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VARIETAL DIFFERENCES IN CANOLA (*BRASSICA NAPUS* L.) FOR THE GROWTH , YEILD AND YEILD COMPONENTS EXPOSED TO CADMIUM STRESS

A. Ghani

Department of Biological Sciences University of Sargodha
Corresponding Author's email:Ghaniuaf@yahoomail.com

ABSTRACT

Cadmium is highly toxic metallic pollutant which adversely affects the plant growth. A green house experiment was conducted to study the variation in growth, yield and yield component of canola *(Brassica napus L.)* varieties namely Waster, Abasin-95, Rainbow and Shiralee at the three plant growth stages, treated with 0, 6, 9 and 12 mg Cd kg^{-1} soil. Maximum significant decrease in the growth parameters was observed with 12 mg Cd kg^{-1} soil in all the varieties at all the sampling times. Among varieties Rainbow proved tolerant and showed minimum reduction in the attributes, whereas Shiralee emerged as sensitive and suffered maximum reduction.

Key words: Cadmium toxicity, varietal, growth, yield, components, stress.

INTRODUCTION

Cadmium is one of the most toxic, non essential mobile metallic elements found on the soil which affects plants adversely and is potential contaminant of the environment. It is recognized as potential pollutant due to high toxicity and greater solubility in water. (Pinto *et el*., 2004). It is released into the environment by various industries like power station, heating system, metal working industries or urban traffic (Sanita di Toppi, 1999).

It is widely used in the electro plating, pigment plastic stabilizer and nickel-cadmium batteries. Important sources of cadmium include metal industry, combustion of fossil fuels, waste incineration, production and use of phosphorus fertilizer, metal gas exhaust energy and industries discharges. The toxic effect of cadmium on the plants has been extensively studied (Zhang et al., 2006). High cadmium contents in the soil lead to reduction in plant growth and dry matter yield. (Schutzenduble, 2001, Sharma et al., 2004 and Wu et al., 2006). The ability of plant genotypes to detoxify Cd can differ between and within the plant species (Yang et al.,1996., Metwaly et al., 2005). Therefore the selection of plant varieties with high ability to tolerate Cd toxicity is reasonable approach to counteract the adverse effects of Cd in the crop plants. In the present study four varieties of canola *(Brassica napus* L.) were treated with different Cd concentrations to determine their relative tolerance response to Cd toxicity on the basis of growth, yield and yield components.

MATERIALS AND METHODS

Seeds of four canola (*Brassica napus* L.) varieties namely Waster, Abasin-95, Rainbow and shiralee were sown in 23 cm diameter clay pots filled with a mixture of soil and compost (3:1) with neutral in reaction. Soil was mixed with the appropriate amount of Cd Cl_2 for 0, 6, 9 and 12 mg $Cdkg^{-1}$ soil. The treatments were arranged in randomized block design (RCBD), and each treatment was replicated three times. After germination, five plants per pot were maintained and watered with tap water as and when required. The pots were kept in naturally illuminated green house of the department of Biological Sciences, University of Sargodha, Sargodha Pakistan.

Growth in terms of shoot length, shoot dry weight, leaf area and number of leaves were determined at 20, 50 and 80 days after sowing corresponding to tillering, pod forming and mature seed stages respectively. Among yield characteristics, number of pods per plant, number of seeds per plant, 100 seed yields were recorded at harvest. Shoot length was measured on meter scale. Leaf area \was measured by a leaf area (LA-211, Sylromes, India). Dry weight was recorded by drying the plants in an oven at 80º C till constant weight. Data were analyzed statistically using analysis of variance (SPSS ver. 10 Inc). F-value was calculated at $p<0.05$. The significant data were identified by calculating least significant difference (Steel and Torrie 1996).

RESULTS AND DISCUSSION

Higher concentration of Cd significantly reduced growth, yield, shoot length, shoot dry weight, leaf area and number of leaves of 4 varieties at 20, 50, and 80 days after sowing were maximally and significantly reduced with 12 mg Cd kg^{-1} soil (table 1-2) Cd at a concentration of 6 mg Cd kg^{-1} soil expressed no change on the observed parameters in all the varieties.

The order of performance of varieties in terms of percent reduction was Waster > Abasin-95 > Shiarlee > Rainbow.

