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**STUDY OF INFLUENCE CADMIUM AND LEAD ON YIELD, COMPONENTS OF  
YIELD AND OIL PRODUCTION IN CANOLA CULTIVARS**

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**ABSTRACT**

An experiment was conducted at Kermanshah, Iran to evaluate the effect of different level of cadmium and lead on seed and oil yield of canola (*Brassica napus* L.). These experiments were conducted as split-plot based on randomized complete block design, with three replications. Experiment factors included two cultivar of canola (Opera and Hyola401) arranged in main plot and four heavy metals rates: 0, 10, 25 and 50 mg/l as subplots. The results showed that Opera cultivar produced seed and oil yields more than Hyola 401. 10 mg/l lead produced a greater number of siliques plant<sup>-1</sup> and greater weight of seed and then, higher seeds and oil yields, and higher harvest index and high oil percentage. However, the difference between 10 and 25 mg/l cadmium and lead is very little and these two treatments have significant differences with 50mg/l cadmium and lead. In this study, the disadvantage effect of lead on canola was less than cadmium.

**Keywords: Quality Trait, Rapeseed, Seeding Rate, Seed Yield**

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**INTRODUCTION**

Heavy metal contamination is one of the most serious environmental problems limiting plant productivity and threatening human health. Amongst the substances that contribute anthropogenically to pollution of the biosphere, Heavy metals are one of the most toxic. Lead (Pb) and cadmium (Cd) are toxic metals of increasing environmental concern as they enter the food chain in increasingly significant amounts. The two metals Lead (Pb) and Cadmium (Cd) presently taken are the common pollutants which are discharged via various industries of batteries, electroplating, paints and pigment etc. in the water bodies. Although, cadmium and lead aren't necessary elements for plant, the plants absorb these elements from soil and concentrate them on different edible organs. These elements are not only toxic for human, but their concentration and absorption in plant organs also causes toxicity [1 and 2]. Controlling of the input of heavy metals to the plant, especially plant's edible organs, is very important in order to make sure of the food's health. Environmental stresses, including heavy metals, affect nearly every aspect of the plant physiology and biochemistry, and significantly diminish yield. Many regions in the world own soils and water resources that are too pollution for most of the common

economic crops, which affect plants through osmotic effects, ion specific effects, and oxidative stress [3 and 4]. In addition, plants are subjected to the interaction of two or more heavy metals under natural conditions, and many studies have been carried out to evaluate separately the effects of these stress factors on plant metabolism. The tolerance of corn, wheat, clover, soybean and sunflower plants to Pb uptake and found that the response of the tested plant species to heavy metals were differed, since the highest amounts of Pb were recorded in corn, clover and soybean, while the lowest ones were associated with sunflower and wheat [5]. The retention of Pb in roots involves binding to the cell wall and extra cellular precipitation, mainly in the form of lead carbonate, which is deposited in the cell wall [6]. The response of Cd, Pb and Ni to uptake and accumulate in root and shoot tissues of lettuce showed a closely relationship to their corresponding bioavailable content in the soil, which were more attributed to the added levels of the studied heavy metals to the soil [7]. This demand, as well as the search for alternative crops by growers, may result in plantings on soils where heavy metals problems already exist or may develop from the use of waste

water irrigation. Although a few preliminary studies on the heavy metals tolerance of rapeseed have been conducted in small pot cultures [8 and 9], heavy metals tolerance data are not available to predict canola yield responses in the field. Therefore, this field plot study was initiated to determine the effect of soil heavy metals (Cd and Pb) on seed yield, and oil content of the seed.

### MATERIALS AND METHODS

Three years field experiment was conducted at the Agronomic Research Area, kermanshah (34°55'N, 47°61'E and 1410 m)-Iran during 2008-2010. The average of minimum and maximum annual temperature is 12.4°C and 41.6°C respectively and the annual precipitation is 309 mm. The purpose of this experiment was to study the impact of different levels of cadmium and lead on yield and some of the agronomical characteristics in canola. These experiments were conducted as split-plot based on randomized complete block design (RCBD), with three replications. Experiment factors included two cultivar of canola (Opera and Hyola401), four heavy metals rates: 0, 10, 25 and 50 mg l<sup>-1</sup> as subplots. Lead and cadmium solution was sprayed on the plants in the form of Pb (NO<sub>3</sub>)<sub>2</sub> and CdCl<sub>2</sub> at rates of 0, 10, 25 and 50 mg l<sup>-1</sup> was applied 30 day after canola

