Study of amount and time application of complete fertilizer on yield and quality characters of winter rapeseed (*Brassica napus L.*)

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Abstract

Rapeseed is grown on a wide range of soil types in Iran, and consequently growers have experienced a variety of nutritional problems with the crop. There are reports of deficiencies of B, Mn, Mo and Zn for this crop in Iran, and it is expected that Cu and Fe deficiencies could also occur. Thus tested new fertilizer for Iranian rapeseed field considered as perfect fertilizer contain notable S, Mn, Mo and Zn microelements (including Fe % 5,Mn % 4,Zn % 0.6, MgO % 2, Cu % 0.5 B % 0.7 and Mo % 0.3). In order to investigation amount and time application of this fertilizer on yield, yield components and some quality traits of grain rapeseed (*Brassica napus* L.), a factorial experiment with three replications was carried out with a silty clay textured soil at Agricultural Experimental Station, Tehran, Iran in 2008–2009. Four full fertilizer levels (F_1=Control, F_2=2.5, F_3=3 and F_4=4.5 Kg/h) and time application 7 day intervals (including T_1=2, T_2=3 and T_3=5 times) after flowering in soil application were allocated to plots. Results showed that amount of complete fertilizer at the ($P<0.01$) probability level had significant differences on morphological traits as stem diameter, flowering period, sub branch height, plant height of brassica which F_4=4.5 kg/h fertilizer were larger than other rates, but in this case there is no difference between 3 and 4.5 kg/h. So analysis showed that time application of fertilizer had significant differences on sub branch number, grain number, thousands grain weight, grain yield and oil content of brassica at the ($P<0.01$) probability level but there is no difference between medium levels of time application. Time and rate application factor not only increase protein and oil content but also decrease Glucosinolat content in which two and three times of foliar application had the best results for quantity and quality yield of rapeseed. Similarly, factors interaction effects on seed yield, oil, protein and glucosinolates were significant. However, the results show that a fertilizer characterized by improvement requirements may be as profitable as methods, despite unequal crop yields.

Key words: Full Fertilizer, ***Brassica napus L***., glucosinolates, Yield and Oil content.

Introduction

In agriculture, canola is the name given to certain varieties of rapeseed oil, or the oil produced from those varieties. Canola has been bred to reduce the amount of glucosinolates, yielding more palatable oil. **Canola** is one of two cultivars of rapeseed or *Brassica campestris* (*Brassica napus L.* and *B. campestris L.*). Canola varieties must have an erucic acid content of less than 2 percent and also have less than 30 micromoles of glucosinolates per gram of seed. Growth, yield and quality of rapeseed are affected by genotype and environment conditions (Shipway, 1981). Mahler and Auld (1991) demonstrated that there was a significant interaction between rapeseed cultivars and environment. Amount and time application of complete fertilizer is very important to determination of growth, development and yield of Plant crops. The experiments result showed although the range of suitable plant nutrition of rapeseed is wide.

Rapeseed is grown on a wide range of soil types in Iran, and consequently growers have experienced a variety of nutritional problems with the crop. There are reports of deficiencies of B, Mn, Mo and Zn for this crop in Iran, and it is expected that Cu and Fe deficiencies could also occur (omidi et al., 2008). Thus tested new fertilizer for Iranian rapeseed field considered as perfect fertilizer contain notable S, Mn, Mo and Zn microelements (including Fe % 5,Mn % 4,Zn % 0.6, MgO % 2, Cu % 0.5 B % 0.7 and Mo % 0.3) on new rapeseed genotype is important.

Nutrient deficiencies are caused by too much or too little of one or several nutrients being available. Nutrients are made available between a pH range of five and seven and a total dissolved solids (TDS) range of 800 to 3000 PPM. To maintain these conditions is the key to the perfect nutrient uptake.

Magnesium (Mg) is found as a central atom in the chlorophyll molecule and is essential to the absorption of light energy. Magnesium aids in the utilization of nutrients, neutralizes acids and toxic compounds produced by the plant. Deficiency symptoms: Lower leaves turn yellow and in the end may even turn white while veins remain dark green.

