J. Bangladesh Agril. Univ. 3(2): 203–208, 2005 ISSN 1810-3030

Salinity tolerance of three mustard/rapeseed cultivars

M.N. Uddin[1], M. Tariqul Islam[2] and M.A. Karim[1]
[1]Department of Crop Botany, Bangladesh Agricultural University, Mymensingh
[2]Senior Scientific Officer, Crop Physiology Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh

Abstract

A pot experiment was carried out at the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, to evaluate salinity tolerance of mustard/rapeseed cultivars viz., BINAsarisha-5, BINAsarisha-6 and Safal during October 2003 to January 2004. Salinity levels were 4, 6, 8 and 10 dSm^{-1} with a control (0.43 dSm^{-1}). Plant height, leaf area, total dry matter, number of siliqua per plant, number of seeds per siliqua, 1000-seed weight and harvest index were decreased with the increase of salinity compared to control. Na^+ content in leaves increased but K^+ content decreased with the increase of salinity. BINAsarisha-6 showed the highest number of siliqua, seed yield per plant, harvest index, higher Na^+ and medium K^+ content in leaves and BINAsarisha-5 showed the highest number of seeds per siliqua, 1000-seed weight, lower Na^+ and higher K^+ content in leaves under the salinity levels. On the other hand, Safal showed the lowest number of seeds per siliqua, seed yield, higher Na^+ and the lowest K^+ content in leaves. BINAsarisha-6 and BINAsarisha-5 were found to be tolerant and Safal was less tolerant to imposed salinity.

Keywords: Salinity, Mustard, Yield, Tolerance

Introduction

Salinity is one of the major environmental stresses affecting plant growth and development and results in severe agricultural losses. It affects nutrient uptake (Varshney *et al.* 1998) and metabolic activities in plants (Singh *et al.*, 2001). Active osmotic adjustment causes positive effect on growth processes (Turner, 1981). Osmotic adjustment helps in two ways under saline condition; i) to make plants capable to uptake water under saline condition and ii) to keep stomata open by maintaining turgor of the plant cell. The magnitude of the effect of salinity varied with the plant species, type and level of salinity (Bishnoi *et al.*, 1987). So, plant species/varieties tolerant to high level of salt are essential for the utilization of the highly salt affected soils.

Oilseed crops play an important role in the economy of Bangladesh. Mustard is the top ranking oilseed crop. It covers about 78% of the total oilseeds acreage and 62% of the total production (BBS, 2004). Optimum dietary allowance (ODA) is estimated to be 35g oils and fats/head/day. The oilseed crop occupied 5% of the total cropped area. Among these areas 73% is covered by rapeseed and mustard, 18% by sesame and 9% by groundnut (BBS, 2004). Total production of rapeseed and mustard was 21,8,000 M tons from 735,000 acres and yield was 0.31 M tons per unit acres. This production covers only 40% of the domestic need. Rapeseed and mustard production should be increased to fulfill the consumption need and at the same time to save our foreign currency.

In Bangladesh, over 30% of cultivated areas are in the coastal belt. Out of 2.85 million hectares of land only 0.88 million hectares are arable lands, which constitute about 52.8% of the cultivable areas. This area is affected by varying degree of soil salinity (Karim *et al.*, 1990). Moreover, the salt affected area is increasing day by day. But salinity affects growth and yield attributes of *Brassica* species (Javaid *et al.*, 2002). After harvesting aman rice, a vast area of land remains either unused or covered by some minor crops. In most of the areas, farmers do not have any suitable crop to bring this land under cultivation in several months (middle of November to June). There is a possibility of bringing this vast fallow saline land under cultivation with salt tolerant mustard/rapeseed varieties in rabi season (November to February). So, the experiment was undertaken to assess the salinity tolerance of three mustard/rapeseed cultivars under different salinity levels.

