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Evaluation of different levels of nitrogen fertilizer on growth analysis in two springs Canola *(B. napus* L.)

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ABSTRACT

In order to investigate the effect of the amount of Nitrogen on growth characteristics of spring type of forage canola in summer cultivation, an experiment was conducted in year 2012 in agricultural research center of Ghazvin. This experiment was done in split plot form and with a randomized complete block design with three replications. The main factor included five levels of Nitrogen (0, 75,150,225 and 300 kg\h). The sub factor included two varieties of spring type of Canola including RGS003 and SARIGOL. The impact of Nitrogen (p≤0/05) on final fresh forage was significant. The highest fresh forage yield was obtained from applying 300 kg/ha Nitrogen and RGS003 variety treatment with the average of 46382/42 kg/ha. The lowest fresh forage yield was approached from non application of Nitrogen and SARIGOL variety treatment with the average of 9020/83 kg/ha.

Key words: Canola, Nitrogen, Fresh forage, Varieties

INTRODUCTION

Growth analysis serves as an approach by which various plant responses to environmental factors to which encounters under different phonologies may be interpreted and explained. To recognize and evaluate growth indices is becoming increasingly substantial while analyzing factors affecting yield so that determination of dry matter in unit area while growing period, as product of photosynthetic accumulation, demonstrates crop yield among others [6]. Russel et al. (1984) pointed out that growth rate and wide variety of biological process are affected by temperature to large extent [10]. Hence, to integrate temperature with growth and developments, allows us to explain and justify for mentioned process (pathways) much efficiently. It has been found that in some genotypes of *B.napus* and *B.Juncea*, grain yield, total dry matter and harvesting index were improved as higher nitrogen rate was applied[2, 4, 5, 9],since, generally, nitrogen accelerates carbohydrate conversion rate into protein as a main pathway in cell protoplasm structure, in turn enlarges cells such that its impacts are reflected morphologically on higher leaf area index(LAI) and crop growth rate(CGR). As growth begins, leaf area index gets improved until it reaches to peak rate at flowering and pod setting, then it decreases in descend trend till zero rate. During this, crop growth rate (CGR) under goes ascending trend until maximum rate, then it decreases to under zero.

Some criteria such as leaf area durability after flowering and pod development, relative growth rate(RGR), crop growth rate (CGR),time to maximum leaf area index, accumulating pattern of dry matter in plants organ and days to crop ripening have been purposed to breed high-productive(yield)genotypes under water stress condition. Yasari et al., (2008) reported that applying combination of P, N, K and S, led to total dry matter, maximum CGR and maximum leaf area index (LAI) up to 880 g/m^2, 13.9 g/m^2 and 4.1 respectively[14]. Consequently, they pointed out that nutrients deficiency and in appropriate management operations, restrict canola production intensely. Grain yield in canola is associated to some plant traits including yield components and growth parameters. To acquire knowledge on how biomass accumulation is affected by yield components under wide variety of condition especially nutrients supply, seems essential. One of the factual methods to judge on desirable plants growth under environmental conditions is dry matter accumulation. So the in going experiment was designed and implemented to determine effect of nitrogen on dry matter accumulation and developmentally important traits in two canola cultivars.

MATERIALS AND METHODS

In order to evaluate effect of different nitrogen fertilizer applications on yield and yield components of two canola cultivars in summer cultivation, an experiment was conducted in Ghazvin province in agronomical year of 2012. Study area is located at 1285 m above sea level with annual average rainfall 310-320 mm, annual average temperature 13.9 C, minimum and maximum absolute annual temperatures of 17.4 and 37.8 C respectively. Soil texture in study area is loam and silt loamy with pH 7.5-8.2 and its electrical conductivity found to be 0.8-1.5dsm^{-1}(table1). Growth analysis was under taken to monitor growth trend under different treatments.This experiment was arranged as split plot in completely randomized block designs in three replication. Nitrogen was considered as the main factor involving five levels of 0, 75, 150, 225 and 300(kg/h) from 46% urea, and the secondary factor involving two spring canola cultivars RGS003 and SARIGOL.

