1.32 million hectares with a total grain or straw production of 8.45 million metric ton. While the total consumption reached about 19.6 million metric tons (USDA, 2018). With consumption gap, increasing wheat production in order to reduce the gap between production and consumption is a strategic aim.

Efforts of scientists to minimize the gap between local production and consumption are directed towards two ways *i.e.* expanding the cultivated wheat area and increasing the wheat productivity from the land unit area by selecting high yielding varieties and balanced fertilization (Atia and Ragab, 2013).

Nitrogen (N) fertilizers are the major input required and limiting factor for cereal crop production worldwide. The management of this resource is a significant challenge to most agricultural systems as it can have significant impacts on yield and the environment (Abdullah 2011; and Inwati *et al.*, 2018). The proper amount of fertilizer application is considered a key to the bumper crop production (Tariq *et al*., 2007). Despite being one of the most abundant elements on earth, N deficiency is one of the most common problems affecting plant growth worldwide (Abdullah 2011). In addition, since nitrogen is the element which stimulates above-ground growth and produces the rich, green color characteristic of healthy plant and increases the protein percentage it plays a direct effect on growth behavior and yield quality (Yasser and Naheif, 2018). The application of proper amount of nitrogen is the key to obtain higher grain yield of wheat in Egypt. (Mosslem *et al* 2014 and Atia and Ragab, 2013).

Wheat genotypes could be considered one of the most favorable factors affecting grain yield (Seleem and Abd El-Dayem, 2013) optimal use of production parameters, such as nitrogen and genotypes may improve grain yield and quality, resulting in higher economic benefits (Bhatta *et al*., 2017).

Lodging is one of the constraints that limit wheat yields and quality due to the unexpected bending or breaking stems on wheat production worldwide. Moreover, it can increase susceptibility to pests and diseases (Berry *et al*., 2004; Zhang *et al*., 2017 and Zenhom 2018) and present extreme problem in harvesting operation (Telkar *et al*., 2017) Severe lodging destroys plant morphology, and reduces photosynthetic efficiency, grain yield, grain filling, and harvesting efficiency (Berry and Spink, 2012). Beside choosing lodging resistance varieties, husbandry practices also have a significant effect on lodging. Nitrogen management is one of the most common and efficient methods that were used widely in rainfed winter wheat production to reduce lodging risk (Can *et al*., 2015, Peake *et al*., 2016 and Zhang *et al*., 2017). Supply the optimum dose of N helps to reduce lodging losses (Telkar *et al*., 2017).

The objectives of the current study were evaluation of 20 genotypes of bread wheat under three levels of N fertilization *i.e.* 50, 75, 100 kg N/fed for yield and estimate the extent of lodging resistance of each genotype traits, *i.e.* plant height, second internode length, stem diameter and dry weight/unit

Materials and Methods

This study was carried out during the two successive growing seasons 2017/2018 and 2018/2019 at the Agronomy Department, Experimental Farm, Faculty Agriculture, Assuit

University to evaluate twenty wheat genotypes for yield and its components preside lodging resistance related traits under three levels of nitrogen fertilization. The soil type was clay in texture. The physical and chemical analyses of the experimental soil are presented in Table 1.

Table 1. Some physical and chemical properties of the experimental soil.

Properties	2017/2018	2018/2019
Mechanical analysis:		
Sand	27.00	27.80
Slit	23.00	22.20
Clay	50.00	50.00
Soil type	Clay	Clay
Chemical analysis:		
pH	7.63	7.85
Organic matter %	1.80	1.70
Total N%	0.09	0.08

Plant material and field experiments.

Twenty bread wheat genotypes (Table 2) were sown on Dec. 5th 2017 and Nov 28th 2018. A randomized complete block Design of three replications was used in both levels of nitrogen and seasons.

Experiments plots consisted to 6 rows, 20 cm apart, and 2.0 m long (plot area=2m^2). The harvest was May 3rd 2018 and 15th 2019. In the first and second growing seasons, respectively. The ordinary cultural practices for growing wheat were adopted as recommended, except the experimental treatments (Nitrogen fertilizer) in both seasons. Three levels of Nitrogen fertilization, *i.e.*, 50, 75 and 100 Kg/fadden in the form of Urea (46.5%N) were applied into three equal doses before first, second and third irrigation.

