Effect of Some Micro and Macro Nutrients on Seed Yield and Oil Content of Rapeseed (*Brassica Napus* L.)

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Abstract**—**In order study separate and combined effects of some micro and macro nutrient as soil and foliar application on grain and oil yield of rapeseed (*Brassica napus* L) an experiment was carried out during 2012-2013. Application of macronutrient significantly increased number of pod per plant, number of seed per pod, 1000-kernel weight, biological yield, grain yield, harvest index and oil yield. Foliar application of micronutrients (iron, zinc, manganese) significantly increased 1000-kernel weight, biological yield, grain yield, oil percentage, harvest index and oil yield. Interaction effects of different levels of NPK and foliar application of micro nutrient was significant on all traits. Changes on grain yield and oil yield were primarily due to the number of pod per plant and grain yield, respectively. In general, applying of 200 kg NPK per ha and 2 parts per thousand of the micronutrient were the best combination to obtain high qualitative and quantitative yield

Keywords**—**Canola, Foliar application, Grain yield, Nutrient elements, Oil yield

I. Introduction

CANOLA (*Brassica napus* L.) is an important oil crop, ranking third only to soybean and palm oil in global production [1]. Obtaining greater cultivated area of canola is limited due to competition with other crops like wheat, corn, fodder and rice. Therefore, it is suggested that instead of increasing cultivated area the yield per hectare must be improved. Higher yield per unit area can be achieved by improving modern cultural practices with better macro and micronutrient management. Optimum use of fertilizers, their type and method of application play an important role in sustainable crop production [2]. Microelements are defined substances that are crucial for crop growth; however, they are used in lower amounts as compared to macronutrients, such as N, P and K [3]. Gul *et al.* [4] claimed that profitability of micronutrients will be obtained in combination with macro elements, such as nitrogen and potassium. Application of 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 [5], [6]. Narimani *et al.* [7] reported that microelements foliar application improve the effectiveness of macronutrients. Therefore, the objective of this study was to find the best method of N,P and K application and optimum level of some micronutrient as foliar application for higher grain yield of canola.

II. Material And Methods

The studies were conducted in an arid area in west of Iran, at the Islamic Azad University of Ramhormoz, Khuzestan, Iran (31°16´ N, 49°36´ E and 150.5 m above the sea level) during 2012-2013. The experiment was factorial on the basis of complete randomized block design, with three replications. Treatments were consisted of 0, 200 and 400 kg N, P and K per ha in forms of urea, superphosphates and potassium sulfate, respectively, and the iron, zinc and manganese elements were sprayed on plants with concentration of 2 parts per thousand and 4 parts per thousand, 25 and 50 kg/ha from secostrine, zinc sulphate and manganese sulphate, respectively. Micronutrient foliar application was done at two times, one time when plants had 6 or 8 leaves and another when they have 10 or 12 leaves (early of flowering stage). To avoid the effect of micronutrient spraying, the plots were separated by borders of 1.5 m in width from all sides. The cultivar used in this experiment was Talayeh. Plots were sown on 2 November 2012 with a cone seeder, and were 6 m long and 2.4 m wide, with 12 rows 0.2 m apart. At maturity, 10 plants were taken randomly from each subplot for recording the following morphological, yield components and yield. The various parameters within the rapeseed plant that are discussed in this paper were evaluated as fallows: Specific seed weight (average weight of 1000 seeds in grams); recorded on 10 random samples from each sub-plot. Seed yield: Center eight rows (of 12 rows) of each plot were harvested for grain yield, and converted to grain yield per hectares. Harvest index: [wt. of grain/ (wt. of grain +straw)]. The oil concentration of a sample of whole seeds from each plot was determined by Near-Infrared Reflectance Spectroscopy as described by Bhatty [8]. Oil yield (kg/ha); calculated by multiplying seed oil percentage ×seed yield per ha. Samples were dried in a forced-air oven at 70^{0} C for 48 h. Data were analyzed by analysis of variance [9]. When significant differences were found (*P=0.05*) among means, Duncan's multiple range test (DMRT) were applied.

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III. Results And Discussion

No. of pod per plant**.** There was only significant difference observed in different levels of NPK fertilizers in this trait (Table 1). The highest no of pod per plant was related to 200 Kg NPK per hectare and 2 parts per thousand Fe, Zn and Mn, and the lowest no of pod per plant was belonged to the 0 NPK and micronutrients (Table 3).

