GROWTH AND YIELD OF DIFFERENT BRASSICA GENOTYPES UNDER SALINE SODIC CONDITIONS

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ABSTRACT:- A field study was conducted at farmer's salt-affected field (ECe=12.3 dS m^{-1}; pH=9.7; SAR=46.2) in Hafizabad to test growth and yield response of six Brassica cultivars (BARD-I, Dunkled, Rainbow, BRS-II, Sultan Raya and cv. 95102-5) under saline sodic conditions. Data on growth and yield parameters were collected randomly (average of five plants per replication) at the time of crop maturity. Ionic concentration in plant tissues and oil content in seeds were also determined. Comparatively more number of branches and pods per plant were produced by cultivar Dunkled closely followed by BARD-I while maximum seed yield (241.7 and 235.1 kg ha^{-1}) was obtained from Dunkled and Sultan Raya, respectively which was statistically at par. However, BRS-II and Rainbow showed significantly more percent oil contents in their seeds but genotype Dunkled showed minimum Na+ and K+ concentration in their tissues.

Key Words: Brassica; Genotypes; Saline; Growth; Crop Yield; Yield Components; Pakistan.

INTRODUCTION

Brassica oilseed species now hold the third position among oilseed crops and are an important source of vegetable oil. The most common Brassica oilseed crops grown for commercial purposes are rape seeds (*Brassica campestris* L. and *Brassica napus* L.) and mustards (*Brassica juncea* L. Czern. and Coss. and *Brassica carinata* A.Br.). It is being grown on 305,000 ha and its total oil seed production is 251,000t in Pakistan (GoP, 2005). It contributes to 21% of the total edible oil consumption in the country. For import of edible oil in Pakistan, Rs.10 billion has been spent during the last few years and this amount increased to Rs. 42 billion to date, with 9% annual growth in the consumption of edible oil (GoP, 2005). With increasing consumption of edible oil, there is a need to increase oilseed production in the country because economy of Pakistan is largely depending upon agriculture. Most of the Brassica species have been categorized as moderately salt tolerant, with the amphidiploids being the relatively more salt tolerant in comparison with the diploids. Due to higher salt tolerance of the amphiploids, it has been suggested that their salt tolerance has been acquired from the A (*Brassica campestris*) and C (*Brassica oleracea* L.) genomes. However, significant inter and intraspecific variation for salt tolerance exists within Brassicas, which can be exploited through selection and breeding for

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enhancing salt tolerance of the crops (Epstein et al., 1980; Munns, 1993; Sadiq et al., 2002 and Mahmood et al., 2007).

Soil salinity is serious problem in Pakistan as well as many regions of the world and posing major threat to the sustainable production of agriculture sector. It is estimated that 6.62 mha of Pakistan is salt-affected (GoP, 2005). A large area of Pakistan is not suitable for cultivation due to salinity problem which contain generally sodium chloride (NaCl) as dominant salt (Khan, 1987; Maas, 1993), therefore, specific effects of Na on plant can be either direct or indirect. Direct effects are caused by the accumulation of toxic level of sodium and indirect effect of sodium includes both nutritional imbalance (Maas and Grieve, 1987) and impaired soil physical conditions. According to Somers (1982) and Shubert and Lauchli (1986), NaCl is one of the most important salts influencing the distribution of natural plant species in soil. Salinity also affects the plant growth by decreasing water availability to plants and high concentration of ionic toxicity (Munns and Termaat, 1986). Despite salinity, genetic variability for salt tolerance has also been observed within species (Norlyn and Epstein, 1984). It is now evident that some plant species can tolerate high salinity (Schachtman and Munns, 1992; Glenn et al., 1996; Rehman et al., 1998). The salt-affected areas can have a good potential to grow some salt tolerant genotypes of oilseed crops and hence, oilseed production can be increased by exploiting genetic potential of Brassica cultivars. Therefore, the present study was planned to compare different Brassica genotypes for their performance in saline sodic soils.

