Journal of Agroecology and Natural Resource Management
p-ISSN: 2394-0786, e-ISSN: 2394-0794, Volume 5, Issue 1; January-March, 2018, pp. 30-33

http://www.krishisanskriti.org/Publication.html

Yield and Quality of Jute (*Corchorus capsularis* L.) Vegetable Seed as Affected by Salinity Environment

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Abstract—*A pot experiment was conducted with three indigenous germplasm of jute (Corchorus capsularis L.) viz., Merha red, Merha green and Birol used as treatment and BJRI deshi pat shak-1 and BINA pat shak-1 were used as control at Jute Agriculture Experimental Station (JAES), Bangladesh Jute Research Institute (BJRI), Jagir, Manikganj during September to November, 2017. The experiment was conducted to investigate the effect of three salt concentrations, 0, 100 and 200 mM NaCl on reproductive growth of five jute genotypes. The experiment was laid out in Completely Randomized Design (CRD) with four replications. Among five genotypes Merha red produced highest seed yield per plant (2.02g) followed by Merha green (2.01g) and the lowest seed yield per plant (0.34g) produced by BINA pat shak-1. Results revealed that plant height, branches per plant, number of capsule per plant, number of seed per capsule, seed yield per plant, 1000-seed weight and germination percent were decreased but false seed percent was increased as a result of salinity. It was also reported that, among five genotypes Merha green was the most salinity tolerant and BINA pat shak-1 was the most salinity sensitive genotype.*

1. INTRODUCTION

Jute (white jute, Corchorus capsularis L.; nalta jute or tossa jute, C. olitorius L.; Tiliaceae family), known as a fiber plant, is a time-honored medicinal vegetable in North Africa, the Middle and Near East and Southeast Asia. The young leaves of C. olitorius that have been introduced into Japan as a healthy vegetable, moroheiya, are rich in vitamins, carotenoids, calcium, potassium and dietary fiber (Resources Council, Science and Technology Agency, Japan, 2000). Jute leaves are the leaves of certain jute plants, used as a food source in Asia, the Middle East, and parts of Africa. In addition to adding a distinct flavor to food, jute leaves also have nutritional value, and they act as thickeners in soups, stews, and sauces. Jute leaves may also be called saluyot or ewedu, depending on the region of the world in which one is cooking. It is possible to grow jute for its fresh leaves in some parts of the world, and some specialty stores also stock it in fresh, frozen, or dried form, depending on their location and size (Calleja, 2010). There is some anti-aging components present in jute leaf. It contains lipid, protein, crude fiber, carbohydrate, different vitamins and minerals and also have some medicinal values.

Salinity is becoming a serious problem in several parts of the world limiting the productivity of agricultural crops (Khadija el al., 2013).The coastal areas of Bangladesh constitute about 20% of the country, of which approximately 53% are affected by diverse ranges of salinity (Minar *et al.*, 2013). Agricultural land use and cropping practices in these salinity-prone areas are very limited, consequently affecting the country's overall crop-productivity. Thus, selection of salinity tolerant jute varieties for vegetable purposes and understanding the mechanisms regulating jute responses and tolerance to salt stress has a great importance for food security and sustainable agriculture in the country. Therefore, the present study was conducted to identify salinity tolerant jute vegetable crop.

2. MATERIALS AND METHOD

An experiment was conducted at Jute Agriculture Experimental Station, BJRI, Manikganj during the period from September to November, 2017 in pot culture to find out the salinity effect on reproductive growth of jute vegetables. Three indigenous Germplasm (Birol, Merha red and Merha green) collected from different location of Bangladesh were used as treatments and BJRI deshi pat shak-1 and BINA pat shak-1 were used as control. The crops were sown on 1st September, 2017. Seeds of jute vegetable cultivars were surface sterilized by keeping the seeds in 1% $HgCl_2$ solution for 2 min, followed by rinsing thoroughly with distilled water. Twenty-five seeds of each variety were sown per pot (19 cm in height and 19 cm in diameter) containing 3.5 kg soil. The atmospheric temperature fluctuated within a range of 29-31 ^{0}C at day and 18-27 ^{0}C at night. The relative humidity fluctuated between 71 and 83% at day and night, respectively. For evaluation of salt-tolerant capacity of the 5 jute cultivars, a gradient of salt solutions (100 and 200mMNaCl) equivalent to an EC (electrical conductivity) of 12.11 and 24.22 dS m^{-1}, respectively, was used. 1.0L of NaCl solution of different concentrations was applied to the topsoil of each pot at one-day interval from 45^{th} days after sowing until day 75^{th} after sowing. For control plants, 1.0L of distilled water was used instead of salt solution. One week after seed germination (day 10^{th} after sowing), five equally grown seedlings from each genotype were selected and allowed to grow in each pot. The treatments were replicated four times in a completely randomized factorial design.

