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ABSTRACT

This study was conducted at the field of Technical Institute in Khabat/ Erbil Polytechnic University during the winter season of 2015-2016 to study the effect of manganese foliar application on some quantitative and qualitative characteristics of some canola varieties. Split-plot based on Randomized Complete Block Design, with three replication was applied. Three canola varieties (Pactol, Srew, and Sputnik) were assigned as main plot, whereas concentrations of Mn (0, 200, 400 and 600 µg ml^{-1}) as subplot. Sputnick variety produces the highest plant height (cm), number of branches and number of Silique plant^{-1}, while Srew variety recorded highest number of seed silique^{-1}, 1000 seed weight (g) and seed yield (kg.ha^{-1}), but Pactol variety surpassed in oil%, oil yield (kg.ha^{-1}), palmitic and oleic acid%. The concentration of 400 µg ml^{-1} manganese foliar application surpassed in all quantitative characters excluding plant height, while 200 µg ml^{-1} of Mn recorded highest oleic and linoleic acids% but the concentration of 600 µg ml^{-1} Mn obtained highest values of palmitic, stearic and erucic acid content %. The interaction between Pactol variety and 400 µg ml^{-1} Mn recorded the highest seed yield (kg ha^{-1}), oil content% and oil yield (kg ha^{-1}), while the highest oleic acid% and lowest erucic acid were recorded from the interaction between Pactol 200 µg ml^{-1} and Pactol 0 Mn respectively. On the other hand the interaction treatment Sputnick variety 200 µg ml^{-1} surpassed in linoleic acid %.

Key words: ***Canola varieties, Manganese, Foliar application***

1. INTRODUCTION

Rapeseed (Brassica napus L.) belongs to (Brassicaceae) family which becomes one of the most important sources of the vegetable oil in the world (Baghdadi *et al,*. 2013). It is cultivated in Northern Europe, including Poland, and considered an important crop used mainly, for cooking. The world produced of rapeseed was about (70,954,407) tones with an average yield (1982.2 $kg.ha^{-1}$) according to FAO statistics in 2015 (FAO, 2015). Which canola name was registered in Canada, which means "double-low" varieties, double low canola varieties indicate that the processed oil contains appropriate rate of erucic acid in the oil and glucosinolates in meal after oil extraction, it has very healthy vegetable oil because of its balance with omega 3-6-9 essential fatty acids. (Sami, 2015). Canola is cultivated for edible oil and for bio fuel production, and can be used for phytoextraction of heavy metals (Turan and Esringu, 2007). Also, (Jensen *et al.,* 1996) reported that canola is an important agricultural crop grown primarily for its edible oil and the meal that remains after oil extraction; it is also regards as a source of protein for the livestock feed industry. Canola seeds contain about 44 percent oil (Robertson and Holland, 2004). Canola contains valuable fatty acids and amino acid required for the human body, with 40-49 oil percent and 35-39 percent protein (after oil extraction). It also contains a desirable profile of saturated fatty acids (7%) and high level of unsaturated oleic acids (about 61%), medium level of unsaturated linoleic fatty acids (21%), (11%) linoleic acid (Molazem *et al.*, 2013), (Abdul Sattar *et al,*. 2013) demonstrated that over 13.2% of the world's edible supply oil now comes from the rapeseed, and also they stated that the obtained oil from conventional rapeseed is not considered as regular cooking oil because of its inferior quality due to the presence of high erucic acid (more than 40%) and glucosinolates (more than 100 $micromole.g^{-1}$ of dry meal) and low level of oleic and linoleic acid. And for this reason rapeseed oil potentially used in bio-diesel market (El-Nakhlawy and Bakhashwain, 2009). Manganese is the most important micro elements required for plants. It is a key element in cell metabolism such as photosynthesis, respiration, enzymes activity (Pourjafar *et al.* 2016). According to the limitations of soil usage of micro-nutrients (such as consolidation and residual effects) foliar spraying or leaf feeding is one of the effective ways in resolve plants food requirement to micronutrients (Wang *et al.,* 2004). Recent researches have shown that a small amount of nutrients, particularly Zn, Fe and Mn applied by foliar spraying significantly increased the yield of crops (Sarkar et al. 2007). Seifi Nadergholi et al. (2011) stated that foliar application of manganese sulphate increased seed yield by plants, foliar application of 400 µg ml^{-1} Mn produced the highest grain yield. Manganese (Mn) participates in several important processes including photosynthesis, and metabolism of both nitrogen and carbohydrate, on the other hand, foliar fertilizers easily absorbed by the plants, rapidly transported, and easily releases their ions to affect the plant (Larue and Johnson, 1989). The cultivars are one of the factors affected on yields of canola, Armin *et al*., (2013) reported that the maximum seed yield (3911 $Kg.ha^{-1}$) among all Canola cultivars was obtained from KR4 cultivar, while the minimum value (1487 $Kg.ha^{-1}$) obtained from Orient and Modena cultivars. Turhan *et al*., (2011) recorded the influence of different genotypes on fatty acid synthesis of rapeseed (Palmitic, Linoleic, Linolinic and oleic acid); the synthesis of oleic acid reached its maximum rate in Titan genotype (64.80 %) as well as Linoleic acid; but in Viking genotype the value was (21.50%). The aim of this study is to study the effect of manganese foliar application on some quantitative and qualitative characteristics of some canola varieties.

