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

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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: I_1= irrigation on the basis of 80 (control), I_2 = 100, I_3 = 120 and I_4 = 140 mL evaporation from the class A pan) and four nitrogen fertilizer rates (N: N_1= 0, N_2 = 50, N_3 = 100, N_4 = 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 150 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 into consideration (Bala-Deh, 2000). Agricultural cultivars of rapeseed (Brasssicaseae) belonging to two species of common rapeseed (*Brassica napus* L.) and turnip rape (*Brassica campestris* L. or *Brassica rapa* L.) (Azizi *et al.*, 1998a). 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 (Hedge, 1976) and its seeds contains 40-45% oil and 20-25% protein (Nuttall *et al.*, 1987).

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 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 ton seed ha^{-1} of rapeseed is about two times more than soil total harvested nitrogen in production of the same rate of wheat (Azizi *et al*., 1998a). Researchers reported nitrogen affecting seed yield by increasing number of branches and buds in plant (Grant and Bailey, 1993). Nitrogen application increase the number of flowering branches, flowering stage period, total dry weight and silique dry weight (Zangani, 2001). Study of nitrogen rates effect on turnip rape seed yield revealed that application of 120 kg N ha^{-1} increased yield (Ali *et al*., 1996). 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 (Mason and Brennan, 1998). 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 (Chauhan *et al*., 1993).

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 (Azizi *et al*., 1998a). Water stress decrease seed yield mainly by decrease of number of silique per plant (Ghasemi and Isfahani, 2006). 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 (Krogman and Hobbs, 1975).

Therefore, the main objective of this study was 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: I_1 = irrigation on the basis of 80 (control), I_2 = 100, I_3 = 120 and I_4 = 140 mL evaporation from the class A pan) and nitrogen fertilizer in four levels (N: N_1 = 0, N_2 = 50, N_3 = 100, N_4 = 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 P_2O_5 ha^{-1} and 50 kg K_2O ha^{-1} pre-plant in the form of di-ammonium phosphate and K_2SO_4, 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.

Studied traits: One Thousand 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

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 I_1 and I_4, 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

Table 1: Factorial analysis of variance components (irrigation, nitrogen and their interactions) for assessed traits

C.O.V	DF	TSW	SY	SOY	BY	HI
Replication	2					
Irrigation	3	**	**	**	**	**
Nitrogen	3	**	**	**	**	**
Irrigation×Nitrogen	9	**	**	**	**	ns
Error	30					
Total	47	-	-	-	-	-
CV (%)	-	6.5	6.06	6.72	7.43	8.26

*, **significant at 5 and 1%, respectively, ns: not significant

Table 2: Effects and means comparisons (simple effect) of irrigation and nitrogen on assessed traits

		SY	SOY	BY	
Treatment	TSW (g)	------------(kg ha^{-1})------------			HI (%)
Irrigation (base on evaporation from class A pan)					
I_1	4.75a	4688a	1956a	14940a	30.78a
I_2	4.25b	3927b	1548b	13540b	28.95ab
I_3	3.45c	3117c	1187c	11070c	27.91b
I_4	3.15d	1711d	627.8d	8838d	19.23c
Nitrogen rate (kg ha^{-1})					
N_1	3.1d	2381d	924.8c	9920c	23.19b
N_2	3.775c	3297c	1309b	11960b	26.77a
N_3	4.225b	3774b	1519a	12960a	28.26a
N_4	4.5a	3991a	1565a	13530a	28.66a

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

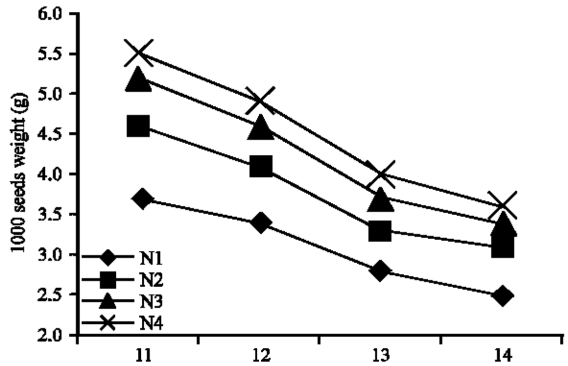

Fig. 1: Interaction effect of N rate and irrigation on 1000 seeds weight (g)

in plant and reduction of nutrients translocation rapidity to seeds (Azizi *et al.*, 1998a). 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 N_4 and N_1, respectively (Table 2). These results agree with the results obtained by some other researchers (Ghasemi and Isfahani, 2006; Krogman and Hobbs, 1975; Jang *et al.*, 1987).

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 I_1N_4 and I_4N_1, respectively (Fig. 1).

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 150 kg ha^{-1} and the lowest seed yield by average of 1711 150 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 150 kg ha^{-1} and the lowest seed yield by average of 2381 150 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 (Zangani, 2001; Ali *et al.*, 1996; Mason and Brennan, 1998; Chauhan *et al.*, 1993; Ghasemi and Isfahani, 2006).