Table 2. The pedigree and origin of studied genotypes.

Ser NO	Genotypes	Pedigree	Origin
1	MISR 1	OASIS/SKAUZ//4*BCN/3/2*PASTOR	Egypt
2	Sakha 93	SAKHA 92/TR 810328	Egypt
3	Sakha 94	Opta/Rayon//KAVZ	Egypt
4	Shandaweel-1	SITE/MO/4/NAC/TH.AC//3*PVN/3/MIRLO/ BUC.	Egypt
5	Sids-1	HD2172/PAVON "S"//1158.57/MAYA 74 "S". SD46-4SD-2SD-ISD-OSD.	Egypt
6	Sids-13	ALMAZ.19=KAUZ"S"//TSI/SNB"S"	Egypt
7	Giza 171	SAKHA 93/GEMMEIZA 9 S.6-1GZ-4GZ-1GZ-2GZ-0S	Egypt
8	Gemmiza 9	ALD “S”/HUAC “S”//CMH 74 A. 630/SX	Egypt
9	103 Mohasan	Agronomy Dep., Fac. Agric., Assiut Univ.	Egypt
10	Entry 13	ND643/2*WBLL1/4/WHEAR/KUKUNA/3/C80.1/3* BATAVIA//2*WBLL1	MXI13-14\M35ES22SAWHT\21
11	Entry 16	MUU/FRNCLN	MXI13-14\M35ES22SAWHT\31
12	Entry 19	BAJ #1/KISKADEE #1	MXI13-14\M35ES22SAWHT\37
13	Entry 20	CHEWINK #1/MUTUS	MXI13-14\M35ES22SAWHT\43
14	Entry 21	SERI.1B*2/3/KAUZ*2/BOW//KAUZ/4/2*MUNAL	MXI13-14\M35ES22SAWHT\50
15	Entry 23	QUAIU #1/2*SUP152	MXI13-14\M35ES22SAWHT\54
16	Entry 24	MUNAL*2/WESTONIA	MXI13-14\M35ES22SAWHT\68
17	Entry 25	MUTUS*2/HARIL #1	MXI13-14\M35ES22SAWHT\74
18	Entry 30	SWSR22T.B./2*BLOUK #1//WBLL1*2/KURUKU	MXI13-14\M35ES22SAWHT\94
19	Entry 42	CROSBILL #1/DANPHE/7/CNDO/R143//ENTE/MEXI_2/3/AEG ILOPS SQUARROSA (TAUS)/4/WEAVER/5/2*KAUZ/6/PRL/2*PASTOR	MXI13-14\M35ES22SAWHT\122
20	Entry 46	WAXWING*2/TUKURU//2*FRNCLN	MXI13-14\M35ES22SAWHT\153

The following traits were recorded for all experiments:

1. **Plant height (PH cm)**: measured as the distance from the ground surface to the base of the main culm spike for average ten plants from each genotype.
2. **Second internode length (SIL, cm)**: measured as the distance from the first node to the second internode of the main stem.
3. **Stem diameter (SD, mm):** measured in as diameter of the second internode**.**
4. **Dry weight per unit length of the second internode (DWSI)** was calculates as the dry weight of

the second internode divided by its length.

5. **Field loading:** estimated as the type of damage assessed was lodging, where the stems inclined at 45° from the horizontal. The proportion of the plot area affected by lodging was assessed as the percentage of lodged plants to the total plants, according to Dorofeev and Ponomarev (1970).

6. **Grain yield/m^2 (GY)**: it was calculated on plot main in g/m^2.

Statistical analysis:

The separate and combined analyses of variance were done on plot mean basis after testing homogeneity of error according to Gomez and Gomez (1984). After testing the significance of variances, revised LSD were calculated to compare differed genotypes means.

Results and Discussion

The performance of bread wheat genotypes under nitrogen levels for plant height, yield and traits related to lodging (second internode length, stem diameter and dry weight/unit length) in the present investigation were presented as follows:

A- Analysis of variance of bread wheat genotypes under nitrogen levels for traits related to lodging resistance.

