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EFFECT OF NITROGEN FERTILIZER AND SEEDING RATES ON GROWTH AND GRAIN YIELD IN OATS (*AVENA SATIVA* L.)

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Abstract

A field experiment were conducted during fall season of 2016-2017 at fields of Collage of Agriculture - University of Diyala to study the effect of nitrogen fertilizer and seeding rates on growth, grain yield in oats. Factorial experiment with two factors was layout in randomize complete block design according to spilt plot arrangement with three replication. The main plots included nitrogen fertilizer levels (0, 40 and 80 kg. ha^{-1}) which represented as (N_1, N_2 and N_3) respectively, while the sub-plots included seeding rates (40, 80, 120 and 160 kg. ha^{-1}) (S_1, S_2, S_3 and S_4) respectively. The results showed that the nitrogen fertilizer (80 kg. ha^{-1}) was supremacy in plant height, Flag Leaf area, number of tillers per m^2, length of panicle, number of grain perpanical and grain yield 111.46 cm, 36.02 cm^2, 204.38 tillers m^2, 43.00 cm and 55.13 grains. $panicle^{-1}$ and 9.870 tons. ha^{-1} respectively. Seeding rate (160 kg. ha^{-1}) gave higher plant height (99.30 cm), flag leaf area (30.44 cm^2), panicle length (39.33 cm), number of grains per panicle (49.50), number of tillers per m^2 (328.67) and grain yield (8.19 t. ha^{-1}). The results showed a significant effect of interaction between nitrogen fertilizer and seeding rates on all studied traits.

Key words : Oats, Nitrogen fertilizer, Seeding rates, Flag leaf area, Panicle length.

Introduction

Oat (*Avena sativa* L). is a winter-growing crop cultivated in many countries. The world's cultivated area is 9.6 million hectares, mostly in Russia, Canada, Poland and Australia while Global production is estimated at 23 million tons, (FAO, (2014). It is necessary for animals feeding specially ruminants, poultry, and ruminants as well as it is used in human nutrition and in the field of medicine for treating skin diseases. Oats are still very limited crops that grown in Iraq, therefore, it is necessary to pay more attention and crop servicing as well as using the typical seed rates which achieved by the appropriate numerical density to invest the growth factors efficiently by using of sufficient nitrogen levels, which leads to in creasing the grain crops production (Essa, 1990). Hanif and Langer, (1972) pointed that the addition of nitrogen has increased the components and grain yield. Dawood, (1999) and Rubaie, (2002) obtained significant increase in grain yield and components with high nitrogen levels. Metwally *et al.,* (1998) found that, using of different nitrogen levels for barley crop (*Hordeum vulgare* L.) 37.5, 75, 100 and 150 kg ha^{-1} led to significant increase in leaf area, plant height, spike length, number of spike and grain yield. Lafond *et al.,* (2006a) pointed that the addition of nitrogen to the oat crop increases the grain yield, also, Pecio and Bichonski, (2010) used different levels of nitrogen (0, 30, 60, 90 and 120 kg. ha^{-1}) and found, that level of 120 kg.ha $^{-1}$ led to increase grain yield and the number of grain per panicles of oats. On the other hand, Tourp *et al.,* (2015) reported that the increase in plant population from 50 to 100 m^{-2} led to increases grain yield. As well as, Lafond *et al.,* (2013) found that distance 40 cm and amount of fertilizer 120 Kg. ha^{-1} gave the highest yield of oats. The aim of this study was to determine the effect of seeding rates and levels of nitrogen fertilizer, which gives the highest yield, and components of oats.

Materials and Methods

A field experiment was carried out during fall season of 2016-2017 at fields of Dep. of Field Crops Sciences / Collage of Agriculture / University of Diyala, to study the effect of nitrogen fertilizer and seeding rate on the growth and grain yield in oats. Chemical and physical properties of experiment soil were showed in table 1.

Factorial experiment with two factors was layout in randomize complete block design according to spilt plots

Table 1: Some physical and chemical properties of experiment soil.

