Nitrogen Rates Effect on Some Agronomic Traits of Turnip Rape under Different Irrigation Regimes

1 M. Begdelo, 2 A. H. Shirani rad, 3 G. Noormohammadi, 4 A. A. Tajalli

1Department of Agronomy, Science and Research Branch, Islamic Azad University, Tehran, Iran
2Department of Oilseed Crops, Seed and Plant Improvement Institute, Karaj, Iran
3Department of Agronomy, Science and Research Branch, Islamic Azad University, Tehran, Iran
4Department of Agronomy and Plant Improvement, Shahry Rey Branch, Islamic Azad University, Shahry Rey, Iran

ABSTRACT

Field experiment was conducted in Qazvin, Iran during 2009-2010 growing season aimed at optimizing nitrogen rates under different irrigation regimes for production of turnip rape (Brassica campestris L.-cv. Goldrush). The experiment was conducted using a randomized complete block, factorial design with three replicates. Experimental treatments were irrigation in four levels (I: I1= irrigation on the basis of 80 (control), I2= 100, I3= 120 and I4= 140 ml evaporation from the class A pan) and four nitrogen fertilizer rates (N: N1= 0, N2= 50, N3= 100, N4= 150 kg ha-1). It was shown that increasing irrigation rate significantly increased 1000 seeds weight, seed yield, seed oil yield, biomass yield and harvest index as control irrigation (80 ml evaporation from the class A pan) had a significant preference in comparison to 140 ml evaporation from the class A pan. Generally application of 100 and 150 kg N ha-1 in control irrigation had a significant preference in comparison to other treatments. The highest seed yield and seed oil yield obtained by application of 150 kg N ha-1 in control irrigation by average of 5586 and 2348 kg ha-1, respectively. The interaction effect of irrigation × nitrogen had not a significant increase on harvest index.

Key words: Turnip rape (Brassica campestris L.); Nitrogen rates; Irrigation regimes; Yield.

INTRODUCTION

Edible oil is one of the most important food sources for human and consumption of it is necessary due to providing energetic and essential fatty acids. Production of edible oil in Iran is not in a desirable level, therefore it is necessary to have a long term and consistent schedule aimed to independence in edible oil production. Increase of edible oil production could be possible by introducing oilseed crops which is adaptable with weather condition in Iran in addition to amending planting methods and improving cultivars with high oil rate and enhancing yield. Recently production of rapeseed as a well adapted oilseed crop with weather condition in Iran taking in to consideration [1]. Agricultural cultivars of rapeseed (Brassicaissae) belonging to two species of common rapeseed (Brassica napus L.) and turnip rape (Brassica campestris L. or Brassica rapa L.) [2]. Turnip rape has been cultivated since about 2000 years ago in an extend area from west Europe to China and Korea and from Norway to African desert and India [3] and its seeds contains 40-45% oil and 20-25% protein [4].

Nitrogen is the most important nutrient affecting yield quantity and quality and one of the most important factors determining crop production as providing nutrient needs during cultivation in a crop such as turnip rape economically would be highly beneficial for farmers and industrialists. No awareness of turnip rape nutrient needs followed by inappropriate application of chemical fertilizers not only do not increase yield, also cause to environmental pollutions, disorder in agro-ecosystems balance, water table pollution, agricultural soils compression and decrease of efficiency and profitability. Soil total harvested nitrogen in production of 1 t seed ha-1 of rapeseed is about two times more than soil total harvested nitrogen in production of the same rate of wheat [5]. Researchers reported nitrogen affecting seed yield by increasing number of branches and buds in plant [6]. Nitrogen application increase the number of flowering branches, flowering stage period, total dry weight and silique dry weight [7]. Study of nitrogen rates effect on turnip rape seed yield revealed that application of 120 kg N ha-1 increased yield [8]. Australian researchers reported nitrogen fertilizer increased turnip rape seed yield although its effect on dry weight, silique length, 1000 seeds weight, number of seeds per silique, seed oil content and nutrients concentration rate in silique and seed was negligible [9]. Chauhan et al. (1993) also reported increasing nitrogen rate
increased number of siliques but had not a prominent effect on 1000 seeds weight and number of seeds per silique [10].

