INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 5, No. 6, p. 47-54, 2014

RESEARCH PAPER OPEN ACCESS

Evaluation of chemical and organic nitrogen sources on yield and yield component of canola (*Brassica napus* L.) cultivars

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Key words: Canola, cultivar, organic manure, yield.

http://dx.doi.org/10.12692/ijb/5.6.47-54 Article published on September 17, 2014

Abstract

Canola is one of the most important oil crops in the world and nitrogen is the vital nutrition element for canola yield and growth therefore a field experiment was carried out a factorial split plot arranged in randomized complete blocks design with four replications in two planting date(PD) at one year. Main plots consisted of two level of organic manure, (OM1) and (OM2) and five level of chemical fertilizer, (CF1), (CF2), (CF3), (CF4), (CF5) and sub plots consisted of two cultivar(C) (Okapi and Zarfam).Results of composed variance analysis showed that chemical fertilizer had significant effect on seed yield and means comparison showed, highest seed yield was observed from third level of chemical fertilizer with 2492 kg/h and in comparison between organic manure levels application of organic manure had highest biological yield with 6673 kg/ha this positive effect was attributed to indicate importance of application of organic manures, in continuance result showed highest oil percent and pod number per plants was observed from third level of chemical fertilizer with 41.9 percent and 88 number respectively.

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Introduction

Canola is important for food, industrial purposes and edible oil (Bandeh-hagh *et al.,* 2008). Nitrogen is the most important fertilizer applied to canola in terms of cost to growers, and inadequate or untimely N applications often restrict yields nitrogen deficit canola plants have fewer and smaller leaves than N-sufficient plants. So Walch- liu (2000) concluded that nitrogen is a part of chlorophyll, the green pigment of the plant that is responsible for photosynthesis plant growth and developmental aspects such as seed germination, leaf development, seed filling duration, seed yield and growth. Kudernatsch *et al* (2008) reported that climate change affected the length of the growing season and growth duration of plants, yield and subsequently the survival and reproduction of high elevation plants. Canola oil, compared with other kinds of oil, contains low levels of saturated fatty acids, a high percentage of oleic acid and an optimal ratio of polyunsaturated fatty acids for both nutrition and feeding needs(Butkut *et al.,* 2006). In continuance results of one research showed that Planting date affects canola yield, seed oil and protein production and delayed sowing reduces total N concentration at 5-6 rosette stage by 50% in young mature leave petioles (Hao *et al.*, 2004). Nitrogen deficit occurs almost every where except when the fertilizer is added thus plants growth. Majnoun Hosseini (2006) reported that the interaction effects of plant density and nitrogen were also significant except for pods per plant and oil percentage and yield of plants. Nitrogen is the most expensive fertilizer used to raise crop plants(Satoh *et al.,* 2002) .Introducing a good fertilization system can lead to increase grain yield and improve food quality(Hao *et all.,* 2004). The objectives of this research were to determine a good fertilization system of nitrogen, evaluated response of canola cultivars to this system and effects of them on yield and yield component of canola.

Materials and methods

Site description

The field assay was conducted in 2012growing season at the Agricultural Research Center of Sanandaj, Iran that located at (36˚ 11′ N latitude and 46˚ 19′ E longitude) with an altitude of 1393 m above sea during 2012-2013. This region has a semi-arid climate (340 mm annual rainfall). The soil texture of the experimental site is a clay loam, with a pH of 7.9 and Ec=.046 ($EC*10^4$) (using an Electrical Conductivity Meter) (Table1).

Experimental design

A field experiment was carried out a factorial split plot arranged in complete randomized blocks design with four replications in two planting date (PD) at one year (11 September and 26 September, 2012) with regarded management of time and quantity Main plots consisted of two level of organic manure, non application (OM1) (control) and application (OM2) and five level of chemical fertilizer that fertilizer split to three section in each treatment (CF1) consisted of non application in planting time, application in shoot appearance stage and beginning of flowering stage(with recommended measure), (CF2) consisted of application in planting time, shoot appearance stage and beginning of flowering stage (with recommended measure), (CF3) consisted of application in double leaf stage, shoot appearance stage and beginning of flowering stage (with recommended measure), (CF4) consisted of application in planting time(with recommended measure), application in shoot appearance stage and beginning of flowering stage (with increased 25 percent), (CF5) consisted of application in double leaf stage(with recommended measure), application in shoot appearance stage and beginning of flowering stage(with increased 25 percent), and sub plots consisted of two cultivar (okapi and zarfam), Each sub plot was 7.5 m long and consisted of 6 rows, 30 cm apart with intra row spacings of 5 cm to achieve the plant density of 66 plants/m2, land of experiment was plowed in autumn of previous year and in spring of experiment year was disked , With attention to annual rainfall mean, soil test and farmyard manure analysis results (table1,2) application of chemical, organic manure and phosphorus with attention to of physiochemical test soil was about 150 kg/ha for chemical manure (Urea), 20t/ha for organic manure