Parameters	Unit parameter	
pH	....	8.4
Ec	Dec simins. m^{-1}	2.74
N	mg. kg^{-1}	34.8
P	mg. kg^{-1}	13.7
K	mg. Kg^{-1}	509
Organic matter	g/Kg	18.26
Sand	g. kg^{-1}	170
Clay	g. kg^{-1}	360
Silt	g. kg^{-1}	470
Soil texture	....	Silty clay

arrangement with three replications. The main plots included nitrogen fertilizer levels of (0, 40 and 80 $kg.ha^{-1}$) which represented as (N_1, N_2, and N_3 respectively), while the sub-plots included seeding rates (40, 80, 120, and 160 kg. ha^{-1}) (S_1, S_2, S_3 and S_4), respectively. Seedbed was prepared, mold board plough followed by disking and levelling. The size of each subplot was 2×2 m^2 with 15 cm between-row spacing, Oats (Pimula var.) seeds were sown according to the above mentioned rates and in depth of 3 cm in 18 Oct. of 2016, Nitrogen fertilizer was added as a form of urea (46 N%) according to the mentioned levels above with two times, first time was given after two weeks of emergence, while second time was given after one month from the first time. Phosphate fertilizer was added before planting as a form of superphosphate (P_2O_5% 46). Weeding and irrigation were done as needed. Five plants were selected randomly from the intermediate rows to study the following traits:

1. **Plant height (cm):** was measured at the stage of 100% flowering on the basis of height from the soil surface to panicle base of main stem.
2. **Flag leaf area (cm^2) :** was measured according to the following equation Thomas, (1975) as an average of 5 leaves which taken randomly of main stems.

   Flag leaf area = flag leaf length × flag leaf width at the middle × (0.75).
3. **Number of tillers (tillers. m^{-2}):** was calculated from 1 m^2 of each experimental unit.
4. Panicle length (cm).
5. Number of grain. $panicle^{-1}$ (grain. $panicle^{-1}$).
6. **Grain yield ($ton.ha^{-1}$):** was calculated depending on the weight of grain that obtained from harvested plants of 1 m^2, then converted to $ton.ha^{-1}$.

Statistical analysis

Data were analyzed statistically according to the split plots arrangement in Randomized Complete Block Design by using Gen Stat software and comparison between mean were made using least significant difference (L.S.D.) at 0.05 probability level (Steel and Torrie, 1980).

Results and Discussion

Plant height (cm)

The results of table 2 showed that there were significant differences between nitrogen fertilizer levels. Level N_3 gave the highest height (111.46 cm) compared with N_1, which gave the lowest height (75.04 cm). The reason may be due to the fact that nitrogen increases division and expansion of cells as it enters the formation of amino acid tryptophan, which is made up of growth regulator (Indole acetic acid). which is necessary for plant cells elongation (Taiz and Zeiger, 2002). This is in agreement with Ratan, *et al.,* (2016). There was a significant difference between seeding rates, Level S_4 gave the highest mean (99.30 cm) compared to S_1 which gave (89.00cm), This increase may be was due to optimum density of plants at this seeding rate, which resulted in provision of an adequate amount of material represented during the growth stages and, this is agreement with Lafond *et al.,* (2013). As for the interaction between two factors, there was a significant effect on the relative response of nitrogen fertilizer treatments by the effect of seeding rates. As shown in table 2, all levels of nitrogen fertilizer have taken similar behavior in increasing of plant height with the increasing of seeding rates.

Table 2: Effect of nitrogen fertilization, seed rates on plant height (cm).

Nitrogen fertilizer Kg. ha^{-1}	Seeding rates Kg. ha^{-1}				Mean
	S_1	S_2	S_3	S_4	
N_1	71.50	72.66	76.00	79.98	75.04
N_2	90.99	92.89	95.70	100.91	95.12
N_3	104.50	108.33	116.00	117.00	111.46
	89.00	91.30	95.90	99.30	mean
L.S.D. 0.05% to nitrogen fertilizer					2.81
L.S.D. 0.05% to seeding rates					1.25
L.S.D. 0.05% to nitrogen fertilizer × seeding rates					2.40

Flag leaf area (cm^2)

Results in table 3 showed that there were significant differences between flag leaf area means according to increasing in nitrogen fertilizer levels. Level N_3 gave the highest mean (36.02 cm^2), compared with N_1 which gave the low estimate (21.01 cm^2), This may be due to the role of nitrogen in increasing cell size and growth rate, which was positively reflected in increasing the flag leaf area, These results are in agreement with the findings of Mohammed and Ayad, (2013). S_1, S_2 and S_3 seeding rats gave the highest mean (30.44, 29.19 and 27.61 cm^2), respectively, compared to S_4, which recorded the lowest flag leaf area (26.54 $cm^{2)}$, This may be due to the fact that increasing seeding rates lead to higher competition among plants for main growth requirements and is essential for growth and development of leaf cells, These results are in agreement with EL–Hag, (2016) who found decreasing flag leaf area by increasing seeding rates.

