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Studies on impact of pre-sowing treatments on seedling growth, vigour and field establishment of karonda cultivars

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Abstract
The experiment entitled "studies on seed germination in karonda cultivars" was carried out at College of Horticulture, Dr.Y.S.R. Horticultural University, Venkataramannagudem, Tadepalligudem, West Godavari District. The seeds of karonda cultivars *viz.*, pink-fruited plants and green-fruited plants were treated with different pre-sowing treatments (IBA, KNO_3, Thiourea) along with control and the experiment was carried out in Factorial Randomised Block Design with 3 replications comprising 14 treatment combinations. The experiment results indicate that the height of stem (5.29 cm, 9.11 cm, 13.58 cm and 17.65 cm at 30, 60, 90, 120 DAP respectively), root length (20.72 cm), root: shoot ratio (0.62), seedling vigour index–I (2,018.46 cm), seedling vigour index–II (205.56 g) and percentage of establishment in main field (98.57 %) were significantly superior in green fruited cultivar when compared to pink-fruited cultivar. Among different pre-sowing seed treatments KNO_3 @ 2% was found to be superior for height of stem (5.47 cm, 9.74 cm, 14.51 cm and 18.86 cm at 30, 60, 90, 120 DAP respectively), root length (22.36 cm), root: shoot ratio (1.04), seedling vigour index–I (2690.70 cm), seedling vigour index–II (351.28 g) and percentage of establishment in main field (100 %) when compared to other treatments. The interaction of different pre-sowing seed treatments and cultivar's combinations showed significant effect, green fruited seeds treated with KNO_3 @ 2 % recorded better result for above said parameters.

Keywords: karonda cultivars, pre-sowing treatments, IBA, KNO_3, thiourea

Introduction
Karonda (*Carissa carandas* L.) known as 'Christ Thorn Tree' is a large dichotomously branched evergreen shrub with short stem and strong thorns in pairs belongs to the family Apocyanaceae. It grows well under tropical and sub tropical climatic conditions (Panda *et al.*, 2014) [15]. Karonda is found wild in Bihar, West Bengal and South India. It is commonly used as a thorny live hedge plant in commercial plantations in the Varanasi district of Uttar Pradesh. It is a drought tolerant plant that flourishes well in areas with high temperatures and wide range of solis. It is a non- traditional fruit crop which thrives well as a rainfed crop. Once established, the plant hardly needs any care and gives yield with minimum management (Banik *et al.*, 2012) [2]. Fruits are sour and astringent in taste and are rich source of iron (39.10 mg/100 g) and vitamin C (9-11 mg/100 g). It is also rich in pectin. Its fruits have antiscorbutic properties and are a very useful to cure anaemia. Ripe fruits of pink fruited and green fruited cultivars are sub-acidic to sweet in taste with a peculiar aroma and can be used in the preparation of fruit products such as jelly, sauce and carissa cream or jellied salad. Karonda is commercially propagated by seed but the seeds are quite hard and germination is low. To improve the seed germination certain pre-sowing treatments like KNO_3, thiourea, IBA etc. has to be done to seed before sowing. KNO_3 improve the seed germination by creating a balance between hormonal ratios in seed and reducing the growth preventing hormones like ABA (Ali *et al*., 2010, Singh *et al*. 2017a; Singh *et al*. 2017b; Singh *et al*. 2017c; Singh *et al*. 2018; Tiwari *et al*. 2018; Tiwari *et al*. 2019a; Tiwari *et al*. 2019b; Kour *et al*. 2019; Singh *et al*.

2019) [1, 21, 22, 23, 24, 25, 26, 27, 28, 29]. Thiourea also improves germination percentage of seed by breaking dormancy (Hartmann *et al*., 1997) [7]. IBA improves seed germination by activating enzymes involved in carbohydrate metabolism. As scare information was available on propagation studies on karonda cultivars the present experiment was conducted.

Materials and methods

The present experiment was carried out during the period of 2017-18 at college farm, College of Horticulture, Dr. Y. S. R. Horticultural University, Venkataramannagudem, Tadepalligudem, West Godavari District.