Table1. Analysis results of soil experiment.

depth	0-30	30-60
EC(ds/m)	1	1.39
PH	8	7.9
SAR	3.75	4
T.N.V%	7.5	7.8
O.C%	0.74	0.5
Total N %	0.07	0.05
Texture	Loam	Loam

RESULTS AND DISCUSSION

Total fresh weight at 25% flowering: Variance analysis showed that just, nitrogen treatment on this trait was significant at probability level of 5% and none of cultivar and nitrogen*cultivar interaction did not affect them significantly. Mean comparison of effect simple cultivar indicated that the higher fresh weight was related to cultivar SARIGOL with average 4794.20(g/m^2) and followed by RGS003 with average 4544.25($g.m^2$). Different nitrogen levels are included in various statistical class so that highest and least fresh weights were attributed to applying 300(kg/h) N with 8023.04(g/m^2) and 75 (kg/h) N with 2834.42(g/m^2) respectively, representing no statistical difference to control treatment (2944.33 g/m^2). Also Mean comparison analysis on nitrogen* cultivar interaction showed that highest fresh weight is related to cultivar RGS003 and applying 300 kg/h N with average 8085.74 (g/m^2), indicating no significant difference to SARIGOL treatment and applying 300 kg/h with average 7960.33(g/m^2).the least fresh weight in the 25% flowering, was recorded in cultivar RGS003 and application of 75 kg/h N on average 269.17 g/m^2, indicating no significant difference to no nitrogen application (control) and both cultivars SARIGOLand RGS003 treatments. The highest total fresh weight in cultivar RGS003 was observed from 300 kg /h nitrogen application (8085.74 g/m2) and at the same time ,The highest total fresh weight in cultivar SARIGOL was attributed to 300 kg/h N with mean 7960.33(g/m^2)(Tables 2, 3, 4).

Total dry weight in 25% flowering: Results from variance analysis indicate that none of N, cultivar and cultivar*nitrogen interactions were not significant. Mean comparison of cultivar showed that cultivar SARIGOL showed highest dry weight with average 768.38(g/m^2) followed by RGS003 with average 745.20 g/m2.diffrent nitrogen applications were classified in various statistical classes so that the highest dry weight was obtained by applying 300 kg/h N on average 1135.79 g/m2 and the least was attributed to non-nitrogen application (control) treatment with average 529.29 (g/m^2). Mean comparison of nitrogen*cultivar interaction showed the highest dry weight in cultivar RGS003 and 300 kg/h N with average 1161.58 g/m^2 and least dry weight in cultivar RGS003 and 75 kg/h N with average 504.00 g/m2.RGS003 showed the highest total dry weight through applying 300 kg/h N with average 1161.58 g/m^2 and similarly, SARIGOL showed the highest total dry weight through applying 300 kg/h N on average 1110.00 g/m^2 (Tables 2, 3, 4). Accumulation of dry matter in aboveground organs and transporting it to grain have been reported in some crops such as rice , soybean, wheat and canola [7, 8]. As a whole, firstly, accumulation of dry matter in above ground is slow, but it increases rapidly with increase canopy and subsequently slowing down as leaves senescent while grain refilling [12]. Dry matter at following is maximum rate while flowering as well[13, 14].

Osunjeck and Renjel (2006) demonstrated genotype variations for canola cultivars in respect to nitrogen use efficiency. Efficient genotypes had higher biomass yield and low nitrogen concentration within above ground organs than inefficient ones. Application of 300 kg/h nitrogen led to the highest dry matter accumulation, showing clear difference to low nitrogen application levels in particular 0, 75 and 150 (kg/h) (Tables 2, 3, 4).

Table2. Variance analysis of forage dry and fresh weight

SOV	df	Forage dry weight in25(%)flowering(g/m^2)	Forage fresh weight in 25(%) flowering(g/m^2)
Replication	2	213165.077 ^{ns}	11327120.344^{ns}
Nitrogen(N)	4	382429.644^{ns}	28610823.202 ^{ns}
error	8	125530.311	4765870.967
Cultivars (V)	1	4031.00 ^{ns}	4685690.964 ^{ns}
N* V	4	25721.429 ^{ns}	508205.187 ^{ns}
error	10	10395.931	800179.019
Total	29		
CV%		13.47	19.16

**, ** and ^{ns}: significantat5%, 1% probability levels, and Non-significant.*

Table 3. Mean comparison of nitrogen and cultivars on forage dry and fresh weight

	Dry weight	Fresh weight
0	529.29 b	2944.33 b
75	542.79b	2834.40 b
150	711.21 ab	3917.54 b
225	864.88 ab	56.2717 ab
300	1135.79 a	8023.04 a
RGS003	745.2 b	4544.25 b
SARIGOL	768.38 a	4794.20 a

Means in each column having similar letter (s), are not significantly at the 5% level.