The collected data on different yield related characters and seed quality parameters were subjected statistical analysis following ANOVA technique. Differences among treatment means were adjusted by Duncan's Multiple Range Test with the help of a computer based statistical package program MSTAT-C (Gomez and Gomez, 1984).

3. RESULTS AND DISCUSSION

Plant height

Plant height varied significantly at different varieties (Table 1). The tallest plant (111.7cm) was recorded in V_4 and the shortest (81.67cm) plant was recorded in V_5. Here V_1, V_2 and V_3, respectively remained in the middle position. The effect of salinity level on plant height was found significant (Table 2). The tallest plant (107.2cm) was recorded in T_0 (control) treatment and the shortest plant (95.0cm) was recorded in T_2 treatment. Salinity level T_1 remained in the middle position. Plant height varied significantly at different varieties x salinity interactions (Table 3). The tallest plant (116.0cm) was recorded in T_0 x V_4 interaction which was statistically identical with T_0 x V_1interaction and the shortest plant (75.0cm) was recorded in T_2 x V_5 interaction which was statistically identical with T_1 x V_5 interaction. Hossain *et al.* (2008) reported that shoot growth was seriously affected under salt stressed condition in peanut. Similar result was reported by Murshed *et al.* (2008) in rice, Siddiqui *et al.* (2017) in wheat. Salt stress significantly reduced the growth of rice genotypes during reproductive stage (Mojakkir *et al.*, 2015).

Table 1: Effect of variety on reproductive growth on jute vegetables

Varieties	Plant height (cm)	Branches/ plant (No)	Capsules/ plant (No)	Seeds /capsule (No)	Seed yield /plant (g)	1000-SW (g)	Germination (%)	False seed (%)
V_1	107.3b	11.62b	48.33b	31.22b	2.02a	2.237c	67.33a	6.203c
V_2	105.3b	13.56a	53.34a	32.67b	2.01a	2.259c	60.67b	3.370d
V_3	98.33c	7.40d	13.37d	41.67a	0.87c	2.446b	51.67c	10.13b
V_4	111.7a	9.20c	39.60c	28.87c	1.00b	2.607a	53.67c	12.86a
V_5	81.67d	4.61e	8.00e	11.13d	0.34d	0.839d	23.33d	2.503e
LSD(0.05)	3.436	0.997	1.591	1.634	0.104	0.052	2.260	0.821
CV	4.14	13.06	5.95	6.83	10.23	3.09	5.35	14.23

Note: V_1= Merha red; V_2= Merha green ; V_3= Birol ; V_4= BJRI deshi pat shak-1 and V_5= BINA pat shak-1.

Table 2: Effect of salinity level on reproductive growth on jute vegetables

Treatments	Plant height (cm)	Branches/ plant (No)	Capsules/ plant (No)	Seeds /capsule (No)	Seed yield /plant (g)	1000-SW (g)	Germination (%)	False seed (%)
T_0	107.2a	10.97a	40.83a	36.13a	1.67a	2.529a	68.80a	5.21b
T_1	100.4b	10.13b	30.73b	26.39b	1.18b	1.896b	46.80b	5.78b
T_2	95.0c	6.73c	26.01c	24.81c	0.90c	1.809c	38.40c	10.05a
LSD (0.05)	2.662	0.772	1.233	1.266	0.081	0.040	1.751	0.636
CV	4.14	13.06	5.95	6.83	10.23	3.09	5.35	14.23