Iron (Fe) is a key catalyst in chlorophyll production and is used in photosynthesis. Deficiency symptoms: Leaves turn pale and veins remain dark green. pH imbalances make iron insoluble.

Manganese (Mg) works with plant enzymes to reduce nitrates before producing proteins. Deficiency symptoms: Necrotic and yellow spots form on top leaves.

Boron (B) is necessary for cells to divide as well as for protein formation. It also plays an active role in pollination and seed production. Symptoms: Growing shoots turn grey, look burned and can die.

Molybdenum (Mn) helps form proteins and aids the plant's ability to fix nitrogen from the air. Deficiency symptoms: Middle of the leaves turn yellow.

Zinc (Z) is a catalyst and must be present in minute amounts for plant growth. Deficiency symptoms: tips of the leaves and between the veins turn white.

Canola (*Brassica napus* L.) is grown in different agro-climatic zones of the world, differing in soil nutrient status. The use of soil and foliar fertilizing in agriculture has been a popular practice with farmers since the 1950s, when it was learned that foliar fertilization was effective and economic. Recent research has shown that a small amount of nutrients, particularly Zn, Fe and Mn applied by foliar spraying increases significantly the yield of crops (Sarkar *et al.*, 2007; Wissuwa *et al.*, 2008). Also, foliar nutrition is an option when nutrient deficiencies cannot be corrected by applications of nutrients to the soil (Crabtree, 1999; Sarkar *et al.*, 2007; Cakmak, 2008). It is likely therefore, in open-field conditions, where the factors that influence the uptake of the nutrients are very changeable, foliar fertilization can get considerable importance. Among the micronutrients, Zn and Fe nutrition can affect the susceptibility of plants to drought stress (Sultana *et al.*, 2001; Khan *et al.*, 2003; Cakmak, 2008).

Compared to most other grain crops in Iran; canola has a greater requirement for nutrient inputs to achieve high yields. Canola needs about 25% more N, P and K, and up to five times more S than Iranian Standard Wheat to balance fertilizer inputs with nutrient removal in grain. However, across Iran there is considerable variation in fertilizer use on canola due to climate and soil factors, and the N contribution from pasture and grain legumes. In estimating the fertilizer requirements for canola, growers use soil tests, field cropping history, balance sheets based on estimated nutrient removal, plant testing to assess crop nutrient status and test strips in fields to see if adequate fertilizer has been applied.

Thus, our objectives were to study the effects of amount and time application of complete fertilizer on yield, yield components and quality characters of winter rapeseed.

Materials and Methods

Field preparation and applying the treatments

In order to investigation amount and time application of perfect fertilizer on yield, yield components and some quality traits of grain rapeseed, a factorial experiment with three replications was carried out at Agricultural Experimental Station, Tehran, Iran during 2008–2010.The study was carried out at the experimental farm of Shahed University. The canola seeds (*Brassica napus* L. C.V. 'SLM046') were sown on 15 Jan. Four full fertilizer levels (F_1=Control, F_2=2.5, F_3=3 and F_4=4.5 Kg/h) and time application with 7 day intervals (including T_1=2, T_2=3 and T_3=5 times) after flowering in soil application were allocated to plots. Perfect fertilizer were contain S, Mn, Mo and Zn microelements (including Fe % 5,Mn % 4,Zn % 0.6, MgO % 2, Cu % 0.5 B % 0.7 and Mo % 0.3). After plough in fall and two disks, the land was flatted by leveler and then plots were prepared. The plots had 4 m length and 3 m width consisted of five rows, 0.6 m apart. Between all plots, 1 m distance was kept to eliminate all influence of lateral water movement.

The between row distance and within distance were 60 cm and 25 cm, respectively. The flooding Irrigation was carried out as similar in all of plots during study. Two week after sowing weed control was efficiently performed by hand. Micronutrient Soil application was done at two, three and fifth times. In control treatments plants were sprayed by water.

