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Impact of salinity on the growth and productivity of selected mustard (*Brasicca juncea* L.) varieties

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SUMMARY

Four mustard cultivars (cvs) NDR 8501, Rohini, Vardan, Varuna were grown as pot culture at three increased levels of soil salinity (4, 8, 12 dSm^{-1}). The total chlorophyll content, Relative water content (RWC), Photosynthetic rate (P_n) were investigated along with seed yield. The seed yield was maintained in NDR8501 but declined in Vardan at higher salinity levels. All cvs showed an increased seed yield at 4 dSm^{-1}. The reduction in yield at increased salinity was the result of reduction in RWC and Pn rate rather than chlorophyll content. The theme result revealed that, increase in salinity decreased the seed yield in varieties such as Rohini, Vardan and this was not much pronounced in NDR 8501 and Varuna.

Key words : Mustard, Salinity, Chlorophyll, RWC, Seed yield

Indian mustard [*Brasicca juncea* (L.) Czern and Coss], the second most important edible oil after groundnut, accounts for nearly one-third of the oil produced in India (Damodaran and Hegde, 2005). India is world's fourth largest edible oil economy after the U.S., China and Brazil, and is the second largest importer after China. India stands third in rapeseed and mustard seed production in the world, with 12 per cent of world's total production grown domestically. The rapeseed/mustard seed produced in India is mainly for domestic consumption, and is mostly consumed in the northern, central and eastern parts of the country. Rapeseed and mustard seeds account for 65 per cent of India's total winter or *rabi* oil crop. Rapeseed and mustard oil content varies between 36 and 42 per cent; of this, average oil recovery is approximately 35 per cent (Srinivasan, 2005). Once the oil is extracted, the remaining part of the seed is used to produce rapeseed/mustard meal, an important source of cattle and poultry feed. This represents a significant source of oil meal in the country, supplying on an average of 3 to 3.2 million tonnes of meal annually. India accounts for seven per cent of global oilseed output; seven per cent of global oil meal production; six per cent of global oil meal exports; six per cent of global vegetable oil production; 14 per cent of global vegetable oil imports; and 10 per cent of global edible oils.

In Indian agriculture sector, oilseeds occupy 13 per cent of the country's gross cropped area and account for nearly three per cent of gross national product. They also account for 10 per cent of the value of agricultural output produced. Oilseed is cultivated in about 26 million hectares of land. Groundnut, soybean and rapeseed/mustard are the major oilseeds and contribute approximately 80 per cent of production. Other oilseeds produced include sesame, castor, linseed, safflower, sunflower, soybean and niger, along with coconut oil, palm oil and secondary oil crops such as maize and cotton. Rapeseed/mustard seed cultivation is carried out widely in 13 states of India. However, most production takes place in the states of Rajasthan (45 per cent); Uttar Pradesh (13 per cent); Haryana (15 per cent); and West Bengal (8 per cent). Peak production increased to seven million tonnes in 2005–06, up from six million tonnes in 1995–96 and 6.65 million tonnes in 1996–97. This represents an overall increase in acreage and production of rapeseed/mustard seed since 1984–85, reflecting the preferences farmers have for rapeseed/mustard seed over competing crops.

Rapeseed/mustard plants grow all over the world, but their cultivation is mainly confined to India, China, Canada, Germany, France, Australia and the United States. Rapeseed/mustard oil, used primarily in cooking, is a rich source of monosaturated fatty acids, making it a healthier option than most other cooking oils. Over the years, its health advantages have continued to improve, especially with the recent, limited introduction of the "Canola" strain of the seeds. A study by researchers at the Department of Medicine in Safdarjung Hospital, New Delhi, links the increase in heart diseases and diabetes to increased consumption of refined vegetable oils. While such oils contain the dangerous type-6 polyunsaturated fatty acid (PUFA), rapeseed/mustard seed are low in

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PUFA and high in monosaturated fatty acid. India does not generally export its rapeseed/mustard seed, as most of its crop contains high levels of erucic acid, and hence does not meet international quality standards. The country does, however, export rapeseed/mustard oil meal, with annual exports of approximately 400,000 tonnes. This accounts for about 4.2 per cent of India's total agricultural exports, and is, therefore, an important source of revenue for the country.

MATERIALS AND METHODS

The pot culture experiment was conducted in the net house at department of crop physiology, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during *rabi* season of the year 2005-2006. The initial soil pH and EC is estimated under 1:2.5 ratio dilution. By keeping this (pH=7.23 and EC= 0.62 dSm^{-1}) as reference, soil was added with NaCl: $CaCl_2$ and the calculated amount of salt added are exhibited in Table 1.