MATERIALS AND METHOD

An experiment was conducted to test the growth and yield response of six Brassica cultivars during 2006-2007 at farmer's salt-affected field in Shorimaneka, district Hafizabad having ECe=12.3 dS m^{-1}, pH=9.7 and SAR=46.2. Physicochemical analysis of the soil was done from a composite soil sample collected before crop sowing (Table 1). Seeds of six Brassica cultivars (BARD-I, Dunkled, Rainbow, BRS-II, Sultan Raya and cv. 95102-5) were collected from Oilseed Program, National Agricultural Research Centre, Islamabad, Pakistan. Experiment was laid out in randomized complete block design (RCBD) with three replications. A basal dose of NPK @ 80, 100 and 50 kg ha^{-1} as urea, SSP and SOP were applied at the time of seed bed preparation. After germination, thinning was done

Table 1. Physicochemical analysis of the soils and soil texture at experimental site

Parameters	Value
pH	9.70
ECe (dS m^{-1})	12.30
SAR	46.20
$CaCO_3$ (%)	7.91
Organic matter (%)	0.07
N (%)	0.02
P (mg kg^{-1})	4.12
K (mg kg^{-1})	24.40
Sand (%)	31.70
Silt (%)	28.20
Clay (%)	40.10
Textural Class	Sandy clay loam

to ensure proper plant population and the crop was allowed to stand till maturity. Three irrigations were applied with canal water throughout the growth season. Data on growth and yield parameters i.e., plant density, plant height, number of branches per plant, number of pods per plant, pod length, number of seeds per pod and seed yield was collected randomly (average of five plants) at the time of crop maturity. Samples for chemical analysis were collected at the time of harvest and oven dried at 60°C to constant weight. Dried samples were ground to pass through 40 mesh sieve using Wiley Mills and were digested in a di-acid mixture (2 perchloric + 1 nitric acid) to estimate Na^+, K^+, Ca^{2+} and Mg^{2+} concentrations in the plant tissues by Atomic Absorption Spectroscopy. Crude oil percentage in seeds was determined by Soxhlet apparatus (AOAC, 1990). The results were analyzed statistically using MSTAT-C package on computer and treatment means were compared using Duncan's Multiple Range (DMR) test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Growth and Yield

Actually, the experiment was conducted at three locations in Hafizabad district. At Locations-II and III, the germination of all Brassica genotypes was negligible and very poor growth which did not produce reasonable results due to high salinity/sodicity (ECe=16.1 dS m^{-1}; pH = 9.2; SAR = 54.8) and (Ece = 14.6 dS m^{-1}; pH = 9.6; SAR = 74.8) respectively. Location-I has comparatively lower salinity/sodicity (Ece = 12.3 dS m^{-1}; pH = 9.7; SAR = 46.2) than other two sites. Therefore, at this location better results were obtained which means that beyond this salinity/sodicity limit, Brassica crop is unable to grow under such lands.

The data obtained from Location-I (Table 2) showed that cultivars Dunkled and BARD-I produced maximum plants population, number of branches $plant^{-1}$, number of pods $plant^{-1}$ and seed yield. Although the plant height and number of seeds pod^{-1} were statistically non-signi-

Table 2. Growth and yield of different Brassica cultivars in saline sodic soil at Shorimaneka district Hafizabad (average of three repeats)

Variety	No. of plants (m^{-1})	Plant height (cm)	No. of branches ($plant^{-1}$)	No. of pods ($plant^{-1}$)	Pod length (cm)	No. of seeds (pod^{-1})	Seed yield (kg ha^{-1})
Sultan Raya	194.3 b	139.0^{NS}	4.3 d	133.0 cd	4.7^{NS}	10.7^{NS}	235.1 a
BARD-I	155.3 c	145.0	6.0 ab	169.0 b	4.8	11.7	199.7 ab
Dunkled	245.0 a	147.3	7.0 a	190.3 a	4.5	18.7	241.7 a
Rainbow	165.7 c	142.3	4.3 d	123.3 d	4.0	15.3	165.7 b
BRS-II	121.0 d	250.0	5.7 bc	102.3 e	4.6	13.7	157.2 bc
cv. 95102-5	195.0 b	137.3	4.7 cd	140.3 c	5.2	13.3	112.6 c

Means followed by same letter(s) do not differ significantly at $P \leq 0.05$ NS = Non-significant

ficant however a close observation indicated that cultivar Dunkled produced comparatively more seeds pod^{-1} (18.67) followed by Rainbow (15.33). Among all the cultivars, nevertheless, Sultan Raya did not perform well in respect of growth parameters but interestingly it produced statistically the same seed yield (235.1 kg ha^{-1}) as that of Dunkled (241.7 kg ha^{-1}). The poor growth performance of Sultan raya, might be due to its more sensitivity to sodicity (Ece = 12.3 dS m^{-1}; SAR = 46.23). Higher seed yield of this cultivar was presumably due to healthy seeds as compared to rest of the cultivars. Adverse effects of salinity and sodicity on plant growth have been reported by many researchers (Grattan and Grieve, 1992; Aslam et al., 1993; Munns, 1993; Flower and Yeo, 1995; Ashraf et al., 1999; Mahmood and Qureshi, 2000; Akhtar et al., 2002; Flower, 2004).