(farmyard manure) and 140 kg/ha for phosphorus. Evaluated traits consist of Pod number per plant, seed number per pod,1000-seed weight, biological yield, seed yield, oil percent and oil yield. The estimation of oil percent was extracted with petroleum ether using Soxhlet (AOAC, 1990).

Sampling

At maturity stage, 12 plants from each plot were randomly selected for the measurement of yield components. Harvested area was 7.5m × 1.8m in each plot. Seed yield of canola was adjusted to 10% moisture content.

Statistical analysis

The experimental data were statistically analyzed by (ANOVA) using MSTAT-C, Version 1.41, Crop and Sciences Department, Michigan State University, and Duncan's multiple range in ($P \leq 0.05$) used to compare means of traits.

Result and discussion

Pod number per plant

Results of composed variance analysis showed that pod number per plant was significantly affected by planting date, organic manure and cultivar (Table 3), so highest pod number per plant was observed from third level of chemical fertilizer with 88 number per pod and comparison between organic manure treatment showed that application of organic manure had highest pod number per plant (Table 4). Nitrogen (N) fertilizer increases yield by influencing a variety of growth parameters such as the number of branches per plant, the number of pods per plant, the total plant weight, the leaf area index. Interaction between planting date and chemical fertilizer so between organic manure and chemical fertilizer had significant effects on pod number per plant, in comparison between cultivars Okapi with 64 number per pod had highest pod number per plant. Hokmalipour (2011) reported that pod number of the stem was significantly affected by genotypes and interaction between the sowing date and genotypes. pod number of fertile genotypes of canola, was effected by weather conditions (Mendham *et al*.,1981). So Degenhart and Kondra (1987) concluded that with delay in sowing date pod number per plant decreases. Nitrogen is one of the most important element that plays a key role in plant growth and yield so protein synthesis, protoplasm, cell size, and photosynthetic activity and thus provides huge pods (Yasari and Patwardhan, 2006).Khan *et al.* (2006) also concluded that positive significant correlation between seed yield and plant height, pods per plant, seeds per pod and pod length.

Table 1. Result of physiochemical test soil**.**

Electrical conductivity	PH	Total nitrogen	Organic carbon	Clay	Silt	Sand	Absorption potassium	Absorption phosphorus
(EC*10⁴)				(Percent)				(mg.g)
46.5	7.9	0.07	1.13	44	34	22	403	9.7

Table 2. Compounds of organic manure.

	pH	N	P	K	Ca	Mg	Zn	S	Cu
			(%)				(ppm)		
Organic manure	7.45	0.74	0.49	0.31	745	1100	23	659	27

Seed number per pod

Regarding seed number per pod results showed that seed number per pod was significantly affected by planting date, chemical fertilizer and organic manure (table 3) so first planting date had highest seed number per pod and lowest seed number per pod observed from fourth level of chemical fertilizer (table 4). Habekotte (1993) reported that the relations of assimilates supply with seed number and seed yield were well studied in some species of canola, pod

density appears to be fully determined just after the end of flowering and reproductive stage. So environmental conditions during flowering period is of great importance in pod formation and amount of vegetative growth and the weather conditions (temperature, rainfall and radiation) during flowering period determine the magnitude of buds and flowers and hence the final pod number. Zang and Zhou (2006) concluded that canola is one of most important edible oil that pods per plant, seeds per plant and 1000-seed weight traits were positively correlated with seed yield. in addition interaction between chemical fertilizer and organic manure, between planting date × cultivar and between chemical fertilizer and cultivar had significant effects on seed number per pod. In comparison between application and non application of organic manure application of organic manure had highest seed number per pod. Angadi (2003) reported that various findings showed that with delay in the sowing date, there pod number per plant was decreased, pod number stem number per plant and finally seed yield and oil quality. Increases number and weight of pods, seeds per plant increased seed yield (Al-Barrak, 2006).