Table 3: Effect of nitrogen levels and seed rates on the flag leaf area cm^2.

Nitrogen fertilizer Kg. ha^{-1}	Seeding rates Kg. ha^{-1}				Mean
	S_1	S_2	S_3	S_4	
N_1	21.84	22.99	20.16	19.06	21.01
N_2	29.33	29.56	27.84	26.50	28.31
N_3	36.40	38.77	34.85	34.06	36.02
	30.44	29.19	27.61	26.54	mean
L.S.D. 0.05% to nitrogen fertilizer					1.29
L.S.D. 0.05% to seeding rates					0.51
L.S.D. 0.05% to nitrogen fertilizer × seeding rates					1.06

There were significant effect due to interaction between two factors may be due to difference in the relative response levels of nitrogen fertilization by the effect of seeding rates, at all levels of nitrogen fertilizer. There were increasing of flag leaf area at the seeding rate $S_{2,}$ then decreasing at seeding rates S_3 and S_4.

Number of tillers (tillers.m^{-2})

There was a significant increase in the number of tillers (Table 4) resulted by nitrogen levels. Level N_1 gave the highest mean (204.38 tiller.m^{-2}) while level N_3 gave the lowest mean (193.12 tiller.m^{-2}). This may be due to the role of nitrogen in the synthesis of cytokine, which was positively reflected on the number of tillers at high level. This result is in agreement with Harfe, (2017) who found an increasing of wheat tillers number by increasing added amount of nitrogen fertilizer.

A significant differences was belong to, S_4 which gave the highest mean (328.67 tiller. m^{-2}), while S_1 achieved the lowest a mean (81.50 tillers.m^{-2}), this may be due to an increasing number of plants in the area unit, which lead to increasing number of tillers, This is in agreement with the findings of Campbell *et al.,* (1991).

Table 4 showed significant differences on this trait according to the interactions effect between nitrogen levels and seed in grates which may be due to link relative response of nitrogen levels with effect of seeding rates. At all levels of nitrogen fertilization, there was positive relationship between tillers number which increased by increasing of seeding rates.

Table 4: Effect of nitrogen fertilizer, seeding rates on number of tllers. m^{-2}(tllers. m^{-2}).

Nitrogen fertilizer Kg. ha^{-1}	Seeding rates Kg. ha^{-1}				Mean
	S_1	S_2	S_3	S_4	
N_1	82.50	146.50	235.50	308.00	193.12
N_2	86.50	151.00	245.00	327.50	202.50
N_3	75.50	164.00	227.50	350.50	204.38
	81.50	153.83	236.00	328.67	mean
L.S.D. 0.05% to nitrogen fertilizer					4.33
L.S.D. 0.05% to seeding rates					3.64
L.S.D. 0.05% to nitrogen fertilizer × seeding rates					5.75

Panicle length cm

Table 5 showed significant differences in nitrogen levels, and N_3 gave the highest mean (43.00 cm) compared to N_1, which achieved lower mean (32.50 cm), This may be due to the fact that low level of nitrogen leads to slow growth and low cell division, thus shortening the length of the panicle. These results was in agreement with the findings of Aghdam and Samadiyan, (2014).

Significant differences were found between panicle lengths according to effect of seeding rate (Table 5). Level treatment S_4 gave the highest panicle length (39.33 cm) compared to the S_1 (36.33 cm), This may be due to increasing in plant height (Table 2), as increased shading at high seed rates had allowed auxin and in combination with gibberellins to increase in ternodes length, including panicle length Essa, (1990).

Table 5 showed significant differences between the two studied factors. The reason behind this interaction may be due to the difference in the relative response to the levels of nitrogen fertilization and seeding rates, In N_1 and N_2, were observe the highest mean of panicle at S_2 and then decreased at S_3 before rising again at S_4,

Table 5: Effect of nitrogen fertilizer, seeding rates on Panicle length cm.