Materials and Methods

An experiment was conducted under varying levels of imposed soil salinity on three mustard/rapeseed cultivars at the potyard of the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, during 24 October 2003 to 29 January 2004. The experiment was laid out in plastic pots and the soil was collected up to 0-15 cm depth from the BINA Farm. The soil was sandy loam in texture and it belongs to the Agro-ecological zone of old Brahmaputra Flood Plain. The collected soil was dried in the sun and then each of the pots was filled with 7 kg soils. A total of 90 pots [3 (cultivars) x 5 (salinity levels) x 3 (replications) x 2 (harvests)] were placed at the potyard of BINA. Urea, TSP, MP, Gypsum, Borax and well rotten cowdung were applied at the rate of 1.57 g, 0.5 g, 0.21 g, 1.05 g, 0.08 g and 8.4 g in each pot to maintain the dose of 225 Kg/ha, 75 Kg/ha, 30 Kg/ha, 150 Kg/ha, 12 Kg/ha and 1200 Kg/ha of urea, TSP, MP, Gypsum, Borax, and cowdung, respectively. All manures and fertilizers were added at the time of final pot preparation except urea. Half of urea was applied at the time of final land preparation and another half at 32 days after sowing (DAS).

Three mustard cultivars namely BINAsarisha-5 (*Brassica napus*), BINAsarisha-6 and Safal (*Brassica campestris*) were used in this study. Seeds of the cultivars were sown in pots on 24 October 2003. Required amount of seeds was sown in each pot but only three plants were kept in each pot and extra plants were uprooted when the plants were established. Nearly 50% field capacity was maintained to ensure proper germination of the seeds and then moisture level was maintained at 80% FC. The salinity of the pot soils was measured through Salinity Bridge and expressed as Electrical Conductivity (EC). The following salinity treatments were applied at 35 days after sowing (DAS).

T_0 = Where no salt solution was added, Average EC of the initial soil was found to be 0.43 dSm^{-1}.
T_1 = Where 4.16 g NaCl was added to the pot soils. The average EC of the soil was found to be 4 dSm^{-1}.
T_2 = Where 6.24 g NaCl was added to the pot soils. The average EC of the soil was found to be 6 dSm^{-1}.
T_3 = Where 8.32 g NaCl was added to the pot soils. The average EC of the soil was found to be 8 dSm^{-1}.
T_4 = Where 10.4 g NaCl was added to the pot soils. The average EC of the soil was found to be 10 dSm^{-1}.

The design of the experiment was RCBD with three replications. Leaf area per plant, Na^+ and K^+ contents in leaves (2nd leaf) were measured at 50 DAS. At maturity, data on yield and yield components were also recorded. The collected data were analyzed using statistical program MSTAT-C of Russell (1986). The mean differences were compared with Duncan's Multiple Range Test (DMRT) at 5% level of significance.

Results and Discussion

The effect of salinity on plant height, leaf area, total dry matter (TDM) per plant, Na^+ and K^+ contents in leaves is presented in Table 1. Plant height did not vary at control and 4 dSm^{-1} and it was thereafter decreased with the increase of salinity levels. The highest plant height was found in Safal followed by BINAsarisha-6 and the lowest plant height was found in BINAsarisha-5. Safal showed the highest plant height at control while the lowest plant height was found in BINAsarisha-5 at 10 dSm^{-1}. Reduced plant height under salinity might be due to inhibited cell division and cell enlargement. Javaid *et al.* (2002) reported that plant height of mustard genotypes was decreased by higher level of salinity.

Table 1. Effect of salinity on plant height, leaf area, total dry matter per plant, Na^+ and K^+ contents in leaves of three mustard/rapeseed cultivars