Water stress could influence germination percentage and rate and the reaction of various plants seed and various species of a plant to this stress have an extended range [5]. Water stress decrease seed yield mainly by decrease of number of silique per plant [11]. Combination of appropriate irrigation and high rates of nitrogen increase rapeseed yield at a rate of four times and this increase was more than two times of total increase of these factors when applied separately. The significant interaction effect of irrigation and nitrogen on seed yield revealed that sufficient rates of water and nitrogen probably cause to increase of root development and nitrogen use efficiency [12].

Therefore the main objective of this study is to assess the effects of nitrogen rates on 1000 seeds weight, seed yield, seed oil yield, biomass yield and harvest index under different irrigation regimes.

MATERIALS AND METHODS

An experiment was conducted at experimental farm in Qazvin, Iran (49°57'E, 36°18'N; 1314 m a.s.l) during 2009-2010 growing season aimed to assess nitrogen rates and irrigation regimes effects on some agronomic traits of turnip rape (Brassica campestris L.). Qazvin is a semi-arid region and receives average annual rainfall of 312 mm. The soil type where the experiment took place was a clay loam soil. The experimental design was a factorial arrangement in the form of randomized complete block design with three replications. Treatments were included two agents: irrigation in four levels (I: I1= irrigation on the basis of 80 (control), I2 = 100, I3 = 120 and I4 = 140 ml evaporation from the class A pan) and nitrogen fertilizer in four levels (N: N1 = 0, N2 = 50, N3 = 100, N4 = 150 kg N ha⁻¹) in the form of Urea. N fertilizer applied in three stages: one-third in 2-4 leaves stage, one-third in stemming stage and one-third in flowering stage. Each experimental plot consisted of 4 rows, 4 m long with 30 cm spaced between rows and 4 cm distance between plants on the rows. Goldrush (Brassica campestris L.- cv. Goldrush) was used as the turnip rape cultivar. P and K were applied at a rate of 75 kg P₂O₅ ha⁻¹ and 50 kg K₂O ha⁻¹ pre-plant in the form of di-ammonium phosphate and K₂SO₄, respectively, and were incorporated in the soil before sowing. Seeds were planted on 4 Oct. 2009. The plants were thinned after complete emergence in the 6 leaf stage as keeping on rows about 4 cm. The final harvest was performed at physiological maturity on 8-11 Jun. 2010. At harvest stage the two middle rows were used for sampling and measured parameters. For sampling ten plants from the middle of each plot were harvested. Also the crop was kept free of weeds by applying 2.5 L ha⁻¹ Trifluralin pre-plant.

The following traits were studied: 1000 seeds weight, seed yield, seed oil yield, biomass yield and harvest index. Analyses were performed using the MSTATC software. A factorial analysis of variance (ANOVA) was performed for all parameters. In addition the Duncan’s Multiple Range Test (DMRT) (P = 0.05) was used to conduct mean comparison.

RESULTS AND DISCUSSION

I. 1000 seed weight (TSW)

The results of factorial analysis of variance revealed that the simple effect of irrigation and nitrogen and the interaction effect of them on 1000 seeds weight were significant at P = 0.01 (Table 1). Comparison of means in different irrigation regimes showed that 1000 seeds weight decrease by irrigation rate reduction as the highest 1000 seeds weight by average of 4.75 g and the lowest 1000 seeds weight by average of 3.15 g obtained in I1 and I4, respectively (Table 2). Generally 1000 seeds weight is the function of rapidity and duration of seed filling which provided by current photosynthesis and re-translocation in plant. Therefore 1000 seeds weight reduction due to decrease of irrigation rate is the result of water shortage effects in seed filling period which cause to reduction of absorption and translocation of water and nutrients in plant and reduction of nutrients translocation rapidity to seeds [5]. Also 1000 seeds weight significantly increased by increasing nitrogen rate as the highest 1000 seeds weight by average of 4.5 g and the lowest 1000 seeds weight by average of 3.1 g obtained in N4 and N1, respectively (Table 2). These results agree with the results obtained by some other researchers [11-13]. Study of interaction effect of irrigation and nitrogen revealed that the highest 1000 seeds weight by average of 5.5 g and the lowest 1000 seeds weight by average of 2.5 g obtained in I1N4 and I4N1, respectively (Fig. 1).
II. Seed yield
The results of factorial analysis of variance revealed that the simple effect of irrigation and nitrogen and the interaction effect of them on seed yield were significant at $P = 0.01$ (Table 1). Comparison of means in different irrigation regimes showed that the highest seed yield by average of 4688 kg ha$^{-1}$ and the lowest seed yield by average of 1711 kg ha$^{-1}$ obtained in I$_1$ and I$_4$, respectively (Table 2). According to previous studies seed yield increase in response to irrigation rate increase is mainly due to increase of number of silique per plant and seed weight which agree with our results. Also seed yield increased by nitrogen rate increase. The highest seed yield by average of 3991 kg ha$^{-1}$ and the lowest seed yield by average of 2381 kg ha$^{-1}$ obtained in N$_4$ and N$_1$, respectively (Table 2). Generally increasing nitrogen application enhance seed yield as non application of nitrogen cause to a prominent decrease of seed yield [7- 11].