Note: T_0= 0 mM NaCl; T_1= 100 mM NaCl and T_2= 200 mM NaCl

Table 3: Interaction effect on salinity level x variety of jute vegetable

Interaction (Tr. x Var.)	Plant height (cm)	Branches/ plant (No)	Capsules/ plant (No)	Seeds /capsule (No)	Seed yield /plant (g)	1000-SW (g)	Germination (%)	False seed (%)
T_0xV_1	115.0a	15.17a	61.33a	35.67d	2.52a	2.254f	73.0a	2.61f
T_0xV_2	105.0cde	15.17a	58.67a	35.33d	2.18b	2.289def	66.0b	1.91f
T_0xV_3	110.0abc	8.00de	17.17f	44.67a	1.22f	2.687b	67.0b	7.63cd
T_0xV_4	116.0a	10.00bc	43.00c	31.60efg	1.40ef	2.895a	68.0b	6.38de
T_0xV_5	90.0h	6.50ef	24.00e	33.40de	1.02g	2.517c	70.0ab	7.51cde
T_1xV_1	108.0bcd	10.20bc	49.50b	29.50fg	2.12bc	2.250f	69.0ab	7.19de
T_1xV_2	97.0fg	14.17a	51.17b	32.17ef	1.98cd	2.288def	59.0c	2.21f
T_1xV_3	104.0cde	7.50ef	12.00g	41.67b	0.78h	2.376d	50.0c	10.69b

T_1xV_4	113.0ab	11.80b	41.00c	28.60gh	1.03g	2.564c	56.0c	8.82c
T_1xV_5	80.0i	7.00ef	0.00h	0.00i	0.00j	0.000g	0.00f	0.00g
T_2xV_1	99.0efg	9.50cd	34.17d	28.50gh	1.42e	2.206f	60.0c	8.81c
T_2xV_2	93.0gh	11.33bc	50.17b	30.50efg	1.87d	2.199f	57.0c	5.99e
T_2xV_3	102.0def	6.70ef	10.93g	38.67c	0.66hi	2.276ef	38.0e	12.07b
T_2xV_4	106.0cd	5.80f	34.80d	26.40h	0.58i	2.362de	37.0e	23.38a
T_2xV_5	75.0i	0.33g	0.00h	0.00i	0.00j	0.000g	0.00f	0.00g
LSD	5.95	1.73	2.76	2.83	0.180	0.090	3.915	1.422
CV	4.14	13.06	5.95	6.83	10.23	3.09	5.35	14.23

In a column, figures having common letter(s) do not differ significantly at 5% level of significance as per DMRT.

Number of Branches per plant

Number of branch per plant varied significantly at different varieties (Table 1). The highest number of branches per plant (13.56) was recorded in V_2 and the lowest number of branches per plant (4.61) was recorded in V_5. Here V_1, V_4 and V_3, respectively remained in the middle position. The effect of salinity level on number of branches per plant was found significant (Table 2). The highest number of branches per plant (10.97) was recorded in T_0 and the lowest number of branches per plant (6.73) was recorded in T_2. Salinity level T_1 remained in the middle position. Number of branches per plant varied significantly at different varieties x salinity interactions (Table 3). The highest number of branches per plant (15.17) was recorded in T_0 x V_1 and T_0 x V_2 interaction which was statistically identical with T_1 x V_2 interaction and the lowest number of branches per plant (0.33) was recorded in T_2 x V_5 interaction. Salinity decreased primary and secondary branches which are also important yield contributing factors (Mojakkir *et al.,* 2015).

Number of capsules per plant

Number of capsules per plant varied significantly at different varieties (Table 1). The highest number of capsules per plant (53.34) was recorded in V_2 and the lowest number of capsules per plant (8.0) was recorded in V_5. Here V_1, V_4 and V_3, respectively remained in the middle position. The effect of salinity level on number of capsules per plant was found significant (Table 2). The highest number of capsules per plant (40.83) was recorded in T_0 and the lowest number of capsules per plant (26.01) was recorded in T_2. Salinity level T_1 remained in the middle position. Number of capsules per plant varied significantly at different varieties x salinity interactions (Table 3). The highest number of capsules per plant (61.33) was recorded in T_0 x V_1 interaction which was statistically identical with T_0 x V_2 interaction and the lowest number of capsules per plant (0.00) was recorded in T_1 x V_5 and T_2 x V_5 interaction. Similar result was reported by Siddiqui *et al.* (2017) in wheat.

