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Effect of Irrigation Intervals and Foliar Application of Boron and Selenium on Growth and Chemical Composition of *Tipuana speciosa* Benth

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Abstract: A pot experiment was conducted at the Experimental Farm of Timber Trees and Forestry Research Department, Horticulture Research Institute, Agricultural Research Centre, Giza, Egypt during two successive seasons (2018/2019 and 2019/2020) to study the effect of application of different concentrations of boron and selenium either individually or as a mixture on growth parameters and chemicals composition of *Tipuana speciosa* seedlings grown under different irrigation intervals. Results showed that, increasing irrigation interval from 4 to 16 days caused a significant decrease in all growth characters, (seedling height, stem diameter, fresh and dry weights of shoots and roots) except root length which is the longest with prolonged interval. Also, N, P, K concentrations and chlorophylls contents decreased while, the contents of total sugars and proline increased with prolonged interval as well as Na+ and Cl^-%. On the other hand, results revealed that application of (B and/ or Se) significantly increased all growth parameters under investigation as well as enhanced N, P, K, chlorophylls, sugars and proline contents with decreasing of Na+ and Cl^- levels. From the current study it can be concluded that the best results referred to spraying the plants with B 4.0 mg/l plus Se 4.0mg/l with prolonged irrigation to counteract the injurious of drought stress on *Tipuana speciosa* seedlings.

Key words: *Tipuana speciosa* · Boron · Drought · Selenium

INTRODUCTION

Tipuana tipu or Tipuana speciosa Benth belongs to Fabacease family which is one of the three largest families of flowering plants. It is a beautiful flowering tree with yellow flowers. This species is becoming widely naturalized and planted in many parts of the world in tropical to warm temperate climates [1]. It is used as an ornamental street and garden tree, growing up to 30 m in height. It grows under a wide range of climatic conditions and tolerates a variety of soils. It tolerates temperatures below 0^c and survives at very high levels of salinity. It is used for windbreaks, erosion control and for soil improvement (nitrogen fixing).The wood of *T. speciosa* is used for furniture and cabinet- work and as a source of fire wood and charcoal. *Tipuana speciosa* were recommended for medical purposes such as wound healing, gastrointestinal tract disorders, hemorrhoids and abdominal and rheumatic pain .Leaves extract of *T.speciosa* Benth growing in Egypt showed good nephroprotective and antimalarial activities [2]. Drought is one of the factorsthat limit plant growth. Plants can respond to drought stress by adapting their cellular metabolism and developing various defense mechanisms. Drought stress has emerged as the single most critical threat to world food security, as it seriously limits agricultural productivity, especially in areas where rainfall is limited or unreliable, so improving yield under limited water condition has become crucial target for arid and semi-arid regions of the world [3].

Boron (B) is required by plants in small quantities that involves several physiological and biochemical processes in the plant [4]. Deficiency of this micronutrient is common in forest trees [5]. Therefore, boron deficiency may affect the resistance of trees to environmental stress such as drought. It is necessary for protein synthesis, seed and cell wall formation, pollen germination and pollen tube growth [6]. Soil water is one of the important

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factors affecting B availability for plant roots therefore, water stress may accentuate B deficiency [7, 8]. Also, B is responsible for stimulating cell division, biosynthesis and translocation of sugars, water and nutrient uptake through plant tissues and IAA biosynthesis [9].

Selenium (Se) is a beneficial element for higher plants and has a positive effect and performance on plant growth and it plays an important role in enhancing the resistance of plants to certain abiotic stresses e.g. drought [10]. It regulates water status and increases biomass production by the activation of antioxidant apparatus of water stressed plants [3]. Moreover, actively growing tissues usually contain large amounts of Se and accumulation is higher in shoot and leaf than in root tissues [11]. Therefore, foliar application of Se is more viable and effective than soil application [12]. The Se efficiency by foliar application may be due to its direct absorption and accumulation in the plants by diffusion from the surface of leaves to epidermal cell, but its high concentration can cause damage to leaf surface. Therefore, concentration of solution at fertigation and foliar application of Se should be chosen with care based on recommendation of Habibi [13].