In season, all traits of FP (Flowering period), PH (plant height), CH (Capsule height from field), SBN (Sub Branch Number), SN (Silique Number), GN (Grain Number), SL (Silique Length), W (Grain 1000 weight), Y (Grain yield) (Kg.ha-1) , RCWE (Relative water content of east rows), RCWW (Relative water content of west rows) , ST (Stand Vegetation Date and fatty acid profile were estimated.

Plants height was measured at end of flowering stage by five sample plant. At the physiological maturity stage plants were harvested and capsule diameter, row number in capsule, number of seed in capsule, seed weight to capsule weight ratio, 1000 seed weight, seed yield, total oil percentage and total protein percentage and oil yield were measured. Oil percentage and protein percentage were measured by soxhlet and Kjeltec method, respectively. Oil yield was calculated via product seed yield in percentage oil. Finally, the crude data of the morphological and biochemical parameters were statistically analyzed by one-way ANOVA and Least Significant Difference (LSD) test to determine significant differences among group means (SAS Institute, 1988). A p-value of 0.05 was considered statistically significant.

Results and analysis

The results of analysis of variance showed that, effect of perfect fertilizer were significant on some traits (Tab. 1 and 2). Analysis of fatty acids showed that, the application of perfect fertilizer increased the fatty acids compared to the control (data not shown). In case of palmitic, palmitoleic and myristic acid 3 applications was better than 2 and 5 application while regarding linolenic acid soil application had better effect. Between 2.5 and 3 kg.ha-1 application was not difference on oleic acid content but application of these elements increased significantly oleic content than control treatment (data not shown). Zakaria et al. (2001) concluded that Zn application significantly increased the total unsaturated fatty acids in cotton.

Analysis of variance showed that there were significant differences among treatments on given traits, fatty acids percentage, plant height, seed weight to capsule weight ratio, protein percentage, oil percentage, oil yield, 1000 seed weight, seed yield, nitrogen, phosphorous and potassium percentage of leaves. The highest seed yield, oil yield, oil percentage, 1000 seed weight, seed weight to capsul weight ratio and protein percentage were obtained from the 2 and 3 times application treatments. Also, the highest amounts of grain yield were achieved from 3 times and 3 kg.ha-1 treatment which was an indication of efficiency of elements. The correlation between effective traits on the seed yield, such as, capsule diameter, number of seed in capsule, seed weight to capsule weight ratio and 1000 seed weight were positively significant. In general, application of perfect fertilizer had the highest efficiency in aspect of seed production. The comparison of the various methods of fertilization showed that 3 times application was more effective. Also, micronutrient application increased concentration of elements, especially zinc and iron (data not shown).

Discussion

Most canola growers in regions with actual or potential micronutrient deficiencies routinely apply rates recommended for wheat. Canola has a high requirement for Zn, particularly on alkaline soils high in carbonates, and Zn is applied adjacent to the seed at sowing. Molybdenum deficiency is a potential problem on acidic or basaltic soils with low Mo levels, and growers in these regions usually apply sodium molybdate before sowing as a precaution. Manganese deficiency in canola is likely on highly calcareous soils in South Australia and some deep sandy soils. Canola is similar to small grains in its response to fertilizer and levels of soil fertility. Nitrogen and sulfur are the key elements for high canola yields. Nitrogen and potash materials should not be placed in direct contact with the seeds but should be broadcast or applied in a band at least 2 inches away from the seed. Canola and mustard are good scavengers of P. Nitrogen recommendations are based on the following formula: NR = (YP x 0.065) - STN – PCC Where NR = supplemental nitrogen recommended YP = Yield potential in lb/A; STN = soil nitrate-N 0- to 24-inch depth; PCC = previous crop credit Canola has special requirements for sulfur. The consequences of low soil S levels are very serious in canola production. Low sulfur can make the difference between having a crop and not having a crop.