Table1: Shoot length (cm plant $^{-1}$) and shoot dry weight (mg plant^{-1}) of four canola varieties exposed to different Cd concentrations at 20, 50 and 80 days after sowing (DAS)

		Cd Treatment (mg Cd kg^{-1} soil)							
		Shoot length (cm plant^{-1})				**Shoot dry weight (mg plant^{-1})**			
DAS	Varieties	0	6	9	12	0	6	9	12
20	Waster	6.5^{a}	4.5^{a}	3.4^{a*}	2.1^{a*}	99^{a}	102.5^{a}	85^{a*}	78^{a*}
	Abasin-95	4.7^{a}	3.9^{a}	2.29^{a}	1.78^{a}	93^{ab}	96^{ab}	73^{ab*}	65^{ab*}
	Rainbow	3.95^{ab}	2.45^{ab}	2.00^{a}	1.49^{b*}	83^{b}	86^{b}	65^{b*}	54^{b*}
	Shiralee	2.33^{bc}	2.11^{bc}	1.93^{b*}	1.50^{c*}	49^{c}	54^{c}	36^{c*}	24^{c*}
	Mean	4.37	3.24	2.40	1.71	81	85	65	50
50	Waster	13.5^{a}	8.5^{a}	6.3^{a*}	4.1^{a*}	275^{a}	283^{a}	232^{a*}	219^{a*}
	Abasin-95	10.3^{a}	7.9^{a}	5.4^{ab*}	3.3^{ab*}	271^{a}	274^{a}	218^{a*}	206^{a*}
	Rainbow	8.9^{a}	6.5^{a}	5.2^{b*}	$2.7b*^{a}$	226^{b}	231^{b}	162^{b*}	143^{b*}
	Shiralee	7.8^{b}	6.2^{b}	4.9^{c*}	2.4^{c*}	145^{c}	147^{c}	93^{c*}	76^{c*}
	Mean	10.12	7.27	5.45	3.1	229	140	176.25	161
80	Waster	31.1^{a}	26.3^{a}	19.2^{a*}	12.3^{a}	687^{a}	692^{a}	557^{a}	532^{a}
	Abasin-95	30.8^{ab}	22.1^{b}	17.3^{b*}	9.4^{b*}	665^{ab}	673^{ab}	492^{a*}	453^{b*}
	Rainbow	25.4^{b}	19.6^{b}	15.7^{c*}	8.2^{c*}	594^{b}	599^{b}	398^{b*}	342^{c*}
	Shiralee	21.2^{c}	17.9^{c}	13.7^{d*}	6.9^{d*}	304^{c}	308^{a}	163^{c*}	130^{c*}
	Mean	27.12	21.47	16.47	36.8	562.5	568	402.5	339.25

Different letters within the column at each sampling time indicate significant differences (P<0.05) between varieties in each external Cd level. *indicate significant differences at (P<0.05) between 6,9 and 12 mg cd kg^{-1} soil and control, and refer to each subset of data within each treatment and can be compared only transversely.

Table2: Leaf area and Number of leaves per plant of four canola varieties exposed to different Cd concentrations at 20, 50 and 80 days after sowing.

		Cd Treatment (mg Cd kg^{-1} soil)							
		Leaf area (cm $^{-2}$)				**Number of leaves**			
DAS	Varieties	0	6	9	12	0	6	9	12
20	Waster	28.5^{a}	31.3^{a}	24.9^{a*}	20.5^{a*}	7^{a}	5^{a*}	3^{a*}	2^{a*}
	Abasin-95	26.2^{a}	24.9^{a}	21.6^{a*}	17.3^{a*}	6^{ab}	4^{a*}	2^{ab*}	2^{ab*}
	Rainbow	23.4^{b}	23.9^{b}	17.5^{b*}	14.9^{c*}	6^{ab}	5^{ab*}	4^{bc*}	1^{c*}
	Shiralee	21.3^{c}	21.8^{c}	14.6^{c*}	8.8^{c*}	5^{bc}	3^{bc*}	2^{cd*}	1^{c*}
	Mean	24.85	25.47	19.65	15.37	6	4.25	2.75	1.5
50	Waster	68.7^{a}	70.1^{a}	52.3^{a*}	45.5^{a*}	9^{a}	7^{a*}	4^{a*}	3^{a*}
	Abasin-95	57.5^{b}	59^{b}	401^{b*}	32.3^{b*}	8^{ab}	6^{ab*}	5^{b*}	3^{a*}
	Rainbow	52.3^{c}	53^{c}	33.30^{c*}	25.4^{c*}	8^{b}	6^{c*}	4^{b*}	2^{c*}
	Shiralee	44.3^{d}	45.1^{d}	26.5^{d*}	17.3^{d*}	7^{c}	5^{c*}	4^{c*}	2^{c*}
	Mean	55.7	56.8	38.05	30.12	8	6	4.25	2.05
80	Waster	42.4^{a}	42.9^{a}	33.7^{a*}	28.9^{a*}	13^{a}	12^{*}	13^{a*}	7^{a*}
	Abasin-95	40.6^{ab}	42.1^{b}	27.4^{ab*}	22.7^{b*}	11^{ab}	11^{ab*}	9^{b*}	5^{b*}
	Rainbow	35.7^{b}	36.7^{b}	25.2^{bc*}	19.4^{b*}	9^{b}	8^{b*}	8^{b*}	3^{b*}
	Shiralee	26.7^{c}	28.1^{c}	16.3^{cd*}	13.2^{c*}	6^{c}	5^{c*}	7^{c*}	1^{c*}
	Mean	36.35	27.95	25.65	21.05	9.75	9	9.25	4