The aim of this investigation was to study the effect of foliar application of boron and selenium to decrease the drought hazards on *Tipuana speciosa* seedlings grown in sandy loamy soil.

MATERIALS AND METHODS

This investigation was conducted at the experimental farm of Timber Trees and Forestry Research Department, Horticulture Research Institute, Agricultural Research Centre, Giza, Egypt during two successive seasons of 2018/2019 and 2019/2020 to determine the effects of boron and selenium foliar application on the growth and chemical composition of *Tipuana speciosa* seedlings grown under different irrigation regimes. The planting date for both seasons was 15thFebruary.The seedlings were obtained from EI -Qanater El- khayria, Qalioubia Governorate, 20-Km northwest of Cairo. (One year old) and used as plant materials. Seedlings were chosen, with an average height of 25-30 cm and average stem diameter of 0.3cm in the both seasons. The seedlings were planted in plastic pots 30 cm height and 25 cm diameter filled with 12 kg of soil mixture from sand and clay in proportion of 2:1(v:v), respectively. Every pot contained individual seedling. The chemical and physical analysis of the used soil is shown in Table (1). Chemical analysis of the soil samples was performed according to the method of Black [14]. Organic matter, calcium carbonate, pH, Ec, Ca, Mg, Na, K, HCO_3 and Cl were determined according to Cottenie *et al*. [15].

The seedlings were grown under three irrigation regimes (in both seasons) i.e:

- Irrigation applied every 4/ days as wet soil moisture content.
- Irrigation applied every 8/ days as intermediate soil moisture content.
- Irrigation applied every 16/ days as drought stress.

The volume of water added to plants was according to 100% field capacity determined in this soils. For each irrigation regime foliar application of two selenium concentrations (2.0 and 4.0 mg/l) from sodium selenate Na_2SeO_4 and two boron concentrations (2.0 and 4.0 mg/l) from boric acid H_3BO_3 as well as control which did not receive any foliar application , in addition, mixtures of both Se and B at different combinations were used as follow:

Tap water (control), B_1(2.0mg/l B), B_2(4.0mg/l B), Se_1(2.0mg/l Se), Se_2(4.0mg/l Se), B_1Se_1(2.0mg/l B +2.0mg/l Se), B_1Se_2(2.0mgl/ B+ 4.0mg/l Se), B_2S_1(4.0mg/l B+2.0mg/l Se) and B_2Se_2(4.0mg/l B+4.0mg/l Se).

In each spray solution, 0.1%Tween-20 as a surfactant was added. The plants were sprayed twice, after 40 and 70 days from planting date. At the terminal of experiment throughout both seasons (12months), three random plant samples from each treatment were taken and the growth characters (seedling height, stem diameter, root length, cm/plant) and (fresh and dry weights of shoots and roots g/plant) were determined.

Total chlorophylls (mg/g F.w) were determined in fresh leaves from middle part according to Mornai [16].

Total sugars were determined in stem using the phenol sulphuric acid reagent as the method described by Dubois *et al*. [17].

Proline concentration in shoots was measured calorimetrically using ninhydrin reagent according to Bates *et al*. [18].

The wet digestion of 0.5g plant material with sulphuric and perchloric acids was carried out in shoots as reported by Piper [19] to determine N, P, K, Na and Cl concentrations.

Nitrogen concentration was determined in shoots by Nessler method according to the Official Methods of Analysis A.O.A.C. [20].

Table 1: Physical and chemical analysis of the used soil

Physical									
Sand (%)		Silt (%)				Clay (%)			Texture class
87.0		7.8				5.2			Sandy loamy
Chemical									
		Soluble cations (meq/l)				Soluble anions (meq/l)			
pH 1:2.5	E.C (dSm^{-1})	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^-	HCO_3^-	Cl^-	$SO4^-$
7.40	0.87	2.20	1.45	1.73	2.96	-	2.43	3.4 0	2.49

Phosphorus in shoots was estimated colorimetrically using the chlorostannous reduced molybdophosphoric blue colour method as described by King [21].

Sodium and potassium concentrations were determined in shoots using the flam photometer apparatus CORNINGM410 [22].