planting. The subplot size was 5.4 m<sup>2</sup> (1.8 × 3 m) containing five rows, three m long and 30 cm apart, at a depth of 2-3 cm with a plant density of 90 plants per m<sup>2</sup> was used. The *Brassica napus* cv. cultivars were sown on depth of 1.5 cm maintaining 30 cm row spacing in each plot. Soil samples were taken before sowing of crop to a depth of 30 cm for physico-chemical analysis. The soil chemical property showed that the experimental soil was clay-loam in texture containing 0.83% OC, 1.33 (ds/m) EC×103, 8.25% TNV, 35% SP, 8% Total N, absorbable K 288 mg.kg<sup>-1</sup>, 29% clay, 45% silt and 26% sand with a pH of 7.8. Weeds were removed by manual weeding during the growth stages. Nitrogen fertilizer was applied at the rate of 240 kg ha<sup>-1</sup> in the form of urea (46% N) at two intervals, the first at sowing date, and the second at flowering stage. Also P<sub>2</sub>O<sub>5</sub> at rate of 90 kg.ha<sup>-1</sup> was applied in the form of triple superphosphate (46 % P<sub>2</sub>O<sub>5</sub>) were drilled with seeds. At the end of growing season, data were recorded on 1000-seed weight (g), seed yield (kg ha<sup>-1</sup>), seed oil percentage (%), harvest index (%) and seed oil yield (kg/ha). The data were analyzed following Analysis of Variance (ANOVA) technique using the statistical computer program MSTATC. Means were compared by using Multiple

Range Test of Duncan (DMRT) taking  $P < 0.05$  as significant.

## RESULTS AND DISCUSSION

### *-Cultivars*

**Table 1** showing effects of two cultivar on yield and components of yield of canola as you see highest yield belong to opera cultivar with 1091.9 kg/ha also this cultivar was better than in some traits such as number of siliques per plant, weight of seed and oil content. It seems the higher yield of this cultivar due to number of silique per plant. Among different crops, the Brassicaceae family distinguishes with their ability tolerance to the heavy metals [10].

### *-Effect of cadmium*

Individual plants of 10 and 25 mg/l cadmium produced a higher number of siliques than those of 50mg/l (119.2) and (110.6) against 81.3 siliques respectively (Table 2), which illustrated that increasing concentration cadmium over 25 mg/l significantly decreased the pod-bearing capacity. Similar to number of pod plant<sup>-1</sup>, weight of seed play a major role in yield. Crop grown with 10 and 25 mg/l cadmium were showed significantly highest seed weight as compared to 50 mg/l cadmium which produced lowest seed weight (Table 2). Similarly, maximum total yield of 645.3 kg ha<sup>-1</sup> was obtained when crop was grown by 10 mg/l cadmium, which was significantly

higher than 25 and 50 mg/l cadmium although different between 10 and 25 mg/l cadmium is not significant and over 25 mg/l cadmium total yield decreased very sharply. The similar result was obtained by [11]. Oil percentage was not significantly affected by cadmium concentration, but oil yields were significantly affected, it was 198.52 kg/ha for 10 mg/l and 185.07 for 25 mg/l but it decreased to 135.11 kg/ha.

### *-Effect of lead*

The obtained results indicated that number of siliques plant<sup>-1</sup> was influenced by different lead concentration (**Table 2**), the number of siliques per plant decreased 15.22% as the lead concentration increased from 25 to 50 mg/l, the number of siliques plant is the most responsive of all the yield components in rapeseed. It is noted from (**Table 2**) that there is no differences between the lead concentration 10 and 25 mg/l in seeds/silique trait, however the 50 mg/l lead concentration decreased number of seeds/silique to 19.13seed/silique. For the same table, it is noted that there is no differences among the 10 and 25 mg/l lead concentration in seed weight, however the seed weight at 50 mg/l lead decreased to 0.14 mg (12.5%) that is due to the decrease of the number of plants m<sup>2</sup>, plant height, number of primary branches plant<sup>-1</sup> which led to increase of competition

between plants over growth factors, consequently led to decrease of number of siliques plant<sup>-1</sup> and seed weight. These results were consistent with the findings of [12]. Lead concentration showed significant effect on total yield (**Table 2**). The negative correlations observed for Pb uptake and yield is in agreement with the findings of [13]. The low lead concentration (10 mg/l) resulted in the highest average yield (797.4 kg ha<sup>-1</sup>). There was a significant decrease and increase in harvest index at the 25 and 50 mg/l respectively, due to the possible advantage of reduced and raised branching or number of primary branches of plant for these treatment. Oil percentage tended to decrease from 29.67% to 25.44% (4.23%) when lead concentration increased from 10 to 50 mg/l, while oil yield tended to decrease 185.11 kg/ha (22%). Excessive metal concentrations in contaminated soils result in decreased soil fertility and yield losses [14].