Table1: Combined analysis (Mean of Squares) of variance for agronomic characters in complete fertilizer.

S.O.V	df	FP	PH	CH	SBN	SN	GN	SL	W	Y	RCWE	RCWW	ST
Rep.	2	ns	ns	ns	ns	**	ns	ns	*	ns	ns	ns	ns
Fertilizer levels(F)	3	ns	ns	ns	ns	*	*	*	*	*	ns	ns	*
Application times(T)	2	ns	ns	ns	ns	**	ns	ns	*	*	ns	ns	ns
F*T	6	ns	ns	ns	ns	*	*	*	*	*	ns	ns	*
CV (%)		18.4	10.9	22.8	16.9	6.7	11.7	20.4	12.7	19.9	13.6	19.5	23.6

ns, * and ** : not significant, significant at the 5 and 1 % levels of probability ,respectively..

Note. FP (Flowering period), PH (plant height), CH (Capsule height from field), SBN (Sub Branch Number), SN (Silique Number), GN (Grain Number), SL (Silique Length), W (Grain 1000 weight), Y (Grain yield) ($Kg.ha^{-1}$) , RCWE (Relative water content of east rows), RCWW (Relative water content of west rows) and ST (Stand Vegetation Date.

Conclusion

The application of complete fertilizer had distinct influences on seed yield. The seed yield was the highest at the 4.5 Kg/h, which was influenced when application of complete fertilizer was changed. The application of complete fertilizer affected the 1000-seed weigh, when the applications of complete fertilizer were increased in this study. The number of pods was changed with the change of theoretical yield besides the other treatments. The application of complete fertilizer didn't affect the quality of rapeseed prominently. However, the change trend of protein and oil content was opposite. So we could regulate the protein and oil content in rapeseed by fertilization reasonably. The application of complete fertilizer didn't show significant effect on some agronomical traits. The applications of complete fertilizer affect mainly main pod length and root/shoot ratio. The more the fertilizers were used, the better were the agronomical characters and the economic coefficient and the yield were beneficial from it at the study. Finally, the result showed application methods of micronutrients are very important to attain the best absorption.

Table2: Means comparison of combined analysis of agronomic characters in perfect fertilizer

Fertilizer(Kg/h)	FP	PH	CH	SBN	SN	GN	SL	W	Y	RCWE	RCWW	ST
F_1=Control	30.07[a]	98.367a	41.683a	5.083a	19.453ab	21.083b	7.863ab	2.473bc	2972b	55.197a	68.540a	12 ab
F_2=2.5	12.63a	87.477a	50.577a	6.226a	20.280ab	22.577ab	7.887ab	3.350a	3649ab	55.883a	53.190a	14a
F_3=3	11.33a	83.500a	49.150a	4.800a	21.733a	25.577ab	6.930b	3.086ab	5487ab	43.690a	68.710a	10.5ab
F_4=4.5	46.18a	88.400a	65.027a	6.126a	17.610b	28.400a	11.040a	2.080c	6027a	56.970a	52.307a	8.b
Application times												
2	13.63a	82.25a	52.5a	6.2a	21.2ab	21.5ab	9.88ab	3.3a	3249ab	51.883a	51.190a	13.000a
3	14.33a	89.51a	47.1a	5.8a	23.3a	20.5ab	7.93b	3.1ab	4387a	49.690a	58.710a	12.500ab
5	15.18a	88.40a	60.0a	6.1a	18.6b	24.4a	10.04a	2.10c	4027ab	51.970a	42.307a	10.0b

Mean followed by the same letters in each column are not significantly different (Duncan multiple rang test 5 %).

Note. FP (Flowering period), PH (plant height), CH (Capsule height from field), SBN (Sub Branch Number), SN (Silique Number), GN (Grain Number), SL (Silique Length), W (Grain 1000 weight), Y (Grain yield) (Kg.ha^{-1}) , RCWE (Relative water content of east rows), RCWW (Relative water content of west rows) and ST (Stand Vegetation Date.

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