No. of seed per pod**.** Different levels of NPK fertilizers were significant at 5 % probability level in this trait and foliar application of Fe, Zn and Mn and interaction between them were not significant (Table 1). The greatest levels of NPK fertilizers produced the highest no of seed per pod (Table 2). 400 kg NPK per hectare and 4 parts per thousand were the best combination to highest no of seed per pod (Table 3). The P effect is attributed to the activation of N and K by P as stated by Jain *et al.* [10]. There are two opinions among the researchers about the role of P in relation to grains formation. According to Salwa *et al.* [11] P had no relation with number of grains per pod, which is in contradiction with our findings. But, Muhammad *et al.* [12] stated that N and P may increase grain per pod.

1000-kernel weight**.** Different levels of NPK fertilizers and foliar application of Fe, Zn and Mn had significant effect on kernel weight at 5 % probability level (Table 1). The highest value of kernel weight was obtained in 200 and 400 kg NPK per hectare and the lowest value were belonged to 0 kg NPK per hectare. Two and four parts per thousand Fe, Zn and Mn produced the greatest values of kernel weight (Table 2). No significant NPK fertilizer × micronutrient foliar application interactions were detected at $P \geq 0.05$ in this trait (Table 1). As studied by Jain *et al.* [10] increase in P level increases the uptake and utilization efficiency on N and K. It seems that the better utilization efficiency of N and K in response on optimum P reflected in greater vegetative growth by N and increased growth enzymatic activity by K. Narimani *et al.* [7] indicated that foliar application of Zn, Mg, Mn and Fe significantly increased growth parameters, yield and its components of durum wheat.

Grain yield**.** Grain yield increased in response to applied NPK fertilizer, with the grain yield of the crop that received 400 kg NPK per hectare being two fold than for that no received NPK and 15% more than 200 kg NPK ha^{-1} (Table 2). However, Increasing in grain yield at 400 kg NPK per hectare was marginal. This implies that there was no response to the application of higher rates of NPK fertilizer. Among the three micronutrient foliar application, 4 parts per thousand Fe, Zn and Mn produced the highest grain yield (Table 2). NPK fertilizer × micronutrient foliar application interaction was not significant in this trait (Table 1). Puri *et al.* [13] gave the credit of increase grain yield to the increase level of NPK. Magnesium acts as a catalyst in many oxidation, reduction reactions inside the plant tissues, as well as it may increase crop resistance to drought. In this concern SeifiNadergholi *et al.* [14] stated that foliar application with magnesium sulphate increase net assimilation rates, seed yield and crude protein content of plants. Iron plays essential roles in the metabolism of chlorophylls. External application of Fe increased photosynthesis, net assimilation and relative growth in seawater-stressed rice [15] Plant yield on many soils is, therefore, limited by poor Fe availability, rather than a low Fe content in the soil. Also Fe leaching is the main pathway for Fe loss in coarse-textured soil with high pH, while excessive Fe uptake was the main pathway for Fe loss in clay-textured and acid soil.

Biologic yield and Harvest Index**.** There was significant difference between NPK fertilizer and foliar application of Fe, Zn and Mn treatments in these two traits (Table 1). 400 kg NPK per hectare fertilizer and 4 parts per thousand Fe, Zn and Mn was more successful than other treatments to produce higher biologic yield (Table 2). Significant NPK fertilizer × micronutrient foliar application interactions were not detected at $P \geq 0.05$ on biologic yield and harvest index. Ghasemian *et al.* [16] reported significant positive effect of zinc treatment on dry matter, seed and straw yield of soybean as well as crude protein % in the seeds. Zinc also plays an important role in the production of biomass [12].

Oil percent and Oil yield**.** NPK fertilizer and foliar application of Fe, Zn and Mn treatments were significant in oil percent and oil yield (Table 1). 200 and 400 kg NPK per hectare produced the highest oil seed and oil seed yield, respectively. Increase in NPK fertilizer more than 200 kg decreased oil seed about 52% (Table 2). However, oil seed yield increased with applying in NPK fertilizer, due to increase in grain yield. Four parts per thousand of Fe, Zn and Mn produced the highest oil seed and oil seed yield and increased them by 35 and 51% more than two parts per thousand and control, respectively. Oil content is typically characteristic of species, variety and their genetic make up. Puri *et al.* [13] reported that the combine NPK improved the oil content of canola. Zn is known to have an important role either as a metal component of enzymes or as a functional, structural or regulatory cofactor of a large number of enzymes [6]. Application of Zn or Fe has been reported significant positive effects, in most cases, on growth measurements and chemical composition [16], [17]