Salinity level (dS/m)	Plant height (cm)	Leaf area/ plant cm^2)	Total dry matter/ plant (g)	Na^+ % in leaves	K^+ % leaves
Control (T_0: 0.43 dS/m)	130 a	481 a	20.07 a	0.69 e	2.43 a
4 (T_1)	126 a	475 a	19.43 a	0.95 d	1.91 b
6 (T_2)	115 b	331 b	15 .30b	1.23 c	1.73 c
8 (T_3	95 c	291 c	12. 77c	1.62 b	1.59 d
10 (T_4)	87 d	270 c	10.06 d	1.80 a	1.12 e
LSD $_{0.05}$	3.99	33.81	1.92	0.08	0.20
Cultivars					
Binasarisha-5 (V_1)	78 c	350 b	16.40 b	1.18 b	2.45 a
Binasarisha-6 (V_2)	121 b	401 a	17 .75a	1.31 a	1.21 b
Safal (V_3)	133 a	357 b	12.58 c	1.28 a	1.30 b
LSD $_{0.05}$	3.09	26.19	0.92	0.06	0.16
Salinity x Cultivar					
V_1T_0	88 fg	497 a	19.09 ab	0.55 h	2.91 a
V_1T_1	89 fg	495 a	18.90 ab	0.69 h	2.71 a
V_1T_2	80 hi	326 bc	17.71 b	1.08 ef	2.69 a
V_1T_3	72 i	228 de	14.09 cd	1.71 bc	2.20 b
V_1T_4	63 j	207 e	12.07 d	1.89 a	1.78 c
V_2T_0	126 d	499 a	21.18 a	0.85 g	2.26 bcd
V_2T_1	125 d	479 a	19.94 ab	1.06 f	1.26 e
V_2T_2	121 de	357 b	18.56 b	1.39 d	1.18 e
V_2T_3	119 de	350 b	14.88 c	1.56c	0.98 e
V_2T_4	115 e	320 bc	13.61 cd	1.71 bc	0.61 f
V_3T_0	175 a	496 a	19.94 ab	0.10 ef	2.13 bc
V_3T_1	164 b	483 a	19.47 ab	0.69 h	1.71 d
V_3T_2	145 c	312 bc	9.64 e	1.22 e	1.30 e
V_3T_3	96 f	298 bc	9.35 e	1.59 c	1.11 e
V_3T_4	85 gh	200 cd	4.51 f	1.81 ab	0.55 f
LSD $_{0.05}$	0.20	58.56	2.06	1.13	0.36

Values having common letter(s) within a column of specific treatments do not differ significantly at 5% level as per DMRT

The highest leaf area was recorded at control condition and 4 dSm^{-1} and the lowest was found in 10 dSm^{-1} and 8 dSm^{-1} (Table 1). The highest leaf area was found in Safal followed by Binasarisha-6 and the lowest leaf area was obtained from in Binasarisha-5. All the cultivars showed the highest leaf area at control and 4 dSm^{-1} while the lowest leaf area was found in Binasarisha-5 at 8 dSm^{-1} and 6 dSm^{-1}. Reduced leaf area per plant under salinity might be due to the fact that photosynthesis and cell division of plate meristem was inhibited under salinity stress.

Total dry matter (TDM) per plant did not vary at control and 4 dSm^{-1} and it was, thereafter, decreased with the increase of salinity levels (Table 1). The highest TDM was found in BINAsarisha-6 followed by BINAsarisha-5 and the lowest in Safal. All the cultivars showed the highest TDM at control and 4 dSm^{-1} while the lowest TDM per plant was found in Safal at 10 dSm^{-1}. Dry matter production in plants at low water potential induced by salinity stress is expected to decrease because of suppressing the net assimilation rates (Levitt, 1992).

Na^+ content in leaves increased but K^+ content decreased with the increase of salinity (Table 1). BINAsarisha-5 showed lower Na^+ content and higher K^+ content. Binasarisha-5 and Safal showed higher Na^+ content at 10 dSm^{-1}. K^+ content was the highest in Binasarisha-5 up to 6 dSm^{-1} and other two cultivars showed the lowest K^+ content at 10 dSm^{-1}. The results are in agreement with Tanveer *et al.* (2002) who observed increased Na^+ in *B. campestris* and *B. juncea*, whereas increase was non-significant in *B. napus* and *B.carinata* under different salinity levels (3, 4.75, 6 and 9.5 dSm^{-1}). They also found high K^+ in *B. napus* and low in *B. campestris.*

Number of siliqua per plant did not vary at control and 4 dSm^{-1} and it was, thereafter, decreased with the increase of salinity levels. The highest number of siliqua per plant was found in BINAsarisha-6 and the other two cultivars produced statistically similar number of siliqua per plant. BINAsarisha-6 and Safal showed the highest number of siliqua per plant at control and 4 dSm^{-1} while the lowest number of siliqua per plant was found in Safal at 10 dSm^{-1}. The results are in conformity with Ashraf *et al.* (1999) who found reduced yield parameters and yield in twelve cultivars from *Brassica napus*, *B. carinata*, *B. campestris*, *B. juncea* and *Raphanus raphanistrum* with the severity of salinity.