Table 4. Mean comparison of nitrogen * cultivars interaction on forage dry and fresh weight

Nitrogen	Cultivar	Dry weight	Fresh weight
0	RGS003	553.08 c	3154.75 cd
0	SARIGOL	505.50 c	2733.92 cd
75	**RGS003**	504.00 c	2609.17 d
75	**SARIGOL**	581.58 c	3058.92 cd
150	RGS003	597.08 c	3367.00 cd
150	SARIGOL	825.33 b	4468.08 bc
225	**RGS003**	910.25 b	5504.59 b
225	**SARIGOL**	819.50 b	5749.75 b
300	RGS003	1161.58 a	8085.74 a
300	SARIGOL	1110.00 a	7960.23 a

Means in each column having similar letter (s), are not significantly at the 5% level.

Leaf Area Index: (A) at buds emergence: Variance analysis Showed that simple effect of nitrogen was significant at probability level of 5% and none of treatments of cultivar and nitrogen*cultivar interactions didn't significant. Mean comparison of cultivar effect indicated highest leaf area index in cultivar RGS003 with average 4.16 followed by SARIGOL with average 3.83. Different nitrogen application levels were categorized in statistical classes. The highest leaf area index was observed during applying 225 kg/h N with average 5.43. In contrast, the least value was attributed to no nitrogen applicationtreatment (control) on average 2.83. Mean comparison of nitrogen*cultivar interaction indicated that different nitrogen*cultivar levels fall into various statistical classes. The highest and the least LAI were observed in SARIGOL (with average 5.78 and 2.45)when 225 and 150 kg/h N were applied respectively.The highest LAI were observed in RGS003 and SARIGOL(with average 5.07 and 5.78)when 225 kg/h N were applied respectively(Tables 5,6, 7). (B) LAI at 25% flowering: Variance analysis showed that just effect of nitrogen was significant at probability level of 5%. Mean comparison of cultivar simple effect showed that cultivar SARIGOL produced highest leaf area with average 5.50 followed by RGS003 with average 4.77. Given that, different nitrogen application levels were categorized to various statically classes. so that the highest and least leaf area index(with average 9.80 and 1.35) were achieved when 300 kg/h N and control treatments were applied respectively. Mean comparison of nitrogen*cultivar interaction showed different levels of nitrogen application and cultivar levels statistically. The highest and least leaf areaindex (LAI) (with average 10.25 and 1.25) were recorded in cultivars SARIGOL and RGS003 when 300 kg/h N and no nitrogen were applied respectively.The highest leaf area index (LAI) (with average 9.35 and 10.25) were recorded in cultivars RGS003and SARIGOL when 300 kg/h N was applied respectively(Tables 5, 6, 7).

Yesari et al., (2008) pointed out that low leaf area index at start and end of growth season is common, presumably attributes to leaves senescent and scattering, specifically those old ones located at lower canopy layers. Canola leaves serve as the main photosynthesis source from emerging until middle of flowering period. Although they may not have direct contribution in development process, they, however, are vital in developing sink capacity. Not only maximum leaf area, but also leaf area durability (consistency) is important to quantify leaf development[14].

Table5. Variance analysis of LAI

SOV	df	LAI in Bud emergence	LAI in25% flowering
Replication	2	0.666 ^{ns}	7.055 ^{ns}
Nitrogen(N)	4	6.270 *	63.759 **
error	8	1.166	5.098
Cultivars (V)	1	0.800 ^{ns}	3.902 **
N* V	4	1.293 ^{ns}	0.206 ^{ns}
error	10	0.677	0.152
Total	29		
CV%		20.61	7.58

**, ** and ^{ns}: significantat5%, 1% probability levels, and Non-significant.*

Table 6. Mean comparison of nitrogen and cultivars on LAI

	LAI in Bud emergence	LAI in25% flowering
0	2.83 a	1.35 d
75	4.46 ab	3.11 cd
150	3.25bc	4.80 bc
225	5.43 a	6.61 b
300	3.99 abc	9.80 a
RGS003	4.16 a	4.77 b
SARIGOL	3.83 b	5.50 a

Means in each column having similar letter (s), are not significantly at the 5% level.