2. MATERIALS AND METHODS

This study was conducted at the field of Technical Institute in Khabat/ Erbil Polytechnic University, Latitude 36° 4' N and Longitude 44°2' E, with the elevation of 415 meter above sea level having annual rainfall between (250-600 mm) during the winter growing season 2015-2016 to study the effect of manganese foliar application on some quantitative and qualitative characteristics of some canola varieties. Split-plot based on Randomized Complete Block Design with three replication was applied. Three canola varieties (Pactol, Srew, and Sputnik) were assigned as main plot, whereas concentrations of Mn (0, 200, 400 and 600 µg ml^{-1}) as subplot. The representative soil samples were taken from various locations of the field at depths (0-30 cm) after tillage. These samples were air dried then sieved by using 2- mm sieve size, then packed for analysis. The field was plowed for preparing a good seedbed and also to controlling weeds prior of planting, the land was divided manually to plots, and each replicate consists of 12 experimental units (2m×2 m). Planting was done manually from 24 October at row spacing 40 cm and plant spacing 5 cm, two seeds were planted in each hole at the depth of 3 cm, and then the plants were thinned after emergence stage to (50 plant. m^{-2}). Plants are sprayed by manganese foliar application after 30 days from sowing in two intervals periods; at six to eight leaves stage and at ten to twelve leaves stage (early flowering stage). Furthermore, five plants were selected randomly from each experimental unit to study the plant height cm, number of primary branches plant^{-1}, number of Siliques plant^{-1}, number of seeds silique^{-1} and weight of 1000 seed (g). All middle-line of each experimental unit were harvested, to calculate the seed yield (kg.ha-1). And also for further estimation of oil content and quality such as saturated and unsaturated fatty acids.

Percentages of saturated and unsaturated fatty acids were determined by using Gas Liquid Chromatography (GLC) using International Union of Pure and Applied Chemistry (I.U.P.A.C, 1979) method. The data was computed within the (GLC), both are provided by Hewlett Packard to record area% and peak area of each peak of fatty acids. Data were taken for all samples of oil extraction from seeds to identify variation in fatty acids percentage. The analysis is performed by the General Company for Vegetable Oils – Baghdad. To diagnose the fatty acids in the oil, the following standard fatty acids were used saturated fatty acids; (Palmitic, Behenic and Stearic acids) and unsaturated fatty acid; (Oleic, Linoleic, Linolenic and Erucic acids). The data was analyzed statistically for all of the studied traits according to analyses of variance using the Statistical Analysis System (SAS Institute, 2005). Duncan's multiple range test DMRT at 5% level of significant was used to the compare among means (Steel and Torrie, 2000). Simple correlation coefficient was calculated between the seed yield and other traits, and among the traits themselves and simple regression among some studied traits (Al-Rawi, 1984).

Table (1): Metrological data for Khabat field during the rainfall season of (2015-2016).

Parameter Years 2015-2016	**Air Temperature in (°C)**			**Monthly total rainfalls mm**	**Relative Humidity R.H%**
	Maximum	**Minimum**	**Average**		
October	31.1	16.8	24.1	31.9	72.2
November	20.8	8.4	14.6	86.3	79.6
December	14.7	2.7	8.7	68.9	85.2
January	10.9	2.2	6.5	77.5	79.4
February	17.8	5.3	11.6	55.1	84
March	20.1	7.9	14.2	39.7	80.2
April	27.2	11.2	19.4	32.6	71.2
May	24.6	15.8	24.6	1.9	59.8

Table (2): Some physical and chemical properties of the soil at depths (0 - 30 cm).