Study of interaction effect of irrigation and nitrogen showed that the highest seed yield by average of 5586 150 kg ha^{-1} and the lowest seed yield by average of 1286 150 kg ha^{-1} obtained in I_1N_4 and I_4N_1, respectively (Fig. 2). These results agree with Fathi *et al.* (2002).

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 150 kg ha^{-1} and the lowest seed yield by average of 627.8 150 kg ha^{-1} obtained in I_1 and I_4, 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 (Faraji *et al.*, 2005). Also the reduction of seed oil yield in

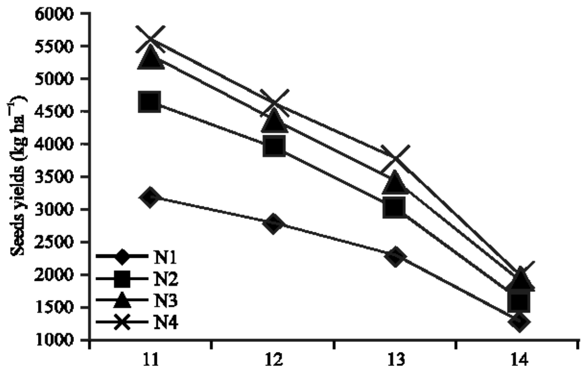

Fig. 2: Interaction effect of N rate and irrigation on seed yield (kg ha^{-1})

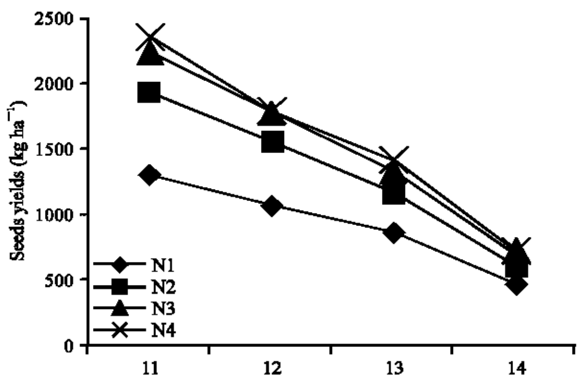

Fig. 3: Interaction effect of N rate and irrigation on seed oil yield (kg ha^{-1})

no nitrogen application in comparison to nitrogen application observed as the highest seed oil yields by average of 1519 and 1565 150 kg ha^{-1} obtained in N_3 and N_4, respectively and the lowest seed oil yield by average of 924.8 150 kg ha^{-1} obtained in N_1 (Table 2). These results agree with the results reported by some other researchers (Grant and Bailey, 1993; Zangani, 2001; Mason and Brennan, 1998; Chauhan *et al.*, 1993; Ghasemi and Isfahani, 2006).

Study of interaction effect of irrigation and nitrogen on seed oil yield revealed that the highest seed oil yield by average of 2348 150 kg ha^{-1} and the lowest seed oil yield by average of 469.6, 150 kg ha^{-1} obtained in I_1N_4 and I_4N_1, respectively (Fig. 3).

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 150 kg ha^{-1} and the lowest biomass yield by average of 8838 150 kg ha^{-1} obtained in I_1 and I_4, respectively (Table 2). These results agree with Azizi *et al.* (1998b). 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 150 kg ha^{-1} obtained in N_4 and N_3, respectively and the lowest biomass yield by average of 9920 150 kg ha^{-1} obtained in N_1 (Table 2),these results agree with Azizi *et al.* (1998b).

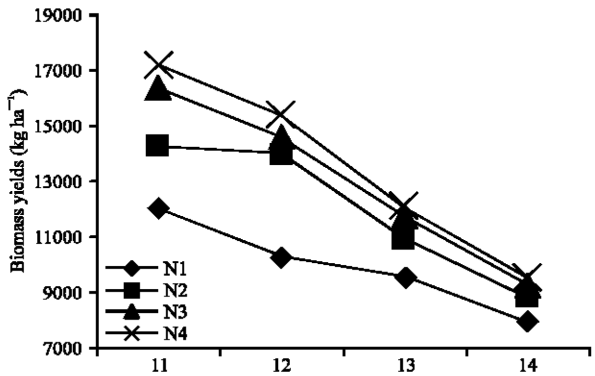

Fig. 4: Interaction effect of N rate and irrigation on biomass yield (kg ha^{-1})

Study of interaction effect of irrigation and nitrogen on biomass yield revealed that the highest biomass yields by average of 17190 and 16350 150 kg ha^{-1} obtained in I_1N_4 and I_1N_3, respectively and the lowest biomass yields by average of 7921 and 8762 150 kg ha^{-1} obtained in I_4N_1 and I_3N_1, respectively (Fig. 4).

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 150 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 150 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.

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