Table7. Mean comparison of nitrogen * cultivars interaction on LAI

Nitrogen	Cultivar	LAI in Bud emergence	LAI in25% flowering
0	RGS003	2.85 cd	1.25 h
0	SARIGOL	2.81 cd	1.45 h
75	**RGS003**	4.93 ab	2.74 g
75	**SARIGOL**	3.93 ab	3.48 f
150	RGS003	4.05 ab	4.20 e
150	SARIGOL	2.45 d	5.39 d
225	**RGS003**	5.07 ab	6.33 c
225	**SARIGOL**	5.70 a	6.89 c
300	RGS003	3.88 bcd	9.35 b
300	SARIGOL	4.11 bc	10.25 a

Means in each column having similar letter (s), are not significantly at the 5% level.

Leaf area ratio (LAR) at 25% flowering: Results of variance analysis showed that only nitrogen imposed significant influence on leaf area ratio at probability level of 1% and there was no significant effect of cultivarsand nitrogen*cultivar in this. Results obtained by mean comparison analysis in cultivars indicated that both genotypes had the same leaf area ratio with 0.01 m^2/g total dry weight. Different nitrogen application levels were categorized in the same statistical class, showing no significant difference to each other. Mean comparison of nitrogen*cultivar interaction indicated that cultivar and various nitrogen application levels were fall into the same statistical class, showing no significant difference. The highest leaf area ratios (0.008 m^2/g TDW) were recorded in RGS003 and SARIGOL, when 300 kg/h N were applied (Tables 8, 9, 10).

Specific leaf area (SLA) at 25% flowering: Analysis of variance denoted significant effect of nitrogen and cultivar on specific leaf area on probability levels of 1% and 5%, however this was not significant for nitrogen*cultivar interaction on this trait. Mean comparison of cultivar effect indicated that genotype SARIGOL dedicated it self higher specific leaf area by 0.02 m2/g TDW followed by RGS003 with 0.01 (m2/g TDW). Different nitrogen application levels were categorized in the same statistical class, showing no significant difference. Result of mean comparison on nitrogen*cultivar interaction indicated that different nitrogen levels and cultivar were classified in the same statistical class showing no significantdifference.The highest specific leaf areas (0.018 and 0.021 m2/g TDW) were recorded in RGS003 and SARIGOL,when amounts of 300 kg/h N were applied(Table 8, 9, 10).

Leaf weight ratio (LWR) at 25% flowering: Variance analysis showed there are no significant difference of nitrogen, cultivar and nitrogen*cultivar interaction. Mean comparison cultivar and nitrogen effects individually denoted that cultivar RGS003 had higher leaf weight ratio(0.47 g/g TDW) than SARIGOL(0.45 g/g TDW). Different nitrogen levels fell into the same statistically class showing no significant difference to each other. Mean comparison of nitrogen*cultivar interaction showed that the highest leaf weight ratio was observed in RGS003 and control treatment (0.52 g/g TDW) and least value (0.39g/g TDW) was attributed to cultivar SARIGOL and 150 kg/g N. Cultivar RGS003 and SARIGOL showed the highest leaf weightratios (0.52 and 0.51g/g TDW) in no nitrogen application treatments respectively (Table 8, 9, 10).

Table8. Variance analysis of LAR, SLA and LWR

SOV	Df	LAR in 25% flowering ($m^2.g^{-1}$)	SLA in 25% flowering ($m^2.g^{-1}$)	LWR in 25% flowering ($m^2.g^{-1}$)
Replication	2	9.100^{*}	$28.433^{n.s}$	0.008^{ns}
Nitrogen(N)	4	26.667^{**}	186.550^{**}	0.008^{ns}
error	8	1.642	21.475	0.012
Cultivars (V)	1	1.633^{ns}	53.333^{*}	0.001^{ns}
N* V	4	0.967^{ns}	6.750^{ns}	0.002^{ns}
error	10	0.600	8.607	0.004
Total	29			
CV%		11.29	13.54	14.15