Depth cm	PSD %			Soil Texture	pH	Ec ds/m	O.M %	(N) %	Available (P)	K^+	Ca^{+2}	Mg^{+2}
	Sand	Silt	Clay									
	g kg^{-1} soil					$dS.m^{-1}$	%		$mg.g^{-1}$	Mmolic.L^{-1}		
0-30	6	50	44	Silty clay	7.5	1.3	1.1	0.27	3.76	0.22	6.57	3.98

3. RESULTS AND DISCUSSION.

Table (3) shows the quantitative, yield and its components characteristics, oil content and its quality for canola varieties in response to the foliar application of manganese with different concentrations and as follows:

3.1. Plant height (cm):

The data presented confirm the existence of significant differences among the studied varieties, the highest plant height (195.08 cm) was recorded from Sputnick variety, compared with Srew variety which obtained the lowest (179.33 cm). Among different concentration of manganese foliar application, plant height was recorded (195.11 cm) in 600 µg ml^{-1} but at 0 µg ml^{-1} recorded (180.22 cm). These results are agree with those of Riki *et al.* (2014) whom reported that foliar application with manganese sulphate increased plant height. However the interaction between varieties and manganese foliar application was also significant effect, the highest plant height (201.00 cm) was obtained for Sputnick variety at 600 µg ml^{-1}, while the lowest value (172.66 cm) was recorded from interaction Srew variety at 0 Mn.

3.2. Number of branches per plants

The maximum number of branches was noted for the Sputnick variety (14.08) whereas the minimum was for Sarwe and Pactol which was (8.08 and 8.00), respectively. These results are agree with those of Sarkees *et al.*, (2007) They reported that different varieties had significant effected on number of branches per plant. However, the different concentration of manganese foliar application, 400 µg ml^{-1} obtained significantly higher number of branches followed by control unit. The superior interaction was for Sputnick variety with 400 µg ml^{-1} (16.66), but the least value was recorded for Pactol variety at 0 µg ml^{-1}. From table (5) there was a positive and highly significant correlation between this trait and number of silique per plant (r= 0.615**) respectively.

3.3. Number of silique/plant

A wide variation was observed between No. of silique.plant^{-1}, the highest number was recorded for Sputnick variety which was (418.08), while the lowest number was recorded for Pactol variety which was (247.83). The foliar application of Mn affected significantly the highest value (397.11) was recorded from 400 Mn. While the minimum values (302.88 and 299.00) were obtained from treatments 0 and 200 µg ml^{-1} Mn respectively, also Rili *et al*,. (2014) stated that 400 µg ml^{-1} of manganese foliar application increased number of silique plant^{-1}. The interaction between varieties and Mn application also affected significantly on Number of silique plant^{-1}, the highest value (445.33) was recorded from interaction Sputnick variety with 400 µg ml^{-1} of Mn, while the lowest value (177.33) was obtained from interaction Pactol variety with 0 µg ml^{-1} of Mn.

3.4. Number of seed/silique

Data in table (3) also shows that the highest number of seed silique^{-1} was recorded for the sample collected from Srew variety (20.58), while the lowest was recorded for Sputnick variety (11.00). Regading Mn concentration, the maximum number of seed silique^{-1}was observed in 400 µg ml^{-1} (18.77), but 0 µg ml^{-1} results minimum seed silique^{-1} (14.66). Considering the interaction between varieties and manganese spry, the highest value (23.66) was obtained for Srew on 400 µg ml^{-1} but the lowest value was recorded from Sputnick variety in 0 µg ml^{-1} (10.00).

3.5. 1000-seed weight (g)

The highest value for 1000 seed weight was recorded for the sample collected from Srew variety (4.42 g), but the lowest was for Sputnick variety which was (3.17 g). Among different concentration of manganese foliar application, 1000-seed weight was recorded (4.03 cm) in 400 µg ml^{-1} but at 0 µg ml^{-1} recorded (3.38 cm). The highest interaction were recorded for the sample collected from Srew with 400 µg ml^{-1} (4.70 g), but the least was (2.99 g) for Sputnick variety at 0 µg ml^{-1}.