Number of seeds per siliqua did not vary at control and 4 dSm^{-1} and it was, thereafter, decreased with the increase of salinity levels. The highest number of seeds per siliqua was found in BINAsarisha-5 followed by BINAsarisha-6 and the lowest number of seeds per siliqua was in Safal. BINAsarisha-5 showed the highest number of seeds per siliqua at 4 dSm^{-1} while the lowest number of seeds per siliqua was found in Safal at 10 dSm^{-1}.

1000-seed weight represents grain size of a cultivars. Thousand-grain weight did not vary at control and 4 dSm^{-1} and it was, thereafter, decreased with the increase of salinity levels. The highest 1000-grain weight was found in BINAsarisha-5 and the other two cultivars produced statistically similar 1000-grain weight. All the cultivars showed the highest 1000-seed weight at control and 4 dSm^{-1} while the lowest 1000-grain weight was found in Safal at 6 dSm^{-1}, 8 dSm^{-1} and 10 dSm^{-1} and BINAsarisha-6 at 8 dSm^{-1} and 10 dSm^{-1}. The results are in agreement with Boem *et al.* (1994) who observed lower 1000-grain weight in rapeseed cultivar ICLOL 41 under higher salinity (6.8-10 dSm^{-1}).

Seed yield per plant decreased with the increase of salinity levels. The highest seed yield per plant was found in BINAsarisha-6 followed by BINAsarisha-5 and the lowest seed yield was found in Safal. BINAsarisha–6 showed the highest seed yield at control and 4 dSm^{-1} while the lowest in Safal at 10 dSm^{-1}. The results are in conformity with Sharma *et al.* (1997) who observed reduced seed yield of 9.2%, 26.08% and 50.4% in DIRA 337, RYS 80 and Varun genotypes (*Brassica juncea*), respectively, under different varied salinity levels (10 dSm^{-1}, 15 dSm^{-1}).

Harvest index decreased with increasing salinity levels. HI was the highest in BINAsarisha-6 followed by BINAsarisha-5 and the lowest in Safal. Higher HI indicates higher translocation ability to sink organ. BINAsarisha-5 and BINAsarisha-6 showed higher HI at control and BINAsarisha-5 and Safal showed the lowest HI at 10 dSm^{-1}.

The above results showed that increasing salinity levels decreased yield and yield attributes of the mustard/rapeseed cultivars. BINAsarisha-6 and BINAsarisha-5 were found tolerant to salinity up to 10 dSm^{-1} and Safal showed less tolerant to salinity.

Table 2. Effect of salinity on yield and yield components of three mustard/rapeseed cultivars

Salinity level (dS/m)	Siliqua /plant (no.)	Seeds /siliqua (no.)	1000-seed weight (g)	Seed yield/ plant (g)	Harvest index
Control (T_0: 0.43 dS/m)	132 a	19.95 a	3.82 a	7.48 a	38.61 a
4 (T_1)	132 a	19.00 a	3.68 a	7.07 b	36.36 b
6 (T_2)	95 b	16.22 b	3.26 b	5.20 c	33.46 c
8 (T_3	67 c	14.59 c	3.12 bc	4.20 d	31.37 c
10 (T_4)	46 d	10.55 d	2.93 d	2.81 e	27.46 d
LSD $_{0.05}$	6.87	0.80	0.46	0.57	1.40
Cultivars					
Binasarisha-5 (V_1)	82 b	17.96 a	3.55 a	5.56 b	33.20 b
Binasarisha-6 (V_2)	120 a	16.25 b	3.33 b	6.67 a	37.00 a
Safal (V_3)	82 b	14.57 c	3.20 b	4.04 c	30.76 c
LSD $_{0.05}$	5.32	0.62	0.26	0.44	1.08
Salinity x Cultivar					
V_1T_0	113 c	20.66 b	3.98 a	7.69 bc	40.28 a
V_1T_1	116 c	21.96 a	3.85 ab	6.88 cd	36.40 b
V_1T_2	92 d	17.96 cd	3.44 cde	5.69 e	32.12 c
V_1T_3	51 fg	15.77 e	3.35 d	4.55 fg	32.29 c
V_1T_4	41 g	12.67 g	3.13 e	3.01 h	24.93 e
V_2T_0	148 a	19.16 bc	3.78 abc	8.85 a	40.57 a
V_2T_1	147 a	17.68 d	3.59 bcd	8.02 ab	40.22 a
V_2T_2	131 b	16.53 de	3.31 cde	6.89 cd	36.94 b
V_2T_3	98 d	15.85 e	3.03 ef	5.35 ef	35.95 b
V_2T_4	77 e	12.03 g	2.08 ef	4.25 g	31.30 c
V_3T_0	137 ab	20.03 b	3.72 abc	6.98 cd	35.00 b
V_3T_1	136 ab	19.56 b	3.60 abcd	9.32 de	32.46 c
V_3T_2	62 f	14.18 f	3.03 ef	3.02 h	31.32 c
V_3T_3	52 fg	12.15 g	2.99 ef	2.70 h	28.87 d
V_3T_4	21 h	6.96 h	2.69 f	1.18 i	26.16 e
LSD $_{0.05}$	11.91	1.39	0.67	0.98	2.42