**, ** and ^{ns}: significantat5%, 1% probability levels, and Non-significant.*

Table9. Mean comparison of simple effects nitrogen and cultivars on LAR, SLA and LWR

	LAR	SLA	LWR
0	0.003 a	0.006 a	0.52 a
75	0.006 a	0.013 a	0.45 a
150	0.007 a	0.017 a	0.42 a
225	0.008 a	0.017 a	0.46 a
300	0.009 a	0.019 a	0.44 a
RGS003	0.006 b	0.015 b	0.47 a
SARIGOL	0.007 a	0.014 a	0.45 b

Means in each column having similar letter (s), are not significantly at the 5% level.

Table10. Mean comparison of nitrogen * cultivars interaction on LAR, SLA and LWR

Nitrogen	Cultivar	LAR	SLA	LWR
0	RGS003	0.003 a	0.006 a	0.52 a
0	SARIGOL	0.003 a	0.006 a	0.51 ab
75	**RGS003**	0.005 a	0.013 a	0.45 ab
75	**SARIGOL**	0.006 a	0.013 a	0.45 ab
150	RGS003	0.007 a	0.017 a	0.45 ab
150	SARIGOL	0.007 a	0.017 a	0.39 b
225	**RGS003**	0.007 a	0.015 a	0.47 ab
225	**SARIGOL**	0.008 a	0.019 a	0.45 ab
300	RGS003	0.008 a	0.018 a	0.43 ab
300	SARIGOL	0.008 a	0.021 a	0.45 ab

Means in each column having similar letter (s), are not significantly at the 5% level.

Net assimilation rate (NAR) at 25% flowering: Results of variance analysis showed that nitrogen effect in probability level of 1 %, cultivar in probability level of 5% and nitrogen*cultivar interactions in probability level of 1% were significant. Mean comparison of cultivar revealed that cultivar RGS003 had higher net assimilation rate (2.75 g/day/m2) than SARIGOL (2.06 g/day/m2). Nitrogen levels were categorized in two different statistical classes. No nitrogen application(control) and 300kg/h treatments were fell into the same statistical class with averages 3.24 and 3.15 g/day/m2 respectively having the highest net assimilation rate. Different nitrogen levels of75, 150 and 225 kg/h N also fell into one statistical class with means 1,78,1.45 and 2.05 g/day/m2 respectively. Mean comparison of nitrogen*cultivar interaction indicated that different nitrogen levels and cultivars fell into different statistical classes. Highest net assimilation rate (4.80 g/day/m2) in genotype RGS003 was recorded when 300 kg/h N was added. The least value (0.73 g/day/m2) was recorded in RGS003, when 75 kg/h N was applied. The highest net assimilation rates in genotypes RGS003 and SARIGOL (4.80 and 2.94 g/day/m2) were obtained when application of 300 kg/h and no nitrogen application (control) respectively (Tables 11, 12, 13).

Specific leaf weight at 25% flowering: Variance analysis indicated that only nitrogen was significantly in probability level of 1%, but this was not true for cultivar and nitrogen*cultivar interaction. Mean comparison of cultivar and nitrogen showed that RGS003 had higher specific leaf weight (93.59 g/m2LA) than SARIGOL (82.93 g/m2LA). Different nitrogen levels fell into various statically classes so that highest specific leaf weight was obtained from no nitrogen application (control treatment187.83 g/m2 LA). Others nitrogen levels were categorized in the same class, showing no significant difference. Mean serration of nitrogen*cultivar interactions showed that both genotypes RGS003/ SARIGOLand controltreatments produced highest specific leaf weight about 203.25 and 172.41 g/m2 LA respectively(Tables 11, 12, 13).