Different letters within the column at each sampling time indicate significant differences (P<0.05) between varieties in each external Cd level, *indicate significant differences at (P<0.05) between 6,9 and 12 mg cd kg^{-1} soil and control, and refer to each subset of data within each treatment and can be compared only transversely

Growth reduction of Cd-treated canola plants have been described (Ouzounido et al 1997 , Wu and Zhang, 2002) due to higher accumulation of Cd and reduction in the availability of other nutrients resulting in disturbed metabolism, the reduction in shoots dry weight by Cd toxicity in the canola varieties could be the direct consequence of the inhibition of photosynthesis. The low

Cd concentration (6 mg kg-¹ soil) did not show decrease in the characteristics indicating that low Cd concentration indirectly influences metabolic processes in association with other metals like zinc. This arguments finds support from the result of (Narwal et al 1996), showing slight increase in dry matter yield of corn shoots at low level of Cd in the soil. Similarly, (Gussarssin 1996) also reported an initial increase in the relative growth rate of *Belula peddata* plant to low Cd treatment.

Regarding varieties, Waster showed lesser decease in growth and yield attributes than the other varieties; whereas, Shiralee suffered maximum decrease by the application of 12 mg Cd kg^{-1} soil (table 3). It may be assumed that the variety Waster posses inherent sequestration mechanism to avoid effects of Cd toxicity. Plants species and even genotypes differ greatly in their ability to take up, transport, accumulate sequester Cd within the plant (Ghani and Wahid 2007).

It can be concluded that 12 mg Cd kg-¹ soil exerted significant reduction in the growth and yield of canola varieties. The Variety Waster appeared to be the Cd tolerant with lesser reduction in all attributes while Shiralee emerged as sensitive variety showing maximum reductions.

Table3: Number of pods per plant, number of seeds per plant, 100 seeds weight(g) and seed yield (g per plant) of four canola varieties exposed to different Cd concentrations at 100 days after sowing

		Cd Treatment (mg Cd kg^{-1} soil)							
		Number of pods per plant				**Number of seeds per plant**			
DAS	Varieties	0	6	9	12	0	6	9	12
100	Waster	9^{a}	7^{a}	5^{a*}	3^{a*}	83^{a}	54^{a}	36^{a*}	16^{a*}
	Abasin-95	7^{ab}	5^{ab}	4^{b*}	2^{b*}	75^{b}	47^{ab}	19^{b*}	9^{b*}
	Rainbow	5^{b}	4^{b}	3^{b*}	2^{b*}	43^{bc}	29^{bc}	11^{bc*}	$7b^{c*}$
	Shiralee	4^{c}	2^{c}	2^{c*}	1^{c*}	35^{cd}	26^{cd}	9^{cd*}	4^{cd*}
	Mean	6.25	4.5	3.5	2.25	59	39	18.75	9
		100 seeds weight (g)				**Seeds yield**			
DAS	Verieties	0	6	9	12	0	6	9	12
100	Waster	4.15^{a}	3.12^{a*}	2.51^{a*}	1.34^{a*}	3.98^{a}	3.18^{a}	1.39^{a*}	0.95^{a*}
	Abasin-95	3.68^{a}	2.39^{a}	1.03^{b*}	0.005^{b*}	3.15^{ab*}	2.67^{ab}	1.52^{ab*}	1.09^{ab*}
	Rainbow	3.45^{b}	1.79^{b}	0.99^{c*}	0.003^{b*}	2.67^{b}	2.15^{b}	1.41^{b*}	1.03^{b*}
	Shiralee	2.49^{c}	1.11^{c}	0.84^{d*}	0.00^{c*}	1.79^{c}	1.27^{c*}	1.01^{c}	0.00^{c*}
	Mean	3.44	2.10	1.34	0.33	2.89	2.31	1.33	0.76

Different letters within the column at each sampling time indicate significant differences ($P<0.05$) between varieties in each external Cd level

*indicate significant differences at ($P<0.05$) between 6,9 and 12 mg cd kg^{-1} soil and control, and refer to each subset of data within each treatment and can be compared only transversely.

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