Table 1 : The calculated amount of Nacl: $Cacl_2$ for creating different salinity level

Sr. No.	Salinity level (dSm^{-1})	NaCl (mg/kg soil)	$CaCl_2$ (mg/kg soil)
1.	Control	0.0	0.0
2.	4	261.0	551.0
3.	8	570.3	1206.3
4.	12	879.4	1855.5

The experiment was laid out in completely randomized design with four replication. The four mustard cultivars NDR 8501, Rohini, Vardan and Varuna were used as test crop. The varieties were grown on different levels of salinity created (4, 8, 12 dSm^{-1}) artificially along with the control. The chlorophyll content was estimated by the method provided by Arnon (1947) at 30 days after sowing (Vegetative period). Relative water content (RWC) of the leaves was measured by the method of Barrs and Weatherley (1962) at 30 days after sowing. The photosynthetic rate (P_n) was recorded by using portable infrared gas analyzer (IRGA) on fully expanded leaves at 30 days after sowing. The data were subjected to statistical scrutiny as per the methods suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The data pertaining to Table 2 reveals that the increase in salinity increases the total chlorophyll content (Fig.1). The fully expanded leaves of mustard showed variation among the genotypes at different levels of salinity. The increase in chlorophyll was higher in NDR 8501 followed by Varuna. In cv. ROHINI the increase in

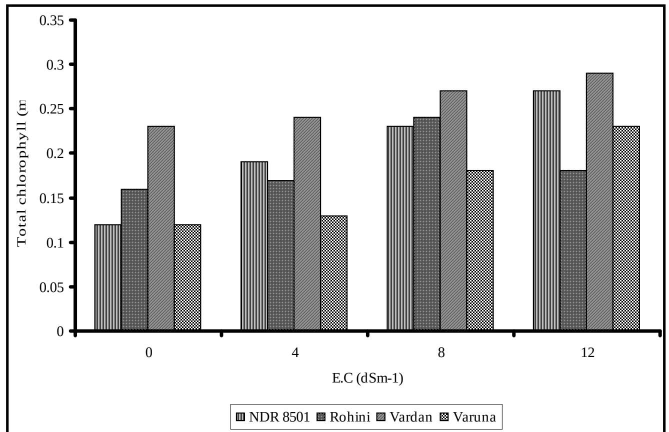

Fig. 1 : The effect of different levels of salinity on total chlorophyll (mg/g) in mustard varieties

chlorophyll content was less (12%) compared to other cultivars. The increase in pigment content was more pronounced in > 4 EC level, the increase in chlorophyll content obviously has to increase the P_n rate. However, Salinity induced pigment reduces the Pn rate. This is due to reduction in RWC (Fig. 2) of the leaves which was the result of osmotic effect of salt stress (levitt, 1980). The cultivars which osmoregulate well under salinity has been considered as a measure of adaptation (Greenway and Mumns, 1980). The reduction in RWC was more on susceptible cultivars such as Rohini and Vardan, 24 per

Table 2 : The effect of different levels of salinity on total chlorophyll (mg/g) and relative water content (%) in mustard varieties

Parameters	Total chlorophyll				Relative water content			
CV / E.C (dSm^{-1})	0	4	8	12	0	4	8	12
NDR 8501	0.12	0.19	0.23	0.27	84.7	85.5	75.5	70.6
Rohini	0.16	0.17	0.24	0.18	83.5	80.9	62.9	55.8
Vardan	0.23	0.24	0.27	0.29	82.9	80.0	60.6	54.1
Varuna	0.12	0.13	0.18	0.23	83.5	86.2	73.8	69.3
C.D. (P= 0.05)	V	T	V*T		V	T	V*T	
	0.02	0.02	N.S		2.3	2.3	4.6	