Separate analysis of variance in each seasons revealed highly significant differences among the genotypes as well as three levels of nitrogen for all studied traits *i.e.* plant height, second internode length, dry weight/unit, stem diameter and grain yield m^2 (Table 3).

Combined analysis of variance for the studied traits over the two seasons, revealed highly significant differences among the three levels of nitrogen, genotypes and the interaction of nitrogen level x genotypes (Table 4).

These results indicate that the studied genotypes responded differently when they were grown at different levels of nitrogen. These results are in agreement with Abdel Nour *et al*. (2011), Abd El-Raouf *et al.* (2013), Ati *et al*. (2016), and Morsy *et al.* (2018). Hindi *et al*. (1990) found low significantly of variety x season x nitrogen interaction for traits related to lodging resistance traits. Also, several workers reported significantly different genotypic for nitrogen level interaction. Kheiralla *et al*. (1993) and Ismail (2001).

B- Performance of the genotypes under nitrogen levels:

1- Plant height, (cm):

The mean plant height over all genotypes increased as nitrogen rate increased up to 100 kg N/fed. Their average were 85.60, 85.50 and 85.55 with 50 kg 94.80, 96.80 and 95.80 with 75 kg and 107.90, 112.80 and 110.35 cm with 100 kg N/fed in 2017/2018 and over both seasons, respectively (Table 5).

In the first season under level of 50 kg N/fed, the average plant height ranged from 83.00 for Sakha 93 to 90.33 for Sakha 94 with an average of 85.60 cm. Under level of 75 kg N/fed, the average ranged from 90.00 for Sakha 93 to 102.67 for Sakha 94.82 with an average of 94.80 cm. Also, under level of 100 kg N/fed, the average ranged from 98.33 for Entry 21 to 117.30 for Gemmeiza 9 with an average of 107.90 cm (Table 5).

In the second season under level of 50 kg N/fed, the average plant height ranged from 82.30 for Entry13 to 89.70 for Sids 1 with an average of 85.50 cm. Under level of 75 kg N/fed, the average of plant height ranged from 88.30 for Entry13 to 104.30 for Entry 25 with an average of 96.80 cm. Also, under level of 100 kg N/fed ranged from 100.00 for Entry 13 to 124.67 for Entry 25 with an average of 112.80 (Table 5).

The same trend over could be found the two seasons. Saad (2007) mentioned that the increase in plant height when the nitrogen was applied at 80 and 100 kg N/fed, were 1.57% and 3.47%, respectively. The same trend was found by Rekaby *et al*. (2016), El-Hag and Shahein (2017), El-Temsah (2017), Solomon and Anjulo (2017), Yadav and Dhanai (2017) and Farooq *et al*. (2018). Differences for the obtained result may be attributed to the genetic variations among the studied genotypes of wheat. The increase of nitrogen dose may be increase the photosynthetic prosses in plants, thereby increase the plant height, due to cell division as well as cell elongation. These results are in agreement with those reported by Hassanein *et al.* (2013), Zaky *et al*. (2015), Kandil *et al.* (2016), El-Hag (2017) and Warda *et al.* (2020).

2. Second internode length (cm):

In general mean of second internode length for all genotypes was high due to the high levels of nitrogen (Table 6).

In the first season under level of 50 Kg N/fed, the average of second internode length ranged from 4.16 for Gemmeiza 9 to 5.82 for Entry 16 with an average of 5.03 cm. Under level of 75 kg N/fed, the average ranged from 5.72 for Entry 21 to 7.78 for Sids 1 with an average of 6.73 cm. Also, under level of 100 kg N/fed, the average ranged from 6.77 for Entry 21 to 90.00 for Sids 1 with an average of 7.99 cm.