Table 3. Results of variance analysis traits under treatments effects.

		Mean square						
S.O.V	df	Pod number per plant	Seed number per pod	1000-seed weight	Biological yield	Seed yield	Oil percent	Oil yield
P D	1	31080.6**	1392.4**	49.729**	25572007.6^{ns}	20237907.6**	499.4**	5239881.6**
Error(Rep)	6	341.1^{ns}	9.05^{ns}	0.033^{ns}	3555805.4^{ns}	13650962^{ns}	0.4^{ns}	2303.7^{ns}
CF	4	8115.9**	43.8**	1.231**	55582.7^{ns}	2034794.9**	33.3**	517524.9**
PD×CF	4	1361.9**	2.1^{ns}	0.125^{ns}	203619.7^{ns}	376318.8**	1.7*	106805.4**
OM	1	4060.2**	24.0**	0.420**	3381131.7**	850597.2**	13.3**	220460.5**
PD× OM	1	78.4^{ns}	2.02^{ns}	0.342**	233402.0^{ns}	544288.9**	1.1*	97444.8**
CF× OM	4	763.3**	22.07**	0.405**	1520625.4**	106780.9**	4.7**	39234.0**
PD×CF×OM	4	582.2**	1.1^{ns}	0.061^{ns}	114886.8^{ns}	46219.0*	0.2^{ns}	12309.07**
Error	54	80.7^{ns}	2.5^{ns}	0.052^{ns}	235338.2^{ns}	15355.4^{ns}	0.6^{ns}	2949.3^{ns}
C	1	1102.5**	0.625^{ns}	0.196**	65731.5^{ns}	92160.0**	3.5*	27165.9**
PD× C	1	286.2**	3.02*	0.001^{ns}	34780.5^{ns}	50.6**	0.3^{ns}	420.2^{ns}
CF× C	4	565.9**	3.3**	0.053**	10481.5^{ns}	21756.5^{ns}	0.8^{ns}	3346.2^{ns}
PD×CF×C	4	311.4**	3.2**	0.006^{ns}	92263.2^{ns}	16011.172^{ns}	1.243^{ns}	3986.1^{ns}
OM × C	1	9.02^{ns}	0.40^{ns}	0.042^{ns}	96874.8^{ns}	504.100^{ns}	0.018^{ns}	399.6^{ns}
PD×OM × C	1	25.6^{ns}	0.40^{ns}	0.012^{ns}	620.156^{ns}	31304.025^{ns}	0.138^{ns}	4472.1^{ns}
CF× OM ×C	4	204.9**	11.1**	0.035^{ns}	48643.6^{ns}	76767.428**	1.056^{ns}	10139.3**
PD×CF× OM × C	4	136.2**	3.3**	0.20^{ns}	51721.6^{ns}	23709.697*	0.723^{ns}	4654.05^{ns}
Error	60	30.1^{ns}	0.742^{ns}	0.20^{ns}	46699.4^{ns}	9596.612^{ns}	0.672^{ns}	2211.3^{ns}
C V(%)		8.93	8.09	4.38	3.31	4.68	2.04	5.55

ns, Non significant; * , Significant at the 5% of probability level(P< 0:05); **, Significant at the 1% of probability level (P < 0:01). C, Cultivar ; CF, Chemical fertilizer; OM, Organic manure; PD, Plating date.