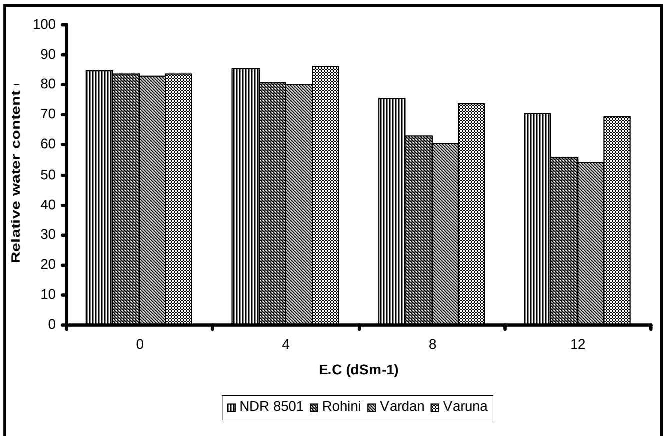

Fig. 2 : The effect of different levels of salinity on relative water content (%) in mustard varieties

positive correlation with yield. However, salinity has negative correlation with RWC which in turn reduced Pn rate and yield. Highest Pn rate and high yield (5.5 g/ plant) was noticed at higher level of salinity (12Ec) in variety NDR 8501. This was at par with the result obtained by Shakhov (1956). The comparative study of salinity induced changes in total chlorophyll, RWC, Pn rate and yield response of mustard varieties reveals that increase in salinity decrease the RWC which leads to reduction in Pn rate and seed yield. Among the cultivars tested cultivar. NDR8501 was found to be salt resistant. Where as cultivars, Rohini, Vardan and Varuna were susceptible to salt stress.

Table 3 : The effect of different levels of salinity on photosynthetic rate (µ mole CO_2 $m^{-2}S^{-1}$) and seed yield (g/plant) in mustard varieties

Parameter	Photosynthetic rate				Seed yield			
CV/ EC (dSm^{-1})	0	4	8	12	0	4	8	12
NDR 8501	31.5	34.3	27.3	22.5	5.5	7.0	6.5	5.5
Rohini	30.7	33.9	23.5	18.8	6.0	7.5	6.5	4.0
Vardan	30.9	32.2	22.8	19.2	9.0	9.5	6.5	5.0
Varuna	30.2	29.7	26.8	22.4	5.0	6.5	6.0	4.5
C.D. (P= 0.05)	V	T	V*T		V	T	V*T	
	1.25	1.25	2.5		0.68	0.68	1.37	

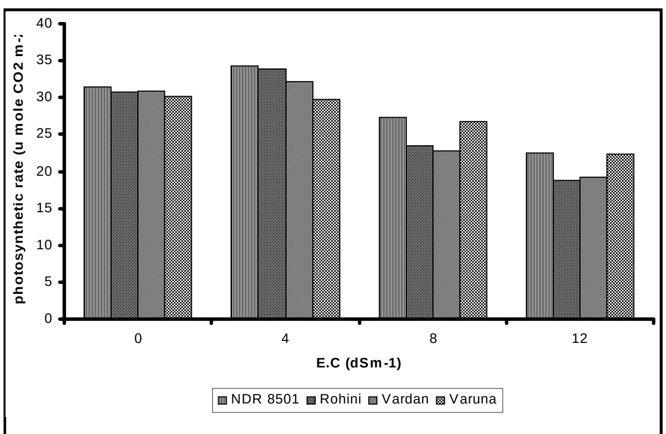

Fig. 3a : The effect of different levels of salinity on photosynthetic rate (µ mole CO_2 $m^{-2}S^{-1}$) in mustard varieties

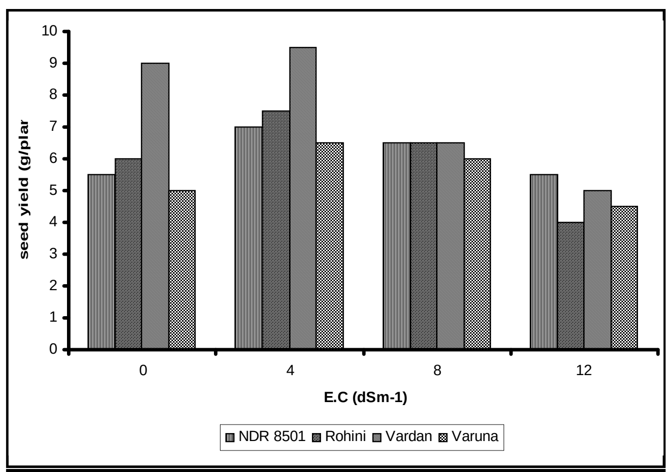

Fig. 3b : The effect of different levels of salinity on seed yield (g/plant) in mustard varieties

cent and 26 per cent, respectively. Where as the cultivars like NDR 8501 and Varuna showed very less reduction in RWC (10-11%). The slight increase in RWC was observed in NDR8501 and Varuna at 4EC level. The photosynthetic rate of mustard showed variation among the cultivars at different levels of salinity (Table 3) along with yield. The total chlorophyll and Pn rate (Fig. 3a and 3b) showed

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