Ionic Concentration

The data indicated Na^+ and Ca^{2+} in plant tissue and seed of different Brassica cultivars differed significantly while K^+ and Mg^{2+} were statistically non-significant (Tables 3 and 4). Under saline sodic conditions minimum Na^+ was determined from tissues of Sultan raya and cv. 95102-5 while BARD-I maintained maximum concentration in both tissues and seeds closely followed by Dunkled. However, comparatively

Table 3. Ionic concentration and oil content in seeds of different Brassica cultivars in saline sodic soil at Shorimaneka, district Hafizabad (average of three repeats)

(%)

Variety	Na	K	Ca	Mg	Oil content
Sultan Raya	0.077 c	4.44 NS	0.68 ab	3.59 NS	36.28 c
BARD-I	0.157 ab	4.43	0.74 a	3.56	31.35 d
Dunkled	0.153 ab	4.75	0.78 a	3.61	37.63 bc
Rainbow	0.093 bc	4.65	0.62 ab	3.62	40.84 a
BRS-II	0.107 abc	4.63	0.53 b	3.60	41.03 a
cv. 95102-5	0.083 c	4.18	0.53 b	3.56	39.58 ab

Means followed by same letter(s) do not differ significantly at P $\leq$0.05   NS = Non-significant

Table 4. Ionic concentration in plant tissues of different Brassica cultivars in saline sodic soil at Shorimaneka, district Hafizabad (average of three repeats)

(%)

Variety	Na^+	K^+	Ca^{2+}	Mg^{2+}
Sultan Raya	0.73 c	1.80 NS	0.75 ab	0.45 NS
BARD-I	2.37 a	1.25	0.68 b	0.32
Dunkled	1.35 b	2.93	0.88 a	0.45
Rainbow	1.31 b	2.80	0.46 bc	0.38
BRS-II	0.66 c	2.28	0.76 ab	0.33
cv. 95102-5	0.47 c	2.07	0.36 c	0.38

Means followed by same letter(s) do not differ significantly at P $\leq$0.05   NS = Non-significant better performance of Sultan raya in maintaining lower percentage of Na^+ content in plant tissues as well as in seeds might be because of its genetic ability for better salt tolerance and hence produced comparable seed yield (Table 1). These results could be supported by the findings of Sadiq et al. (2002), Ali et al. (2003) and Flower (2004). Mahmood et al. (2007) found that Sultan raya maintained significantly high level of K^+ and less Na^+ in its tissues and showed promising results than rest of the cultivars grown under saline soil (Ece = 13.02 dS m^{-1} and SAR = 12.70).

Oil Content

There were significant differences in oil contents of different *Brassica* cultivars grown under saline sodic soil conditions. Maximum percentage of oil contents (41.03 and 40.84) were determined in the seeds of BRS-II and Rainbow, respectively, closely followed by cv. 95102-5 that was 39.58 % (Table 2). Under saline sodic soil conditions (Ece = 13.02 dS m^{-1} and SAR = 12.70), BARD-I showed comparatively less percentage of oil content in seeds. The reason might be excessive absorption of toxic ions, which may cause metabolic disturbance in processes where low Na^+ and high K^+ are required for optimum functioning. Furthermore, nutritional imbalance as a result of depressed uptake, shoot transport, chlorophyll breakdown and impaired internal distribution of mineral ions presumably have caused less percentage of oil content in its seeds. Similar interpretations have also been documented by Munns (1993), Kinraide (1999), Ali et al. (2003), Ahmad et al. (2005) and Mahmood et al. (2007).

It is therefore concluded that better production could be obtained from saline-sodic soils by cultivation of suitable genotypes tolerant to salinity and sodicity. The utilization of saline-sodic soils is itself an advantage in addition of crop yields. Among all genotypes under study, Dunkled and Sultan Raya produced comparable more seed yield. These results lead to conclude that Dunkled and Sultan Raya may be superior and could successfully be cultivated on saline-sodic soils having an Ece = 12.3 dS m^{-1} and SAR = 46.2 with-out application of any amendment.

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