Values having common letter(s) within a column of specific treatments do not differ significantly at 5% level as per DMRT

References

Ashraf, M.Y., Wahed, R.A., Bahtti, A.S., Baig, A., Aslam, Z., Hamdy, A., Leith, H., Todorovic, M. and Moshenko, M. 1999. Salt tolerance potential in different *Brassica* species: growth studies. *Proc. Progress Biometrol.*, 14.: 119-125.

BBS. 2004. *Monthly Statistical Bulletin, June 2004.* Bangladesh Bureau of Statistics. Planning Division. Ministry of Planning. Government of the People's Republic of Bangladesh. p. 57.

Bishnoi, N. R., Siddiqui, S. and Kumar, S. 1987. Effect of salinity, salinization and desalinization on the various aspects of dry matter production at vegetative stage in pea and gram. *Front Bot.*, 1: 1-11.

Boem, F. H. G., Scheiner, J. D. and Lavado, R. S. 1994. Some effects of soil salinity on growth, development and yield of rapeseed (*Brassica napus* L.). *J. Agron.*, 172 (3): 182-187.

Javaid, A., Tanveer, U. H., Muhammad, S. and Khalid, M. 2002. Effects of salinity on yield, growth and oil contents of four Brassica species. *Pakistan J. Agric. Sci.*, 39 (2): 76-79.

Karim, Z., Hussain, S. G. and Ahmed, M. 1990. Salinity problems and crop intensification in the coastal region of Bangladesh. Bangladesh Agricultural Research Council (BARC), *Publication No. 33.* p. 1, BARC, Farmgate, Dhaka.

Levitt, Y. 1992. *Responses of plants to environmental stresses.* Vol. 11. Aca. Press, New York, p. 491-505.

Russell, D. F. 1986. *MSTAT-C.* Crop and Soil Science Department, Michigan University, USA.

Sharma, S. K. and Manchanda, H. R. 1997. Relative performance of yellow Sarson (*B. napa var. glauca*) and toria (*B. napa var. napus*) grown at different salinity levels with different chloride and sulphate rations. Indian J. Agric. Sci., 67 (1): 1-5.

Singh, R. A., Roy, N. K. and Hoque, M. S. 2001. Changes in growth and metabolic activity in seedlings of lentil (*Lens culinaris* Medic) genotypes during salt stress. *Indian J. Plant Physiol.* 6: 406-410.

Tanveer, U. H., Akhtar, J., Anwar, U. H. M. and Mumtaz, H. 2002. Effect of soil salinity on the concentration of Na^+, K^+ and Cl^- in the leaf saf of the four *Brassica* species. *Int. J. Agric. Biol.*, 4 (3): 385-388.

Tumer, N. C. 1981. Techniques and experimental approaches for the measurement of plant water status. *Plant and Soil*, 58: 359-361.

Varshney, K. A., Sanwal, N. and Agarwal, N. 1998. Salinity induced changes in ion uptake and chemical composition in chickpea (*Cicer arietinum* L.). *Indian J. Plant Physiol.*, 3: 140-142.