Crop growth rate (CGR) at 25% flowering: Variance analysis indicated significant nitrogen effect and nitrogen*cultivar interactions on CGR at probability level of 1% but it was not case for cultivar effect. Mean comparison of cultivar and nitrogen showed that the highest crop growth rate (10.05 g/day/m2) was recorded in RGS003 followed by SARIGOL (8.48 g/day/m2). Different nitrogen levels fell into different statistical classes. The highest and least crop growth rates were obtained (16.77 and 3.70g/day/m2) when 300 kg/h and no nitrogen were applied respectively. Results obtained from mean comparison on nitrogen*cultivar interaction that genotype RGS003 exhibited the highest CGR (23.03 g/day/m2), when 300 kg/h N was applied.Also, the least CGR value (2.29 g/day/m2) was obtained when 75 kg/h N was added. Both genotypes RGS003and SARIGOL showed the highest crop growth rate (23.03 and 13.85 g/day/m2), when 300 and 225 kg/h N were applied respectively (Tables 11, 12, 13).Crop growth rate was increased with increase nitrogen. In addition, some researchers reported that crop growth rate is affected by plants photosynthetic area directly[3, 11].

Table11. Variance analysis of NAR, SLW and CGR

SOV	Df	NAR in 25% flowering ($g.day^{-1}\backslash m^2$)	SLW in 25% flowering (g/m^{-2})	CGR in 25% flowering ($g.day^{-1}\backslash m^2$)
Replication	2	0.174 ^{ns}	3995.312 ^{ns}	4.397 ^{ns}
Nitrogen(N)	4	3.622 **	19297.864 *	173.478**
error	8	0.404	3686.586	4.087
Cultivars (V)	1	3.254 *	852.054 ^{ns}	18.581 ^{ns}
N* V	4	5.424 **	232.588 ^{ns}	75.690**
error	10	0.344	8.607	3.960
Total	29			
CV%		24.58	354.049	21.48

**, ** and ^{ns}: significantat5%, 1% probability levels, and Non-significant*

Table12. Mean comparison of nitrogen and cultivars on NAR, SLW and CGR

	NAR	SLW	CGR
0	3.24 a	187.83 a	3.70 d
75	1.45 b	81.06 b	5.08 d
150	1.78 b	59.94 b	8 .34 c
225	2.05 b	60.80 b	11.65 b
300	3.15 a	51.66 b	16.77 a
RGS003	2.72 a	93.59 a	10.05 a
SARIGOL	2.06 b	82.93 b	8.48 b

Means in each column having similar letter (s), are not significantly at the 5% level

Table13. Mean comparison of nitrogen * cultivars interaction on NAR, SLW and CGR

Nitrogen	Cultivar	NAR	SLW	CGR
0	**RGS003**	3.54 b	203.25 a	4.71 ef
0	**SARIGOL**	2.94 bc	172.41 a	2.70 f
75	RGS003	0.7 f	82.33 b	2.29 f
75	SARIGOL	2.18 cde	79.78 b	7.29 cde
150	**RGS003**	1.21 def	60.18 b	5.79 def
150	**SARIGOL**	2.35 cd	59.70 b	10.89 bc
225	RGS003	2.96 bc	67.98 b	13.85 b
225	SARIGOL	1.13 ef	53.61 b	9.46 cd
300	**RGS003**	4.80 a	54.21 b	23.03 a
300	**SARIGOL**	1.49 def	49.11 b	10.52 bc

Means in each column having similar letter (s), are not significantly at the 5% level.

It is impossible to grow plants with disregarding their nutritional demands. In recent years, increased application rate of synthetic fertilizers has led to higher yield and productivity in unit area. While abusing these fertilizers has caused enormous environmental concerns specially pollution issues. Due to increasingly rate of population growth in recent decades, it is impossible to apply traditional agriculture without input considerateness. However, suitable chemical fertilizers application management as well as accommodating organic fertilizers in future plan, can help us to cope with environmental pollution much more efficiently.Resultsobtained on the present research indicated that the highest fresh forage yield was obtained when 225 kg/h N treatment was applied and adding up to 300 kg/h showed no significant difference on yield. Nitrogen affected leaf area index (LAI) significantly so that as its rate was increased up to 300 kg/h, LAI was enhanced accordingly. Also it significantly influenced crop growth rate (CGR) so that as nitrogen rate increases, higher CGR was obtained. Final forage yield was affected by single nitrogen and nitrogen*cultivar significantly. Increased N rate improved fresh forage weight, however, adding 300 kg/h N did not make significant yield variation. At the same time, RGS003 showed higher yield than SARIGOL. The best nitrogen application rate to achieve maximum fresh forage weight is 225 kg/h.

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