Source of seeds and seed extraction/preparation

The fully ripped karonda fruits were collected and ripe fruits were soaked in water for overnight to allow the fruit pulp to become soft. The seeds were separated from the pulp by sequeezing, washed with water, shade dried and stored at ambient temperature in butter paper bags. These stored seeds were taken for further seed germination studies. The seeds were soaked in pre - sowing treatments *i.e.,* IBA, KNO_3, Thiourea for 12 hours and were allowed to dry for 15 minutes. Untreated (control) seeds were soaked in distilled water. Treated seeds were sown treatment wise in polythene bags containing potting mixture at a depth of 1-1.5 cm. The potting mixture was moistened before sowing and watering was done regularly as and when the top 2 cm media got dried.

Observations Recorded

Growth Parameters

Growth parameters were recorded on five randomly selected and tagged seedlings in each replication in a treatment.

Height of stem (cm)

Plant height was recorded at monthly intervals and measured from a marked point just above the crown region up to the tip and was expressed in centimeters.

Root length (cm)

The length of the longest root was measured on 120th day. The length of the root was recorded from the morphological base to the morphological top with the help of scale and is expressed in centimeters.

Root: Shoot ratio

Five seedlings were selected at random in each replication for measuring root: shoot ratio. The root shoot ratio was calculated using the following formula at 120 DAS.

$$\text{Root: Shoot ratio} = \frac{\text{Dry weight of the root}}{\text{Dry weight of the shoot}}$$

Vigour Parameters

Seedling vigour index - I (cm)

Vigour index of seedling was calculated by multiplying seedling length (root length + shoot length) with germination percentage and expressed in terms of centimeters.

Seedling vigour index - II (g)

Vigour index-II of seedling was calculated by multiplying dry weight of seedling with germination percentage and expressed in grams.

Percentage of establishment in main field (%)

This was calculated based on the number of seedlings survived in one month after planting in the main field.

Statistical Analysis

The data was analyzed using computer software programmed by the method of variance outlined by Panse and Sukhatme (1978) [16]. Statistical significance was tested by F value at 5 per cent level of significance. Critical difference at 0.05 level was worked out for the effects which were significant. The results have been depicted graphically where ever necessary.

Results and Discussions

Height of stem (cm)

The difference observed in stem height at 30, 60, 90 and 120 DAP were found significantly influenced by the type of cultivars, pre-sowing treatments and their interaction effect has been presented in Table 1. Seeds of green fruited plants showed maximum stem height at all the intervals (5.29 cm, 9.11 cm, 13.58 cm and 17.65 cm respectively), while seeds of pink fruited plants recorded minimum height of stem *i.e.* 4.69 cm, 8.29 cm, 12.35 cm and 16.06 cm at respective intervals. The mean height of the stem was significantly higher in treatment of KNO_3 @ 2 % at all intervals (5.47 cm, 9.74 cm, 14.51 cm and 18.86 cm at 30, 60, 90 and 120 DAP respectively), while control recorded the least height at 30, 60, 90 and 120 DAP (3.98 cm, 7.43 cm, 11.07 cm and 14.39 cm respectively). Among interactions, the pre soaked seeds of green fruited plants in KNO_3 @ 2 % solution recorded maximum height at 30, 60, 90 and 120 DAP with 6.25 cm, 10.73 cm, 15.99 cm and 20.78 cm respectively. The above results are in accordance with that of Dey *et al.* (2016) [6] in hog –plum and Patel *et al.* (2016) [17] in mango. Significant difference in stem height among cultivars and pre-sowing treatments may be due to the genetic variation between them. Whereas among pre-sowing treatments KNO_3 influenced stem elongation by inducing cell wall loosening, increasing cell wall extensibility, stimulating the wall synthesis, reducing the rigidity of cell wall and by increasing cell division leading to more growth (Muralidhara *et al.*, 2015) [13].