#### ***- Lead and cadmium interaction effects***

The interaction effect of lead and cadmium concentration on all characteristics studied was also significant (table3). The effects of lead on both cultivars had highest value of total yield and this event show that effects of lead on canola have minimum disadvantage on agronomic traits.

## **CONCLUSION**

Based on results of this study, it could be concluded that lead and cadmium had significant influence on growth, yield and its components of rapeseed. Effects of lead on yield and components of yield of both cultivar of canola was less than cadmium and opera cultivar had more resistance to heavy metals study. From above mentioned, discussion and under the conditions of this experiment, Cd and Pb concentration less than 50 mg/l did not adversely affect plant growth of canola. Whereas, concentration of Cd and Pb in different organs of plant did not reach the permissible limits that led to toxic effects on plants and consequently animal and human.

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**Table 1: Effect of cultivars (Opera and H401) on yield, yield components and oil of canola (mean three years 2008-2010)**

Cultivars	No. of Siliques per plant	No. of Seeds per Silique	Weight of seed (mg)	Seed Yield (Kg/h)	Harvest Index (%)	Oil Percent (%)	Oil Yield (Kg/h)
Opera	130	21.09	0.17	1091.9	32.1	31.47	341.46
H401	107.1	23.16	0.15	453.3	37.8	30.67	137.19

**Table 2: Effect of cadmium and lead on yield, yield components and oil of canola (mean three years 2008-2010)**

Treatment	No. of Siliques per plant	No. of Seeds per Silique	Weight of seed (mg)	Seed Yield (Kg/h)	Harvest Index (%)	Oil Percent (%)	Oil Yield (Kg/h)
Control	140	21.37	0.18	1037.3	31.4	30.17	311.09
Cd10	119.2	20.87	0.16	645.3	34.1	29.27	198.52
Cd25	110.6	19.81	0.15	631.31	32.3	27.4	185.07
Cd50	81.3	14.23	0.11	501.8	33.6	23.34	135.11
Pb10	129.7	22.87	0.16	797.4	34.9	29.67	238.52
Pb25	112.3	22.41	0.16	740.01	33.3	28.5	223.07
Pb50	95.2	19.13	0.14	588.7	38.6	25.44	185.11

Note: Cd10=10mg/l cadmium, Cd25=25mg/l cadmium, Cd50=50mg/l cadmium  
Pb10=10mg/l lead, Pb25=25mg/l lead, Pb50=50mg/l lead

**Table 3: Effect of cultivars and heavy metals interaction on yield, yield components and oil of rapeseed (mean three years 2008-2010)**

Treatment	No. of Siliques per plant	No. of Seeds per Silique	Weight of seed (mg)	Seed Yield (Kg/h)	Harvest Index (%)	Oil Percent (%)	Oil Yield (Kg/h)
Control Opera	152.67	18.47	0.21	1344	36.62	29.62	398.34
Opera×Cd10	121.22	22.75	0.15	945	29.63	29.16	281.23
Opera×Cd25	101.09	19.66	0.13	812	27.45	29.12	245.61
Opera×Cd50	75.14	12.43	0.1	572	24.43	24.43	169.25
Opera×Pb10	138	26.33	0.17	1047	31.07	29.97	238.52
Opera×Pb25	131	25.41	0.16	991	30.77	31.35	223.07
Opera×Pb50	107.67	15.93	0.14	775	27.67	27.44	202.11
Control H401	131.47	24.12	0.18	730	27.2	29.62	398.34
H401×Cd10	108.02	21.65	0.15	915	29.43	29.1	281.23
H401×Cd25	96.19	21.26	0.14	802	28.15	28.72	245.61
H401×Cd50	63.18	11.23	0.11	532	23.41	23.33	169.25
H401×Pb10	125	27.21	0.16	693	38.9	27.91	238.52
H401×Pb25	109	26.25	0.14	635	39.07	28.35	223.07
H401×Pb50	95.23	18.24	0.12	504	31.01	25.44	202.11

Note: Cd10=10mg/l cadmium, Cd25=25mg/l cadmium, Cd50=50mg/l cadmium  
Pb10=10mg/l lead, Pb25=25mg/l lead, Pb50=50mg/l lead