In the second season under level of 50 kg N/fed, the average second internode length ranged from 4.23 for Entry 42 to 5.60 for Giza 171 with an average of 4.79 cm. Under level of 75 kg N/fed. The average of second internode length ranged from 6.80 for Shandaweel 1 to 8.3 for Entry 16 with an average of 7.45 cm. Also, under level of 100 kg N/fed, ranged from 7.80 for Entry 20 to 9.00 for Entry 16 with an average of 8.39 cm (Table 6). The same trend proposed over the two seasons. The mean second internode length over all genotypes increased as nitrogen rate increased up to 100 kg N/fed. The same results were found by Kheiralla *et al*. (1993), Ismail (2011) and Zhang *et al* (2017) who found an increase of 10-25% in the length of the three lowest internodes due to high nitrogen levels in wheat. Pinthus (1973) reviewed that the increase of internode length may be due to cell division as well as cell elongation. Ahmed *et al.* (2000) and Zhang *et al*. (2017) found that plant height was highly significantly correlated with the second internode length. The promotion of the weakening of the basal internode due to increased nitrogen supply have been found to enhance lodging **(**Pinthus, 1973 and Zhang *et al.* 2017). Kheiralla *et al*. (1993), Ismail (2011) and Zhang *et al.* (2017). Tripathi (2003) and Zhang *et al*. (2017) found that length of basal internodes negatively associated with lodging resistance.

3. Stem diameter (mm):

In general, stem diameter showed significant increase with increasing N rate up to 75 kg/fed. However, adding more nitrogen fertilizer had negative effect on this trait (Table 7).

In 2017/2018 Season under level of 50 kg N/fed, the average stem diameter ranged from 2.70 for Entry 16 to 3.10 for Entry 46 with an average of 2.90 mm. Under level of 75 Kg N/fed, the average ranged from 3.30 for Entry 19 to 4.00 for Entry 24 with an average of 3.80 mm. Also, under level of 100 Kg N/fed, the average ranged from 3.10 for Entry 19 to 3.80 for Entry 46 with an average of 3.40 mm (Table 7).

In 2018/2019 season under level of 50 Kg N/fed, the average stem diameter ranged from 2.30 from Entry 30 to 3.00 for Shandaweel 1 with an average of 2.70 mm. Under level of 75 Kg N/fed, the average of stem diameter ranged from 3.40 for Sakha 94 to 4.10 for Entry 24 with an average of 3.90 mm. Also, under level of 100 kg N/fed, ranged from 3.00 for Sakha 94 to 3.70 for Sakha 93 with an average of 3.30 mm (Table7). The same trend extended over the two seasons. The same trend was found by Pinthus (1973), Kheiralla *et al.* (1993), Ismail (2011), and Zhang *et al* (2017). The high rate of 100 kg N led to an increase of plant height but not stem diameter, this is one well known effect of nitrogen. Ahmed *et al*. (2000) found that plant height was not significantly correlated with stem diameter. Awad (1987) reported that a positive correlation for lodging resistance with stem diameter. Ismail (2001) indicated that The level of 100 kg N/fed. treatment produced the plant height/stem diameter ratio (28.81) and the lowest diameter/length ratio (0.406) for the second internode. These two ratios imply that the high N rate results in stems that are thin, tall, with less dry matter that is reflected on a high percentage of lodging (15.00%). This is supported by the findings of Kheiralla *et al* (1993), Ahmed *et al.* (2000) and Zhang *et al* (2017). Awad (1987) showed lodging resistance was positively correlated with stem diameter of second of internode.

Pinera *et al* 2016 reported that grain yield was associated positively with stem diameter and positive associations between stem dry weights per unit length with stem diameter. Previous studies showed that significant correlations between the lodging score and several morphological traits were found for stem diameter (Zuber *et al*., 1999 and Kong *et al*., 2013).

4. Dry weight per unit length of the second internode (g):

In 2017/2018 season under level of 50 kg N/fed, the average dry weight per unit length of the second internode ranged from 1.80 for Entry 13 to 2.80 g for Entry 16 with an average of 2.40 g. Under level of 75 kg N/fed, the average ranged from 2.57 for Entry 13 to 3.90 for Sids 1 with an average of 3.32 g. Also, under level of 100 kg N/fed, the average ranged from 2.21 for Entry 13 to 3.60 for Sids 1 with an average of 2.87 g (Table 8).