1000-seed weight

1000-seed weight trait was significantly affected by planting date (Table 3), chemical fertilizer and organic manure and means comparison with Duncan's multiple range in ($P \leq 0.05$) showed that first planting date had highest 1000-seed weight with3.4 and lowest 1000-seed weight was observed from second planting date with 2.3 and 2.9 1000-seed weight was observed from application of organic manure (Table 4), Jasmine Ara *et al.*, (2014) concluded that nitrogen did influence significantly on the thousand seed weight and The maximum thousand seed weight (4.46 g) was produced by 120 kg N/ha, which was statistically similar with 60 kg N/ha and 180 kg N/ha treatment and 0 kg N/ha produced the lowest thousand seed weight. Interaction between treatments showed that planting date and organic manure so chemical fertilizer and organic manure had significant effects on 1000-seed weight, cultivar and interaction between chemical

fertilizer and cultivar had significant effects on 1000-seed weight . Seed weight and filling seed period is an important factor of seed yield and depends on environmental conditions (Diepenbrock., 2000). in comparison between cultivars okapi cultivar had highest 1000-seed weight, Results of one research showed that with increasing levels of nitrogen fertilizer application 1000-seed weight was increased (Chauhan, *et al*., 1995).

Table 4. Mean values of traits as influenced by treatments.

Treatment	Pod number per plant (per plant)	Seed number per pod (per pod)	1000-seed weight (g)	Biological yield (kg/ha)	Seed yield (Kg/ha)	Oil percent (%)	Oil yield (kg/ha)
First PD	75a	14a	3.4a	6927a	2248a	41.9a	1028.9a
Second PD	48b	8b	2.3b	6127b	1737b	38.3b	667b
CF1	52.84c	10.19bc	2.775b	6475a	2010c	39.90b	808.5c
CF2	56.47c	10.22bc	2.841b	6552a	1975c	39.66bc	787.5c
CF3	88.06a	12.56a	3.128a	6562a	2492a	41.92a	1058a
CF4	41.16d	9.46c	2.581c	6559a	1828d	39.42c	724.8d
CF5	63.22b	10.81b	2.825b	6489a	2155b	39.68bc	861.1b
OM1	57b	10b	2.8b	6382b	2019b	39.8b	810.9b
OM2	67a	11a	2.9a	6673a	2165a	40.4a	885.1a
Okapi C	64a	11a	2.9a	6547a	2116a	40.3a	861a
Zarfam C	59b	11a	2.8b	6507b	2068b	40b	834.9b

Different letters within each group of a column indicate significant differences at $P \leq 0.05$ according to Duncan's multiple range test. C, cultivar; CF1,First level of chemical fertilizer; CF2, Second level of chemical fertilizer; CF3,Third level of chemical fertilizer; CF4, Fourth level of chemical fertilizer; CF5, Fifth level of chemical fertilizer; OM1, Non application of organic manure; OM2,Application of organic manure; PD, Planting date.

Seed yield

Planting date, organic manure and chemical fertilizer had significant effects on Seed yield in ($p<1\%$), (table 3) and means comparison with Duncan's multiple range in ($P \leq 0.05$) showed that third level of chemical fertilizer had highest seed yield with 2492 kg/ha so 2248 and 2165 kg/ha were observed from first planting date and application of organic manure respectively(Table 4), that showed importance of suitable planting date and application of organic manure, Jasinska *et al* (1989) concluded that with delay in sowing date seed yield decreased that similar to findings of Taylor and Smith (1992) concluded that seed yield declined when sowing date is delayed ,in comparison between planting dates result showed that first planting date had highest seed yield that showed importance of suitable planting date, result showed that interaction between planting date and organic manure and planting date and chemical fertilizer so interaction among planting date×chemical fertilizer×organic manure × cultivar had significant effect on seed yield and okapi cultivar had highest seed yield. Fathi *et al* (2002) reported that increasing nitrogen fertilizer and plant density caused a boost in seed yield in rapeseed and the highest yield per hectare resulted from 225 kg N ha-1, so result of one research showed that the highest rapeseed seed yield were achieved when 180 to 220 kg N ha-1 of nitrogen was applied. Absorption of other nutrients is also strongly related to sufficient nitrogen (Jackson *et al.,* 2000). Interaction between organic manure and third level of chemical fertilizer had highest seed yield, this positive effect was attributed to indicate importance role of organic manure and application of chemical fertilizer in leaf bud stage (Fig.1).

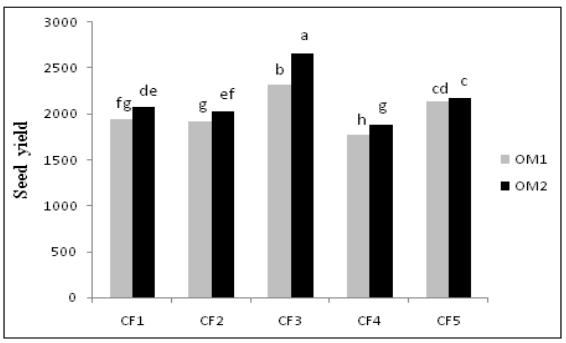

Fig. 1. Interaction effects of organic manure and chemical fertilizer on seed yield.