Study of interaction effect of irrigation and nitrogen showed that the highest seed yield by average of 5586 kg ha$^{-1}$ and the lowest seed yield by average of 1286 kg ha$^{-1}$ obtained in I$_1$N$_4$ and I$_4$N$_1$, respectively (Fig. 2). These results agree with Fathi et al. [14].

**Table 1- Factorial analysis of variance components (Irrigation, Nitrogen and their interactions) for assessed traits**

<table>
<thead>
<tr>
<th>C.O.V</th>
<th>DF</th>
<th>TSW</th>
<th>SY</th>
<th>SOY</th>
<th>BY</th>
<th>HI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replication</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td>3</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>3</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Irrigation×Nitrogen</td>
<td>9</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>ns</td>
</tr>
<tr>
<td>Error</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CV (%)</td>
<td></td>
<td>6.5</td>
<td>6.06</td>
<td>6.72</td>
<td>7.43</td>
<td>8.26</td>
</tr>
</tbody>
</table>

*, ** significant at 5 and 1% respectively, ns: not significant
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Table 2- Effects and means comparisons (simple effect) of Irrigation and Nitrogen on assessed traits

<table>
<thead>
<tr>
<th>Treatment</th>
<th>TSW (g)</th>
<th>SY (kg/ha)</th>
<th>SOY (kg/ha)</th>
<th>BY (kg/ha)</th>
<th>HI (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation (base on evaporation from class A pan)</td>
<td>I₁</td>
<td>4.75a</td>
<td>4688a</td>
<td>1956a</td>
<td>14940a</td>
</tr>
<tr>
<td></td>
<td>I₂</td>
<td>4.25b</td>
<td>3927b</td>
<td>1548b</td>
<td>13540b</td>
</tr>
<tr>
<td></td>
<td>I₃</td>
<td>3.45c</td>
<td>3117c</td>
<td>1187c</td>
<td>11070c</td>
</tr>
<tr>
<td></td>
<td>I₄</td>
<td>3.15d</td>
<td>1711d</td>
<td>627.8d</td>
<td>8838d</td>
</tr>
<tr>
<td>Nitrogen rate (kg ha⁻¹)</td>
<td>N₁</td>
<td>3.1d</td>
<td>2381d</td>
<td>924.8c</td>
<td>9920c</td>
</tr>
<tr>
<td></td>
<td>N₂</td>
<td>3.775c</td>
<td>3297c</td>
<td>1309b</td>
<td>11960b</td>
</tr>
<tr>
<td></td>
<td>N₃</td>
<td>4.225b</td>
<td>3774b</td>
<td>1519a</td>
<td>12960a</td>
</tr>
<tr>
<td></td>
<td>N₄</td>
<td>4.5a</td>
<td>3991a</td>
<td>1565a</td>
<td>13530a</td>
</tr>
</tbody>
</table>

Any two means not sharing a common letter differ significantly from each other at 5% probability