3.6. Seed yield (kg ha-1)

That the highest seed yield was recorded from Srew variety (4940.00 $kg.ha^{-1}$), while the lowest was obtained from Sputnick variety (3931.91 $kg.ha^{-1}$). Regarding Mn concentration, the highest value was obtained at 400 µg ml^{-1} (5145.22 kg ha^{-1}) but the lowest value was recorded at 600 µg ml^{-1} (4159.88 $kg.ha^{-1}$). The variations in seed yield, confirm that the interaction between varieties and concentrations of manganese foliar application are significant. The superior value was from Srew variety at 400 µg ml^{-1} (5540.21 $kg.ha^{-1}$), whereas the minimum was for Sputnick variety at 0 µg ml^{-1} (3574.00 kg ha^{-1}). These results are agree with those of Seifi Nadergholi *et al*. (2011) whom reported that foliar application with manganese sulphate increased seed yield of plants. From table (5) there was a positive and highly significant correlation between this trait and number of branches per plant, number of silique $plant^{-1}$, number and 1000-seed weight (r= 0.962**, 0.740** and 0.639**) respectively. Also Sarkees (2015) stated that increase the number of silique $plant^{-1}$ and seed weight resulted increase seed yield.

3.7. Oil Percentage (%):

The data presented in (Table, 3) inducted significant differences between canola varieties, manganese foliar and their interactions. It was found that the Pactol variety recorded the highest oil content (43.66%), while the Sputnick variety recorded the lowest oil content (28.66%), Also Sana, *et al*. (2003) concluded that the maximum oil content obtained from some canola varieties might be due to the variation in genetic makeup of the variety. The results showed that 400 µg ml^{-1} of Mn concentration was surpassed in oil percentage (37.77%), while 0 µg ml^{-1} gave the lowest oil percentage (35.00%), The interaction between varieties with manganese foliar significantly affected on this trait, it was found that Pactol variety with 400 µg ml^{-1} recorded the highest oil percentage (46.33%), compared with other interactions.

3.8. Oil yield (kg ha-1):

The results showed that all the studied factors had significantly affected the oil yield (Table 3), it was found that Pactol variety recorded the highest oil yield (2079.48 $kg.ha^{-1}$), compared with Sputnick variety which gave the lowest oil yield (1131.18 $kg.ha^{-1}$), Also 400 µg ml^{-1} of Mn produced maximum oil yield (1957.98 $kg.ha^{-1}$), while 600 µg ml^{-1} produced the minimum oil yield (1509.00 kg ha^{-1}), Pactol variety recorded the highest oil yield (2577.41 kg ha^{-1}) at 400 µg ml^{-1} compared with Sputnick variety recorded lowest rate (964.76 kg ha^{-1}) at 0 µg ml^{-1} . This result is in agreement with Ghasemian *et al.* (2010) reported that four parts per thousand of Mn produced the highest oil seed and oil seed yield with increasing rate by 35 and 51% more than two parts per thousand and control, respectively. From table (5) there was a positive and highly significant correlation between this trait and seeds yield and oil% (r= 0.827** and 0.494**) respectively.

Table (4) shows the effect of different concentrations of manganese foliar application on some quality of canola varieties; the results showed significant differences and as follows:

3.9. Palmitic acid composition (%):

The oil seed for Pactol variety was distinguished by high percentage of palmitic acid (5.29%), while Srew variety gave the lowest (4.26%). The results shown that 600 µg ml^{-1} of concentrated manganese foliar application produced (5.49%) compared with other concentrated. From the results of interaction between varieties with manganese foliar application on palmitic acid, the Pactol variety gave higher rate for this trait at 600 µg ml^{-1} (5.98%), compared to Srew variety which gave lower percentage (3.93%) at 0 µg ml^{-1}.

3.10. Stearic acid composition (%):

The results explain that the Sputnick variety produced the highest percentage of stearic acid (1.86%), while Pactol variety gave the lowest rate for this trait (1.42%). Also 600 µg ml^{-1} of Mn foliar application recorded (2.03%), while 0 µg ml^{-1} gave less rate of stearic acid which was (1.26%). The interaction between variety with Mn concentration significantly effected stearic acid, it was found in highest value at Sputnick variety with 600 µg ml^{-1} of Mn (2.14%), compared with Pactol variety at 0 µg ml^{-1} which recorded the lowest value (0.45%). From table (5) there was a negatively and highly significant correlation between this trait and oil% and oil yield (r= -0.607** and 0.758**) respectively.