Table 1: Effect of pre – sowing treatments on height of stem (cm) in karonda cultivars

Concentration of pre–sowing treatments (T)	30 DAS		Mean	60 DAS		Mean	90 DAS		Mean	120 DAS		Mean
	Cultivars (V)			Cultivars (V)			Cultivars (V)			Cultivars (V)		
	V_1	V_2		V_1	V_2		V_1	V_2		V_1	V_2	
T_1 (IBA @ 20 ppm)	4.86	5.54	5.20	8.48	9.19	8.84	12.64	13.69	13.17	16.43	17.80	17.11
T_2 (IBA @ 40 ppm)	4.67	5.27	4.97	8.14	8.84	8.49	12.12	13.17	12.65	15.76	17.11	16.43
T_3 (KNO_3 @ 1%)	4.87	5.62	5.24	8.89	10.00	9.44	13.25	14.90	14.07	17.22	19.36	18.29
T_4 (KNO_3 @ 2%)	4.70	6.25	5.47	8.75	10.73	9.74	13.03	15.99	14.51	16.94	20.78	18.86
T_5 (Thiourea @ 1%)	5.35	4.75	5.05	8.41	8.50	8.45	12.53	12.66	12.60	16.29	16.46	16.37
T_6 (Thiourea @ 2%)	4.78	5.30	5.04	8.57	8.50	8.53	12.76	12.66	12.71	16.59	16.46	16.52
T_7 (Control)	3.62	4.34	3.98	6.80	8.06	7.43	10.14	12.00	11.07	13.18	15.60	14.39
Mean	4.69	5.29		8.29	9.11		12.35	13.58		16.06	17.65	

V_1: Pink-fruited plant V_2: Green-fruited plant

	V	T	V x T	V	T	V x T	V	T	V x T	V	T	V x T
SE(m) ±	0.02	0.04	0.05	0.07	0.13	0.19	0.10	0.20	0.28	0.13	0.26	0.36
CD at 5%	0.06	0.11	0.16	0.21	0.39	0.55	0.31	0.58	0.82	0.40	0.76	1.07

Root length (cm)

From the findings of present investigation, there was a significant difference with respect to the cultivar type and pre-sowing treatments (Table 2). Root length of green fruited plant's seedlings recorded the highest length (20.72 cm), when compared to seedlings of pink fruited plants (19.31 cm). Among the pre-sowing treatments KNO_3 @ 2% recorded maximum length of the root (22.37 cm) followed by KNO_3 @ 1% (21.02 cm), IBA @ 40 ppm (20.12 cm) and control recorded minimum root length *i.e.* 18.02 cm. Pre-soaked seeds of green fruited plant in KNO_3 @ 2% solution showed maximum root length (23.36 cm), while untreated seeds of pink fruited recorded minimum root length *i.e.* 17.63 cm. The difference in root length among the cultivars may be due to the genetic and environmental factors, which was similar to the observations of Lalit (2017) [12]. KNO_3 significantly increased root length, which might be due to the vigorous shoot growth promoted by potassium nitrate that resulted in more production of photosynthates and their translocation through phloem to the root zone. The increased root length with KNO_3 might also be probably due to an increase in oxidation of nicotinamide adenine dinucleotide phosphate during respiration at seed germination (Hendricks and Taylorson, 1975) [8]. The above results are in agreement with Kolekar *et al.* (2017), Parmar *et al.* (2016) and Kadam *et al.* (2010) [10, 17, 9].

Table 2: Effect of pre – sowing treatments on root length (cm) in karonda cultivars

Concentration of pre – sowing treatments	Cultivars		Mean
	V_1 (Pink-fruited plant)	V_2 (Green-fruited plant)	
T_1 (IBA @ 20 ppm)	19.24	20.44	19.84
T_2 (IBA @ 40 ppm)	19.88	20.36	20.12
T_3 (KNO_3 @ 1%)	20.52	21.51	21.02
T_4 (KNO_3 @ 2%)	21.39	23.36	22.37
T_5 (Thiourea @ 1%)	18.23	20.47	19.35
T_6 (Thiourea @ 2%)	18.31	20.49	19.40
T_7 (Control)	17.63	18.41	18.02
Mean	19.31	20.72	
	V	T	V x T
SE(m) ±	0.10	0.19	0.27
CD at 5%	0.29	0.55	0.79