Biological yield

Results of composed variance analysis showed that organic manure had significant effect on biological

yield in ($P \leq 0.05$) and interaction between chemical manure and organic manure had significant effects on biological yield (Table 3). Azimzadeh *et al.,*(2013) reported that Urea fertilizer treatment Nitroxin usage increased biological yield of reapeseed at the rate of 15% and the highest biological yield observed in 200 kg/h Urea fertilizer and Nitroxin usage, results of means comparison with Duncan's multiple range in($P \leq 0.05$) showed that chemical fertilizer levels stand in equal statistical groups and first planting date had highest biological yield with 6927kg/ha and second planting dates had lowest biological yield (Table 4). Baghdadi *et al.*, (2013) reported that application of 300 kg/ha nitrogen had the most biological yield with mean of 8931 kg/ha.

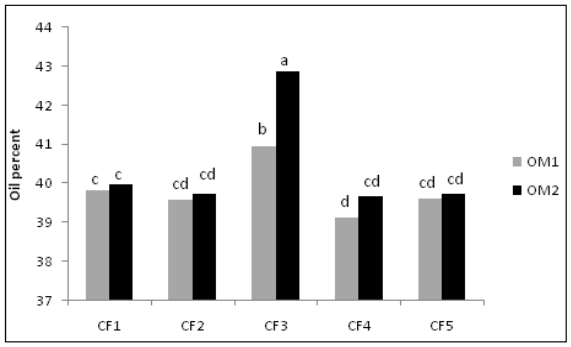

Fig. 2. Interaction effects of organic manure and chemical fertilizer on oil percent.

Oil percent

Oil percent was significantly affected by planting date, chemical fertilizer and organic manure (Table 3), thus result of means comparison with Duncan's multiple range in ($P \leq 0.05$) showed that highest oil percent was observed from first planting date with 41.9 percent and second planting date with 38.3 had lowest oil percent (Table 4) that showed importance of suitable planting date that similar to findings of Mackinnon and Fettell (2003) reported that with delaying in planting date grain yield was decreased so delayed planting date had significant reduction on grain yield and oil grain. Jasmine Ara *et al.,* (2014) reported that application of N at 120 kg/ha (N2) gave the maximum oil content. Cultivars had significant effect on oil percent and interaction between planting date ×organic manure and chemical fertilizer×organic manure had significant effects on oil percent and okapi cultivar had highest oil percent with 40.3 percent (Fig.2).

Oil yield

Results of composed variance analysis showed that planting, chemical fertilizer and organic manure had significant effects on oil yield so highest oil yield was escaped from third planting date with 1058 kg/ha (Table 3) and in comparison between organic manure showed that application of organic manure had highest oil yield (Table 4). Ali *et al.,* (2013) concluded that 1000-seed weight in the range of 3.00 to 3.60 g may be useful for getting higher seed yield and oil yield. So compared different canola cultivars showed that all cultivars had significant effect on seed oil yields (Kolte, *et al.,* 2000). Baranyk and Zukalova (2000) reported that differences Brassica species had different oil yields. Chango and Mc Vetty (2001) observed that total dry matter and harvest index had a significant correlation with seed yield.

Conclusions

Our results showed that application of organic nitrogen source caused increase yield and yield component of canola plants so third level of chemical nitrogen was a best fertilization system of nitrogen for canola plants in that condition.

Acknowledgements

We are grateful for grants from Faculty Research of Takestan Branch, Islamic Azad University,Takestan Iran, Agricultural Research Center of Sanandaj, Iran and Seed and Plant Improvement Institute, Karaj,Iran.

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Abbreviations

C, cultivar; CF1,First level of chemical fertilizer; CF2,Second level of chemical fertilizer; CF3,hird level of chemical fertilizer; CF4,Fourth level of chemical fertilizer; CF5,Fifth level of chemical fertilizer; OM1, Non application of organic manure; OM2,Application of organic manure; PD, Planting date.