In 2018/2019 season under level of 50 kg N/fed, the average dry weight per unit length of the second internode ranged from 1.67 from Shandaweel 1 to 3.00 for Giza 171 with an average of 2.42 g. Under level of 75 kg/fed, the average of second internode length ranged from 2.57 for Entry 13 to 3.90 for Sids 1 with an average of 3.35 g. Also under level of 100 kg N/fed, ranged from 2.21 for Entry 13 to 3.60 for Sids 1 with an average of 2.91 (Table 8). The same trend could be found over the two seasons. Dry weight per unit length of the second internode showed significant increase with increasing N rate up to 75 kg/fed. However, adding more nitrogen fertilizer had negative effect on the above mentioned trait. The same trend was found by Pinthus (1973), Kheiralla *et al.* (1993), Ismail (2011), and Zhang *et al*. (2017). Ahmed *et al*. (2000) found that plant height was not significantly correlated with dry weight per unit length of the second internode. Tripathi 2003 and Zhang *et al*. (2017) found that dry weight per of basal internodes were positively associated with lodging resistance. Lodging resistance in wheat was found to be was positively correlated with the dry weight per unit length of the second internode (Awad, 1987, Kheiralla *et al.* 1993, Ismail (2011). Kheiralla *et al.* (1993) and Zhang *et al* (2017) reported that the slight decreases in grain yield at high nitrogen levels were in coincidence with the decrease in dry weight per unit length of the second internode. Tripathi (2003) found that dry weight per unit length was positive correlated with grain yield. Also, positive association was recorded between stem dry weight per unit length and stem diameter.

5- Percentage of lodging:

In 2017/2018 season, the percentage of lodging under fertilizer of 50 kg N/fed. ranged from 0 (no lodging) for fourteen genotypes to 1.33% for genotype 25 with an average of 0.28%. Under fertilizer of 75 kg N/fed, it ranged from 0% for eight genotypes to 7 for Entry 13 with an average of 2.47%. As well as fertilizer with 100 kg N/fed revealed a percentage of lodging ranged from 4.0 for Entry 21 to 13.33% for two Entries (24 & 46) and Giza 171 with an average of 9.23% (Table 9).

In 2018/2019 season the percentage of lodging under fertilizer of 50 kg N/fed ranged from 0 for seventeen genotypes to 1.33 for Entry 23 with an average of 0.171%. Also under fertilizer of 75 kg N/fed, it ranged from 0.0 for eight genotypes to 7.0 for Entry 21 with an average of 2.23%. But, under fertilizer with 100 kg N/fed, the percentage of lodging ranged from 3.67 for Entry 13 to 15.33 for Giza 171 with an average of 9.40% (Table 9).

Percentage of lodging over two seasons was the same trend in each season which increased with increase the level of nitrogen from 50, 75 to 100 kg N/fed and recorded 0.23, 2.35 and 9.32%, respectively.

The high lodging percentage with increasing the level of nitrogen fertilizer until 100 kg N/fed due to the increase of plant height, second internode length, low stem diameter and dry weight/unit.

These results are in line with those reported by Kheiralla *et al*. (1993) who reported that, the high lodging percentage was attributed to the low dry weight/unit and increase the length of the second internode. Also, Kheiralla (1994) stated that lodging percentage increased with the increase of nitrogen dose. As well as Berry *et al*. (2000) in England, suggested the controlling nitrogen fertilization under a certain limit could improve lodging resistance. Peng *et al*. (2014) in China, showed that lodging resistance was significantly correlated with some morphological characteristics particular plant height.

Also, Xiaoguang *et al*. (2018) and Khan *et al*. (2019) in China, found that increasing nitrogen fertilization rates are a prerequisite for high yields, but simultaneously increase lodging risk.

6. Grain yield/m^2:

In the first season under level of 50 kg N/fed, the grain yield ranged from 437.60 for Shandaweel 1 to 560.60 for Sids 1 with an average of 489.10 g. Under level of 75 kg N/fed, the average ranged from 653.30 for Entry 13 to 826.00 for 103 Mohsan with an average of 732.90 g. Also, under level of 100 kg N/fed, the average ranged from 746.40 for Entry 20 to 957.50 for Entry 16 with an average of 855.90 g (Table 10).