3.11. Behenic acid composition (%):

Srew variety surpassing in behenic acid percentage (0.21%) also 200 µg ml^{-1} of Mn recorded the highest rats (0.26%). The interaction between varieties and manganese foliar application significantly affected on this trait, it was found that Srew variety with 0 µg ml^{-1} recorded the highest behenic percentage (0.45%), compared with Sputnick variety on 600 µg ml^{-1} give the lowest rate (0.01%).

3.12. Oleic acid composition (%):

The oil seed for Pactol variety was recorded by high percentage of oleic acid (69.77%), while Sputnick variety gave the lowest (30.17%). The results shows that 200 µg ml^{-1} of concentrated manganese foliar application produced (53.83%) compared with other concentrated. From interaction between varieties with manganese spry application on oleic acid%, the plants of Pactol variety gave higher rate for this trait at 200 µg ml^{-1} (71.77%), compared Sputnick variety which gave lower percentage of oleic acid (29.07%) at 600 µg ml^{-1} (Table, 4). From table (5) there was a highly negative significant correlation between this oleic acid and linoleic, linolenic and erucic acids (r= -0.879**, -0.929 ** and -0.719**) respectively.

3.13. Linoleic acid composition (%):

The results explain that the Sputnick variety produced the highest percentage of linoleic acid (34.28%), while Srew variety gave the lowest rate for this trait (15.47%). Also 200 µg ml^{-1} of Mn foliar application recorded (23.38%), while 0 µg ml^{-1} gave less rate of linoleic acid was (21.55%). The interaction between variety with Mn concentrated had significantly affected linoliec acid, it was found at Sputnick variety with 200 µg ml-1 of Mn gave the highest value (35.63%), compared with Srew variety at 0 µg ml-1 which recorded the lowest value was (14.26 %) for this trait.

3.14. Linolenic acid composition (%):

The results also exhibited that Sputnick variety was superior in linolenic acid percentage (15.93%). On the other hand 0 µg ml^{-1} of Mn recorded the highest rats (12.72%). The interaction between varieties and manganese foliar application significantly affected on this trait, it was found that Sputnick variety with 0 µg ml^{-1} recorded the highest linolenic acid percentage (17.31%), compared with Pactol variety on 600 µg ml-1 give the lowest rate (4.61%).

3.15. Erucic acid composition (%):

The data shows existence of significant differences among all the factors studied the highest erucic acid (13.20%) from Srew variety, compared with Pactol variety that recorded (0.43%). Among different concentration of manganese foliar application, erucic acid was recorded (9.33 cm) in 600 µg ml^{-1} but at 0 µg ml^{-1} recorded (8.37 cm). However the interaction between varieties and manganese foliar application was significant, the highest erucic acid% (16.06%) was observed for Srew variety at 600 µg ml^{-1}, compared with the inferior interaction of Pactol variety with 0 µg ml^{-1} (0.01 %). Table 5 inculcate that erucic acid had positive correlation with linolenic acid at (0.662**).

4. CONCLUSION:

It is concluded that Srew variety recorded heights seed yield (4940 kg ha^{-1}) and Pactol variety produced the heights oil content (43.66%) and oil yield (2079 kg ha^{-1}). Concentration of manganese foliar application 400 µg ml^{-1} recorded heights seed yield (5145 kg ha^{-1}), oil content and its yield (37.55% and 1957.98 kg ha^{-1}) respectively. Also 200 µg ml^{-1} surpassed in oleic (53.83) and linoleic (23.38) acids%, and the lowest erucic acid (0.01%) was obtained from interaction Pactol variety with 0 µg ml^{-1} of manganese foliar application.

Table (3): Effect of cultivars, Manganese foliar application and their interactions on growth characters, yield components, yield and oil yield of canola.