TABLE I
RESULTS OF ANALYSIS OF VARIANCE NPK FERTILIZERS AND FOLIAR APPLICATION OF SOME MICROELEMENT

Sources	df	No. of pod per plant	No. of seed per pod	1000-Kernelweight (g)	Grain Yield kg/ha	Biological yield kg/ha	Harvest Index (%)	Oil percent	Oil yield kg/ha
Replication	2	10202.1ns	2.52 ns	0.79ns	1588.8ns	40842.52ns	21.56ns	81.0ns	30173.6ns
NPK Fertilizers	2	16013.84*	32.38*	3.07*	9388.97*	226435.07*	42.63*	189.7*	91365.69*
Foliar application of microelements (F)	2	81.18ns	24.1ns	2.623*	6444.46*	2011794.2*	37.39*	170.5*	86030.60*
NPK × F	4	4203.60ns	5.35ns	0.363ns	621.83ns	33322.93ns	24.37ns	39.4ns	25880.4ns
Error	16	3489.739	8.393	0.63	1644.463	54491.09	8.212	46.65	23153.43
CV (%)		20.946	16.23	28.92	2.607	3.477	14.28	21.22	18.71

*,** Significant at 0.05 and 0.01 probability levels, respectively. NS=nonsignificant at *P> 0.05*.

TABLE II
MEAN VALUES OF TRAITS OF CANOLA CULTIVAR AT NPK FERTILIZERS AND FOLIAR APPLICATION OF SOME MICROELEMENT

Treatments	No. of pod per plant	No. of seed per pod	1000-Kernel weight (g)	Grain yield kg/ha	Biological yield kg/ha	Harvest Index (%)	Oil percent	Oil yield kg/ha
NPK fertilizers (kg/ha)								
0	54 b	16 b	1.91 b	870 b	5986 b	18 b	23.5 b	180.8 b
200	93 a	17 b	2.95 a	1499 a	6825 a	21 a	26.7 a	262.6 a
400	103 a	22 a	3.36 a	1706 a	7325 a	21 a	18.8 c	289.5 a
Foliar application of Fe, Zn, Mn part perthousand								
0	80 a	17 a	2.83 b	880 b	6127 b	19 b	19.1 b	176 b
2	83 a	19 a	3.17 a	1224 a	6795a	20 a	23.3 a	238 a
4	86 a	21 a	3.30 a	1532 a	7215 a	21 a	25.7 a	268 a

Same letters in columns are not significantly different at P ≤ 0.05.

TABLE III
INTERACTION BETWEEN NPK FERTILIZERS AND FOLIAR APPLICATION OF SOME MICROELEMENT ON MEAN VALUES TRAITS

Treatments		No. of pod per plant	No. of seed per pod	1000-Kernel weight (g)	Grain yield kg/ha	Biological yield kg/ha	Harvest Index (%)	Oil percent	Oil yield kg/ha
NPK fertilizers kg/ha	Foliar application of Fe, Zn, Mn part per thousand								
0	0	25 d	15b	2.82 a	810 b	5382 b	13 b	25.5 b	171 b
	2	67 c	17 ab	2.28 b	924 b	4807 c	17 b	24.5 b	172 b
	4	69 c	18 ab	2.75 b	877 b	5776 b	17 b	30.3 b	240 ab
200	0	90 b	18 ab	3.18 ab	936 b	6009 b	21 ab	17.3 b	240 ab
	2	139 a	19 ab	3.28 a	821 b	7696 ab	22 a	17.1 b	260 ab
	4	51 c	16 b	3.06 ab	843 b	7107 ab	22 ab	22.3 b	281 ab
400	0	94 b	19 a	3.25 ab	896 b	6401 b	21 ab	17.5 b	289 a
	2	94 b	20 a	3.24 ab	1347 a	8567 a	22 a	28.5 a	290 a
	4	121 b	21a	3.1 b	1054 a	7602 ab	22 a	24.5 a	306 a

Same letters in columns are not significantly different at P ≤ 0.05.

IV. CONCLUSION

In conclusion, application of macronutrient used in this study significantly increased all measurement traits. However, no significant difference was observed between 200 and 400 kg/ha NPK fertilizers treatments in some traits. Oil seed percentage increased with increasing levels of NPK fertilizer to 200 kg/ha, but 400 kg/ha decreased it. Foliar application of micronutrients also significantly increased all measurement traits. Foliar application of 2 and 4 parts per thousand of micronutrients were statistically in the same levels. Results of correlation between traits also showed that changes on grain yield and oil yield were primarily due to the number of pod per plant and grain yield, respectively.

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