Number of Seeds per capsule

Number of seeds per capsule varied significantly at different varieties (Table 1). The highest number of seeds per capsule (41.67) was recorded in V_3 and the lowest number of seeds per capsule (11.13) was recorded in V_5. Here V_2, V_1 and V_4, respectively remained in the middle position. The effect of salinity level on number of seeds per capsule was found significant (Table 2). The highest number of seeds per capsule (36.13) was recorded in T_0 and the lowest number of seeds per capsule (24.81) was recorded in T_2. Salinity level T_1 remained in the middle position. Number of seeds per capsule varied significantly at different varieties x salinity interactions (Table 3). The highest number of seeds per capsule (44.67) was recorded in T_0 x V_3 interaction and the lowest number of seeds per capsule (0.00) was recorded in T_1 x V_5 and T_2 x V_5 interaction. Similar results were reported by Mojakkir *et al.* (2015) in rice and Tareq *et al.* (2011) in wheat.

Seed yield per plant

Seed yield per plant varied significantly at different varieties (Table 1). The highest seed yield per plant (2.02g) was recorded in V_1 which was statistically identical with V_2 and the lowest seed yield per (0.34) was recorded in V_5. Here V_4 and V_3, respectively remained in the middle position. The effect of salinity level on seed yield per plant was found significant (Table 2). The highest seed yield per plant (1.67g) was recorded in T_0 and the lowest number of seeds per capsule (0.90g) was recorded in T_2. Salinity level T_1 remained in the middle position. Seed yield per plant varied significantly at different varieties x salinity interactions (Table 3). The highest seed yield per plant (2.52g) was recorded in T_0 x V_1 interaction and the lowest seed yield per plant (0.00) was recorded in T_1 x V_5 and T_2 x V_5 interaction. Similar results were reported by Mojakkir *et al.* (2015) in rice and Tareq *et al.* (2011), Siddiqui *et al.* (2017) in wheat.

1000-seed weight

1000-seed weight varied significantly at different varieties (Table 1). The highest 1000-seed weight (2.607g) was recorded in V_4 and the lowest 1000-seed weight (0.839g) was recorded in V_5. Here V_3, V_2 and V_1, respectively remained in the middle position. The effect of salinity level on 1000-seed weight was found significant (Table 2). The highest 1000-seed weight (2.529g) was recorded in T_0 and the lowest 1000-seed weight (1.809g) was recorded in T_2. Salinity level T_1 remained in the middle position. 1000-seed weight varied significantly at different varieties x salinity interactions (Table 3). The highest 1000-seed weight (2.895g) was recorded in T_0 x V_4 interaction and the lowest 1000-seed weight (0.000) was recorded in T_1 x V_5 and T_2 x V_5 interaction. Mojakkir *et al.* (2015) reported that, reduced 1000-seed weight under salinity condition might be due to lower assimilate production and translocation to grain which might be due to damage of chlorophyll and toxicity raised in the plant. Similar result also reported by Tareq *et al.* (2011) in wheat.

Germination percent

Germination percent varied significantly at different varieties (Table 1). The highest Germination percent (67.33) was recorded in V_1 and the lowest germination percent (23.33) was recorded in V_5. Here V_2, V_4 and V_3, respectively remained in the middle position. The effect of salinity level on germination percent was found significant (Table 2). The highest germination percent (68.80) was recorded in T_0 and the lowest germination percent (38.40) was recorded in T_2. Salinity level T_1 remained in the middle position. Germination percent varied significantly at different varieties x salinity interactions (Table 3). The highest germination percent (73.0) was recorded in T_0 x V_1 which was statistically identical with T_0 x V_5 and T_1 x V_1 interactions and the lowest T_0 x V_1 (0.00) was recorded in T_1 x V_5 and T_2 x V_5 interaction. Similar result was found by Siddiqui *et al*. (2017).

False seed percent

False seed percent varied significantly at different varieties (Table 1). The highest false seed percent (12.86) was recorded in V_4 and the lowest false seed percent (2.503) was recorded in V_5. Here V_3, V_1 and V_2, respectively remained in the middle position. The effect of salinity level on false seed percent was found significant (Table 2). The highest false seed percent (10.05) was recorded in T_2 and the lowest false seed percent (5.21) was recorded in T_0 which was statistically identical with T_1. False seed percent varied significantly at different varieties x salinity interactions (Table 3). The highest false seed percent (23.38) was recorded in T_2 x V_4 and the lowest (0.00) was recorded in T_1 x V_5 and T_2 x V_5 interaction. Similar results were reported by Mojakkir *et al.* (2015) in rice.

4. CONCLUSION

It can be concluded that Merha green was most salt tolerant genotype among all other genotypes whereas BINA pat shak-1 was the most sensitive genotype.

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