Canola Varieties		Plant height (cm)	No.of branch	No. of silique	No. of seed/ silique	seed/ 1000 Weight (g)	Seed yield (Kg ha^{-1})	Oil %	Oil yield (Kg ha^{-1})
Pactol		186.91 b	8.00 b	247.83 c	17.58 b	3.30 b	4745.00 b	43.66 a	2079.48 a
Srew		179.33 c	8.08 b	344.66 b	20.58 a	4.42 a	4940.00 a	35.83 b	1771.25 b
Sputnick		195.08 a	14.08 a	418.08 a	11.00 c	3.17 c	3931.91 c	28.66 c	1131.18 c
Mn Conc. (µg ml^{-1})		Plant height (cm)	No.of branch	No. of silique	No. of seed/ silique	1000seed/ Wieght (g)	Seed yield (Kg ha^{-1})	Oil %	Oil yield (Kg ha^{-1})
0		180.22 c	8.88 c	302.88 c	14.66 c	3.38 d	4512.44 b	35.00 c	1608.81 b
200		186.88 b	9.88 b	299.00 c	17.00 b	3.50 c	4347. 33 c	35.77 bc	1566.75 c
400		186.22 b	11.66 a	397.11 a	18.77 a	4.03 a	5145.22 a	37.55 a	1957.98 a
600		195.11 a	9.77 bc	348.44 b	15.11 c	3.66 b	4150.88 d	35.88 b	1509.00 d
Canola Varieties	Mn Conc. (µg ml^{-1})	Plant height (cm)	No.of branch	No. of silique	No. of seed/ silique	1000seed/ Wieght (g)	Seed yield (Kg ha^{-1})	Oil %	Oil yield (Kg ha^{-1})
Pactol	0	179.33 cde	7.33 e	177.33 e	15.00 d	3.00 f	4391.66 cd	41.00 c	1800.00 d
	200	180.66 cde	7.33 e	202.00 e	18.00 bc	3.10 ef	4570.00 b	43.00 b	1965.33 c
	400	186.66 bcd	9.33 d	340.33 c	19.66 b	3.90 c	5562.66 a	46.33 a	2577.41 a
	600	201.00 a	8.00 de	271.33 d	17.00 c	3.21 e	4454.23 c	44.33 b	1974.83 c
Srew	0	172.66 e	8.33 de	331.00 c	19.00 bc	4.23 b	5570.66 a	37.00 d	2061.07 b
	200	184.33 cd	7.33 e	284.00 d	22.00 a	4.40 b	4353.33 de	36.66 cd	1581.71 e
	400	177.00 de	9.00 de	405.66 b	23.66 a	4.70 a	5540.21 a	35.00 d	1938.96 c
	600	183.33 cd	7.66 de	358.00 c	17.66 c	4.36 b	3702.00 g	35.00 d	1503.22 f
Sputnick	0	188.66 bc	11.00 c	400.33 b	10.00 f	2.99 f	3574.00 h	27.00 g	964.76 j
	200	195.66 ab	15.00 b	411.00 ab	11.00 f	3.00 f	4118.33 e	28.00 g	1153.58 h
	400	195.00 ab	16.66 a	445.33 a	13.00 e	3.50 d	4333.00 de	31.33 f	1357.58 g
	600	201.00 a	13.66 b	415.66 ab	10.00 f	3.24 e	4296.22 e	28.33 g	1048.92 i

The values sharing the same letter are not significantly at level of significant 0.;05

Table (4): Effect of cultivars, Manganese foliar application and their interactions on fatty acid concentration% of canola varieties .

Canola Varieties	Palmitic acid C:16	Stearic acid C:18	Behenic acid C:22	Olic acid C 18:1	Linoleic acid C18:2	Linolenic acid C 18:3	Erucic acid C 22:1
Pactol	5.29 a	1.42 c	0.16 c	69.77 a	17.42 b	5.47 c	0.43 c
Srew	4.36 c	1.84 b	0.21 a	55.30 b	15.47 c	9.60 b	13.20 a
Sputnick	5.16 b	1.86 a	0.81 b	30.17 c	34.28 a	15.93 a	12.37 b

Mn Conc. (μg ml^{-1})	Palmitic acid C:16	Stearic acid C:18	Behenic acid C:22	Olic acid C 18:1	Linoleic acid C18:2	Linolenic acid C 18:3	Erucic acid C 22:1
0	4.41 d	1.26 d	0.20 b	51.02 c	21.55 d	12.72 a	8.37 d
200	4.69 c	1.60 c	0.26 a	53.83 a	23. 38 a	9.73 c	8.44 c
400	5.15 b	1.94 b	0.15 c	51.47 b	22.48 b	9.97 b	8.58 b
600	5.49 a	2.03 a	0.12 d	50.60 d	22.15 c	8.91 d	9.33 a