Nitrogen fertilizer Kg. ha^{-1}	Seeding rates Kg. ha^{-1}				Mean
	S_1	S_2	S_3	S_4	
N_1	31.00	33.50	31.50	34.00	32.50
N_2	36.50	38.50	38.00	39.50	38.13
N_3	41.50	42.50	43.50	44.50	43.00
	36.33	38.17	37.67	39.33	mean
L.S.D. 0.05% to nitrogen fertilizer					3.32
L.S.D. 0.05% to seeding rates					0.51
L.S.D. 0.05% to nitrogen fertilizer × seeding rates					2.78

while N_3 achieved an increase in length of panicle by increasing seeding rates.

Grains number per Panicle (grain.panicle^{-1})

Table 6 indicated significant differences between fertilization levels in the number of grains per panicle when N_3 gave the highest mean (55.13 grain. Panicle^{-1}) compared to N_1, which achieved 34.63 grain. panicle^{-1}, The increasing in nitrogen levels led to increasing of plant height, flag leaf area and number of tillers per m^2 (Table 2, 3 and 4) which led to increasing of grain number per panicle. Nitrogen also plays an important role in increasing the fertility of most florets compared to the low levels (Hanif and Langer, 1972), These results were similar of findings reports by Jat *et al.,* (2015) and Mantai *et al.,* (2016.

There was a significant effect of seeding rates on number of grains per panicle^{-1}, when S_4 gave the highest mean (49.50) compared to S_1, which achieved 42.50 grain. panicle^{-1}, as gave, increasing ratio 16.47%, This increasing may be due to increasing of plant height, flag leaf area and number of tillers per m^2 (Table 2, 3 and 4). There was a Significant interaction between two studied factors, which may be due to the difference in the relative response of the seeding rates and nitrogen fertilization, noting that all levels of nitrogen fertilization had increased number of grains per panicle by increasing seeding rates.

Table 6: Effect of nitrogen fertilizer, seeding rates on grains number per Panicle (grain . panicle^{-1}).

Nitrogen fertilizer Kg. ha^{-1}	Seeding rates Kg. ha^{-1}				Mean
	S_1	S_2	S_3	S_4	
N_1	31.00	32.50	34.50	40.50	34.63
N_2	44.00	46.50	48.50	50.00	47.38
N_3	52.50	54.00	56.00	58.00	55.13
	42.50	44.33	46.33	49.50	mean
L.S.D. 0.05% to nitrogen fertilizer					1.76
L.S.D. 0.05% to seeding rates					0.46
L.S.D. 0.05% to nitrogen fertilizer × seeding rates					1.35

Grains yield ton.ha^{-1}

The results showed a significant effect of nitrogen fertilizer levels on this trait (Table 7). Level N_3 recorded the highest mean grain yields (9.87 ton.ha^{-1}), while N_1 gave the lowest mean (4.18 tons.ha^{-1}). This increasing may be due to higher fertilizer level of the highest means of number of tillers.m^{-1}, panicle length and number of grains.panicle^{-1} compared to the lowest level (Tables 4, 5 and 6). This is in agreement with Pecio and Bichonski (2010) and Engel, (1997).

Table 7: Effect of nitrogen fertilizer, seeding rates on grain yield (ton. ha^{-1}).

Nitrogen fertilizer Kg. ha^{-1}	Seeding rates Kg. ha^{-1}				Mean
	S_1	S_2	S_3	S_4	
N_1	3.80	3.90	4.17	4.85	4.18
N_2	6.84	7.17	7.89	8.93	7.70
N_3	9.17	9.69	9.85	10.79	9.87
	6.60	6.92	7.30	8.19	mean
L.S.D. 0.05% to nitrogen fertilizer					0.12
L.S.D. 0.05% to seeding rates					0.16
L.S.D. 0.05% to nitrogen fertilizer × seeding rates					0.24

There was a significant increasing in grain yield (Table 7) with increasing of 24.09 and 10.61 ton. ha^{-1} for S_4 and S_3 respectively in comparison with S_1. This increasing was due to higher mean of tillers.m^{-1} and number of grains. Panicle^{-1} (Tables 4 and 6). This corresponded with the findings of Mantai *et al.,* (2016). There was a significant interaction between two studied factors in this trait due to the difference in the relative response to levels of nitrogen by effect of seeding rates. At N_1, N_2 and N_3 levels grain yield was increased by increasing seeding rates.

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