Root: Shoot ratio

The data pertaining to root: shoot ratio on the type of cultivar and pre-sowing treatment recorded significant difference (Table 3). Seedlings of green-fruited plant recorded maximum root: shoot ratio (0.62) and minimum was observed in pink fruited plant (0.50). Maximum root: shoot ratio (1.04) was recorded in KNO_3 @ 2 % and remaining treatments were on par with each other and minimum root: shoot ratio (0.45) were recorded in control and IBA @ 40 ppm. Interaction between type of cultivar and pre-sowing treatment also recorded significant difference. Maximum root: shoot ratio (1.36) was recorded in green fruited plant's seeds treated with KNO_3 @ 2 %. Difference in root: shoot ratio among the type of cultivars and pre-sowing treatment may be due to the genetic factors and in case of pre-sowing treatments it may be due to the high vigour of seedlings. The present tendings are line with Dey *et al.* (2016) [6] in hog-plum and Bhan and Sharma (2011) [3] in apricot.

Table 3: Effect of pre – sowing treatments on the root: shoot ratio in karonda cultivars

Concentration of pre – sowing treatments	Cultivars		Mean
	V_1 (Pink-fruited plant)	V_2 (Green-fruited plant)	
T_1 (IBA @ 20 ppm)	0.40	0.49	0.49
T_2 (IBA @ 40 ppm)	0.42	0.47	0.45
T_3 (KNO_3 @ 1%)	0.44	0.61	0.52
T_4 (KNO_3 @ 2%)	0.72	1.36	1.04
T_5 (Thiourea @ 1%)	0.49	0.48	0.48
T_6 (Thiourea @ 2%)	0.48	0.53	0.51
T_7 (Control)	0.48	0.41	0.45
Mean	0.50	0.62	
	V	T	V x T
SE(m) ±	0.03	0.06	0.09
CD at 5%	0.10	0.19	0.27

Seedling vigour index I (cm)

Seedling vigour index – I as affected by the type of cultivars and pretreatments revealed significant difference (Table 4). Among different type of cultivars green fruited plants recorded maximum vigour index –I (2,018.46 cm), while minimum was recorded in pink fruited plants (1343.04 cm). The seedlings treated with different treatment concentrations also showed significant variations. KNO_3 @ 2 % showed maximum seed vigour index -I (2690.70 cm) followed by KNO_3 @ 1 % (2054.71 cm). Control recorded the minimum seed vigour index -I (833.04 cm). Seeds of green fruited plant pre-soaked in KNO_3 @ 2 % solution showed maximum seed vigour index -I (3176.15 cm) among interaction effects, while lowest was recorded in untreated seeds of pink fruited plant (735.54 cm). The maximum vigour index-I was observed in seeds of green fruited plants treated with KNO_3 @ 2 % might

be due to the vigorous growth of rootstock, greater seedling emergence ability, cotyledonary photosynthesis and maximum germination percentage. This also might be due to the enhanced uptake of nitrogen, potassium, water and nutrients and resulted in better root and shoot growth which ultimately resulted in maximum vigour index - I (Kumar *et al.* 2007) [11]. Similar results were reported by Bhavya *et al.* (2017) [4] in karonda and Rajamanickam *et al.* (2004) [19] in amla.

Table 4: Effect of pre – sowing treatments on seedling vigour index I (cm) in karonda cultivars

Concentration of pre – sowing treatments	Cultivars		Mean
	V_1 (Pink-fruited plant)	V_2 (Green-fruited plant)	
T_1 (IBA @ 20 ppm)	995.40	1,841.75	1,418.58
T_2 (IBA @ 40 ppm)	1,501.73	2,045.07	1,773.40
T_3 (KNO_3 @ 1%)	1,326.37	2,783.05	2,054.71
T_4 (KNO_3 @ 2%)	2,205.26	3,176.15	2,690.70
T_5 (Thiourea @ 1%)	1,530.76	1,907.98	1,719.37
T_6 (Thiourea @ 2%)	1,106.23	1,444.68	1,275.45
T_7 (Control)	735.54	930.53	833.04
Mean	1,343.04	2,018.46	
	V	**T**	**V x T**
SE(m) ±	11.71	21.91	30.98
CD at 5%	34.23	64.04	90.57

Seedling vigour index II (g)