Canola Varieties	Mn Conc. (μg ml^{-1})	Palmitic acid C:16	Stearic acid C:18	Behenic acid C:22	Olic acid C 18:1	Linoleic acid C18:2	Linolenic acid C 18:3	Erucic acid C 22:1
Pactol	0	4.66 h	0.45 l	0.05 j	70.21 b	17.84 f	6.18 i	0.01 l
	200	4.97 e	1.45 k	0.29 c	71.77 a	18.92 e	5.31 k	0.15 k
	400	5.55 c	1.83 f	0.19 e	69.92 c	16.53 h	5.81 j	0.64 j
	600	5.98 a	1.94 d	0.12 f	67.91 d	17.04 g	4.61 l	0.91 i
Srew	0	3.93 k	1.62 i	0.45 a	53.18 h	14.26 l	14.66 d	11.48 g
	200	4.04 j	1.85 g	0.06 i	58.67 e	16.23 i	7.47 h	11.51 f
	400	4.54 i	1.87 e	0.07 h	53.60 g	15.98 j	8.63 f	13.74 c
	600	4.56 h	2.01 c	0.25 d	55.76 f	15.42 k	7.62 g	16.06 a
Sputnick	0	4.66 g	1.73 h	0.11 g	29.67 k	32.55 d	17.31 a	13.96 b
	200	4.70 f	1.50 j	0.43 b	31.04 i	35.63 a	16.42 b	13.17 d
	400	5.37 d	2.11 b	0.19 e	30.09 j	34.92 b	15.48 c	15.45 h
	600	5.92 b	2.14 a	0.01 k	29.07 l	34.01 c	14.51 e	11.92 e

The values sharing the same letter are not significantly at level of significant 0.;05

Table 5: Correlation coefficient analysis among the traits of canola varieties.

	Plant height	No.of branch	No. of silique	No. of seed/ silique	seed/ 1000 weight	Seed yield	Oil %	Oil yield	Palmitic acid C:16	Stearic acid C:18	Behenic acid C:22	Oleic acid C 18:1	Linoleic acid C18:2	Linolenic acid C 18:3	Erucic acid C 22:1
Plant height	1.000														
No.of branch	0.487 **	1.000													
No. of silique	0.310	0.615 **	1.000												
No. of seed/ silique	- 0.40	- 0.306	- 0.286	1.000											
1000 seed/weight	- 0.164	- 0.414 *	- 0.229	0.916 **	1.000										
Seed yield	0.087	0.962 **	0.740 **	0.625 **	0.639**	1.000									
Oil %	- 0.150	0.384 *	- 0.322	0.655 **	0.629 **	0.164	1.000								
Oil yield	- 0.409	0.715 **	0.483 _**	0.240	0. 318	0.827**	0.494 **	1.000							
Palmitic acid C:16	0. 345 *	0.506 **	0.553**	- 0.262	-0.359	0.141	- 0.071	-0.326	1.000						
Stearic acid C:18	0.361 *	0.565 **	0.447 **	- 0.354 *	- 0.452 **	- 0.187	-0.607 **	-0.758 **	0.363 *	1.000					
Behenic acid C:22	- 0.021	- 0.158	-0.065	0.028	- 0.087	- 0.078	- 0.059	-0.013	-0.406 *	- 0.050	1.000				
Oleic acid C 18:1	0.074	0.035	0.127	0.167	0.312	0.247	0.247	0.022	-0.043	-0.399 *	- 0.049	1.000			
Linoleic acid C18:2	-0.016	- 0.047	- 0.055	- 0.166	- 0.319	- 0.164	-0.077	0.141	0.317	0.200	-0.005	- 0.879 **	1.000		
Linolenic acid C 18:3	-0.181	- 0.250	-0.321	- 0.068	- 0.182	- 0.227	-0.154	0.111	-0.172	0.220	0.281	-0.929 **	0.783 **	1.000	
Erucic acid C 22:1	- 0.099	0.006	- 0.109	- 0.131	- 0.180	- 0.324	-0.392 *	-0.180	- 0.443 **	0.457 **	0.129	- 0.719 **	0.348 *	0.662 **	1.000

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