In the second season under level of 50 kg N/fed, the average grain yield ranged from 417.70 for Sids 1 to 559.70 for Entry 23 with an average of 465.11 g. Under level of 75 kg N/fed, the average ranged from 663.00 for Entry 20 to 839.30 for Giza 171 with an average of 755.10 g. Also, under level of 100 kg N/fed, ranged from 690.80 for Entry 20 to 861.70 for Entry 19 with an average of 793.70 g (Table 10). The same trend recorded over the two seasons (Table 10). The combined average of grain yield/m^2 under fertilizer of 50 kg N/fed, ranged from 451.00 m^2 for Entry 25 to 546.70 m^2 for Entry 23 with an average of 477.10 g m^2. As well as under level of 75 kg N/fed, the grain yield/m^2 ranged from 684.80 for Entry 20 and Sakha 93 to 818.20 m^2 for Entry 19 with an average of 744.00 g m^2. Also, under level of 100 kg N/fed, ranged from 718.60 m^2 for Entry 20 to 884.80 m^2 for Giza 171 with an average of 824.80 g m^2 (Table 10). The mean grain yield over all genotypes increased as nitrogen rate increased up to 100 kg N/fed. The results showed highly significant differences among wheat genotypes for grain yield in both seasons. The increase in yield of the genotypes with increasing N rates up to 100 kg N/fed, adequate levels might be due to the role of N in increasing the leaf area and promote photosynthesis efficiency which promote dry matter production and increase yield. In line with this, improvements in wheat yield and its components under the acceptable increasing N rates were reported by Rekaby *et al*. (2016), Zen El-Dein and Seif El-Nasr (2016), El-Temsah (2017) and Solomon and Anjulo (2017).

Yasser and Naheif (2018) noted that the variation of yield and its attributes in response to increasing N fertilization levels in wheat varieties, to the genetic constitution ability of the genotypes to benefit from the amount of N applied. These results are in agreement with those mentioned by Atia *et al.* (2016), Jarecki *et al.* (2017), Solomon and Anjulo (2017) and Morsy *et al*. (2018). Moreover, some genotypes gave highly significantly grain yield/m^2. These genotypes could be used to improve grain yield/m^2.

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تأثير التسميد النيتروجيني علي الصفات ذات العلاقة بالرقاد والمحصول في تراكيب وراثية من قمح الخبز

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الملخص

أجري هذا البحث في موسمين ٢٠١٨/٢٠١٧، ٢٠١٩/٢٠١٨ بهدف تقييم عشرون تركيب وراثي مختلفة من قمح الخبز تحت ثلاث مستويات من التسميد النيتروجيني هي ٥٠ ، ٧٥ ، ١٠٠ كيلوجرام نيتروجين/للفدان للصفات المرتبطة بالرقاد وهي ارتفاع النبات، طول السلامية الثانية، قطر الساق، الوزن الجاف/للوحدة، نسبة الرقاد بالإضافة إلي محصول الحبوب بمزرعة بحوث قسم المحاصيل – كلية الزراعة – جامعة أسيوط.
وكانت أهم النتائج المتحصل عليها:

–كانت هناك فروق معنوية جداً بين مستويات التسميد النيتروجيني وكذلك بين التراكيب الوراثية والتفاعل بين التسميد النيتروجيني والتراكيب الوراثية لجميع الصفات تحت الدراسة وذلك في كلا الموسمين والتحليل المشترك بين الموسمين.

–أدي زيادة التسميد النيتروجيني ٧٥ كيلوجرام/للفدان إلي زيادة في الصفات المرتبطة بالرقاد (ارتفاع النبات – طول السلامية الثانية – قطر الساق – المادة الجافة) وبالتالي زيادة نسبة الرقاد. ولكن علي الجانب الآخر أدي ذلك إلي زيادة محصول الحبوب وذلك لجميع التراكيب الوراثية في كلا الموسمين.

–زيادة التسميد النيتروجيني إلي ١٠٠ كيلوجرام للفدان أدي إلي زيادة ارتفاع النبات وطول السلامية الثانية كما أدي هذا المعدل من زيادة التسميد النيتروجيني إلي نقص في قطر الساق والمادة الجافة/للوحدة.