The mean seedling vigour index II recorded significant difference in combination of cultivar types and pre-sowing treatments. Among different type of cultivars green fruited seeds recorded maximum vigour index –II (205.56 g). Minimum (165.60 g) was recorded in pink fruited seeds (Table 5). Among the pre-sowing treatments KNO_3 @ 2 % showed maximum seed vigour index -II (351.28 g) followed by KNO_3 @ 1 % (219.86 g), while untreated seedlings of karonda (control) recorded minimum (54.52 g). Interaction effects also showed significant variation, green fruited seeds pre-soaked with KNO_3 @ 2 % showed maximum seed vigour index -II (382.60 g), while lowest was recorded in untreated seeds of pink fruit plant (45.11 g). The above results are in confirmatory with the findings of Reddy and Khan (2001) [20] in khirni, Rajamanickam *et al.* (2004) [19] in amla and Kumar *et al.* (2007) [11] in mango. The above results might be due to the genetic makeup of cultivars. Choudari and Chakrawar (1982) [5] stated that increase in number of leaves and root length had led to the overall assimilation and redistribution of photosynthates within the plant and resulted in higher dry weight of the seedling and thereby increased the vigour of seedlings in case of KNO_3 treated seeds.

Table 5: Effect of pre – sowing treatments on seedling vigour index II (g) in karonda cultivars

Concentration of pre – sowing treatments	Cultivars		Mean
	V_1 (Pink-fruited plant)	V_2 (Green-fruited plant)	
T_1 (IBA @ 20 ppm)	138.37	204.66	171.51
T_2 (IBA @ 40 ppm)	187.86	206.85	197.36
T_3 (KNO_3 @ 1%)	151.73	287.98	219.86
T_4 (KNO_3 @ 2%)	319.97	382.60	351.28
T_5 (Thiourea @ 1%)	176.18	185.15	180.66
T_6 (Thiourea @ 2%)	121.16	126.58	123.87
T_7 (Control)	63.93	45.11	54.52
Mean	165.60	205.56	
	V	**T**	**V x T**
SE(m) ±	2.61	4.88	6.91
CD at 5%	7.63	14.29	20.21

Percentage of establishment in main field (%)

The data pertaining to the percentage of establishment in the main field varied significantly with respect to the type of cultivar and pre-sowing treatments (Table 6). Seeds of green fruited plants showed better establishment in the main field (98.57 %) when compared to the seeds of pink fruited plants (97.95 %). In case of pre-sowing treatments the percentage of establishment in main field was significantly maximum (100 %) in KNO_3 @ 2 %, which was on par with KNO_3 @ 1 % (99.66 %) and lowest was recorded in control (96.50 %). The above results might be due to the better root system with more number of roots and root length in seeds treated with KNO_3 @ 2 % and the genetic make up of the cultivar. The above results are in line with Padma *et al.* (2015) [14] in papaya. No significant difference was observed with respect to the interaction effect caused by the type of cultivar and pre-sowing treatments.

Table 6: Effect of pre – sowing treatments on percentage of establishment in main field (%) in karonda cultivars

Concentration of pre – sowing treatments	Cultivars		Mean
	V_1 (Pink-fruited plant)	V_2 (Green-fruited plant)	
T_1 (IBA @ 20 ppm)	99.00	98.33	98.66
T_2 (IBA @ 40 ppm)	97.00	98.33	97.66
T_3 (KNO_3 @ 1%)	99.33	100.00	99.66
T_4 (KNO_3 @ 2%)	100.00	100.00	100.00
T_5 (Thiourea @ 1%)	97.00	98.00	97.50
T_6 (Thiourea @ 2%)	97.33	98.33	97.83
T_7 (Control)	96.00	97.00	96.50
Mean	97.95	98.57	
	V	**T**	**V x T**
SE(m) ±	0.18	0.34	0.49
CD at 5%	0.54	1.02	N/S

Conclusion

From this study we have observed that among the cultivars, seeds of green fruited plants and among the different pre-sowing treatments, KNO_3 @ 2 % performed the best with respect to the above parameters. Among the interactions, seeds of green fruited plants treated with KNO_3 @ 2 % was found to be best.

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