III. Seed oil yield

The results of factorial analysis of variance revealed that the simple effect of treatments and their interaction on seed oil yield were significant at P = 0.01 (Table 1). Comparison of means in different irrigation regimes showed that seed oil yield decreased by irrigation rate reduction as the highest seed yield by average of 1956 kg ha⁻¹ and the lowest seed yield by average of 927.8 kg ha⁻¹ obtained in I₁ and I₄, respectively (Table 2). The significant reduction of seed oil yield by irrigation rate decrease could be attributed to genetic dependence of this trait to seed oil content which shows the same reaction to water stress. Appropriate irrigation regime could increase seed oil yield in this plant [15]. Also the reduction of seed oil yield in no nitrogen application in comparison to nitrogen application observed as the highest seed oil yields by average of 1519 and 1565 kg ha⁻¹ obtained in N₃ and N₄, respectively and the lowest seed oil yield by average of 924.8 kg ha⁻¹ obtained in N₁ (Table 2). These results agree with the results reported by some other researchers [6-7-9-11]. Study of interaction effect of irrigation and nitrogen on seed oil yield revealed that the highest seed oil yield by average of 2348 kg ha⁻¹ and the lowest seed oil yield by average of 469.6 kg ha⁻¹ obtained in I₁N₄ and I₄N₁, respectively (Fig. 3).

Fig.3. Interaction effect of N rate and irrigation on seed oil yield (kg/ha)
IV. Biomass yield
The results of factorial analysis of variance revealed that the simple effect of irrigation and nitrogen and the interaction effect of them on biomass yield were significant at $P = 0.01$ (Table 1). Comparison of means in different irrigation regimes showed that biomass yield decrease by irrigation rate reduction as the highest biomass yield by average of 14940 kg ha$^{-1}$ and the lowest biomass yield by average of 8838 kg ha$^{-1}$ obtained in $I_1$ and $I_4$, respectively (Table 2). These results agree with Azizi et al. (1998) [5]. The biomass yield was affected by different N rates and increased with N fertilization as the highest biomass yields by average of 13530 and 12960 kg ha$^{-1}$ obtained in $N_1$ and $N_3$, respectively and the lowest biomass yield by average of 9920 kg ha$^{-1}$ obtained in $N_1$ (Table 2). These results agree with Azizi et al. (1998) [5]. Study of interaction effect of irrigation and nitrogen on biomass yield revealed that the highest biomass yields by average of 17190 and 16350 kg ha$^{-1}$ obtained in $I_1N_4$ and $I_1N_3$, respectively and the lowest biomass yields by average of 7921 and 8762 kg ha$^{-1}$ obtained in $I_4N_1$ and $I_3N_1$, respectively (Fig. 4).

V. Harvest index (HI)
The results of factorial analysis of variance revealed that the simple effect of treatments on harvest index were significant at $P = 0.01$ (Table 1). Comparison of means in different irrigation regimes showed that the highest harvest index rates by average of 30.78 and 28.95% obtained in $I_1$ and $I_2$, respectively and the lowest harvest index by average of 19.23% obtained in $I_4$ (Table 2). Also harvest index significantly increased by nitrogen application as the highest harvest index rates by average of 26.77, 28.26 and 28.66% obtained in $N_2$, $N_3$ and $N_4$, respectively (the same statistical group) and the lowest harvest index by average of 23.19% obtained in $N_1$ (Table 2). The interaction effect of irrigation and nitrogen on harvest index was not significant.

CONCLUSIONS
According to our results the interaction of irrigation and nitrogen had a significant effect on assessed traits except on harvest index. Achievement to the highest rates of seed yield and seed oil yield was the most important goal in this study. Application of 150 kg N ha$^{-1}$ was the most appropriate rate of nitrogen due to production of the highest seed yield and seed oil yield by average of 3991 and 1565 kg ha$^{-1}$, respectively. Also irrigation on the basis of 80 ml evaporation from the class A pan (normal irrigation) produced the highest seed yield and seed oil yield by average of 4688 and 1956 kg ha$^{-1}$, respectively. Application of 150 kg N ha$^{-1}$ under normal irrigation had an additive effect on seed yield and seed oil yield. Therefore to produce the highest seed yield and seed oil yield on turnip rape ($Brassica campestris$ L.-cv. Goldrush) in the same condition application of 150 kg N ha$^{-1}$ under normal irrigation recommend. Also it would be a good suggestion to carry out the same consecutive studies in the similar regions.

REFERENCES