Chloride concentration was determined in shoots by titration method with silver nitrate according to Brown and Jackson [23].

Statistical Analysis: The layout of the experiment was a split plot design, the main plots were the irrigation intervals and sub plots were the treatments of Se and B. The experiment consists of 27 treatments and each treatment was replicated three times. Data were statistically analyzed according to Duncan, [24] multiple range test 5% and according to Snedecor and Cochran [25].

RESULTS AND DISCUSSION

Effect of Irrigation Intervals and Foliar Application of B and Se on Growth Parameters of *Tipuana speciosa* Benth:

Seedling Height: Data presented in Table (2) indicated that, different irrigation intervals significantly decreased seedling height in descending order (102.33, 84.78 and72.22cm) with 4, 8and16 days irrigation intervals, respectively in the first season and the reduction was severely at prolonged interval 16/day.

As regard foliar application of B and Se data illustrated that all treatments significantly increased seedling height as compared to control. On the other hand, increasing concentration of both B and/or Se significantly increased seedling height in an ascending order as the treatments were B_1, B_2, Se_1, Se_2 , B_1Se_1, B_1Se_2, B_2Se_1 and B_2Se_2 respectively in the same season.

For the interaction between irrigation intervals and foliar application, the treatment of B_2Se_2 with 4/ days interval significantly increased seedling height as compared to all other treatments.

For the second season, data showed the same trends for irrigation and foliar application of B and Se and their interaction on seedling height approximately.

Root Length: As shown in Table (3) data indicated that different irrigation intervals significantly increased root length in ascending order (45.22, 49.00 and 52.22 cm) with 4, 8and16 days irrigation intervals, respectively in the first season. On the other side , all foliar applications of B and Se treatments significantly increased root length as compared to control .Moreover, increasing the concentration of both B and/or Se significantly increased the root length in an ascending order with the treatments of B_1, B_2, Se_1, Se_2 , B_1Se_1, B_1Se_2, B_2Se_1 and B_2Se_2 respectively in the same season. For the interaction between irrigation intervals and foliar application it was found that, the treatment of B_2Se_2 significantly increased the root length as compared to all other treatments.

For the second season, data on root length take the same trends in response to irrigation and foliar application of B and Se.

Stem Diameter: The obtained data on stem thickness in response to irrigation and the foliar application of Se and B (Table 4) revealed that prolonging irrigation intervals significantly decreased stem diameter in descending order(1.08, 0.77 and 0.74cm) with the treatments of 4, 8and16 days irrigation intervals, respectively in the first season.

The foliar application of B and Se at the two levels significantly increased stem diameter as compared to control. On the other hand, increasing concentration of both B and/or Se significantly increased stem diameter in an ascending order as follows: B_1, B_2 , Se_1 , Se_2, B_1Se_1 B_1Se_2, B_2Se_1 and B_2Se_2, respectively in the same season.

For the interaction effect between irrigation intervals and foliar application, the data revealed that the treatment of B_2Se_2 significantly increased stem diameter as compared to all other treatments.

In the second season the response of stem thickness to irrigation regime and the treatments of Se and B, take the same trends as in the first one.

Table 2: The effect of irrigation intervals and foliar application of B and Se on seedling height of *Tipuana speciosa* seedlings during 2018/2019 and 2019/2020

Treatments	Seedling height (cm) 4 day	8 day	16 day	Mean	4 day	8 day	16 day	Mean
	First season (2018/2019)				Second season (2019/2020)			
Control	90.00i	73.00o	56.00s	73.00I	85.00j	68.00p	50.00u*	67.67I
B_1	92.00h	75.00n	59.00r	75.33H	90.00h	71.00o	56.00t	72.33H
B_2	95.00fg	78.00m	65.00q	79.33G	92.00g	73.00n	59.00s	74.67G
Se_1	97.00f	81.00l	70.00p	82.67F	95.00f	77.00l	61.00r	77.67F
Se_2	103.00e	85.00j	73.00o	87.00E	98.00e	81.00k	65.00q	81.33E
B_1Se_1	105.00d	87.00j	77.00m	89.67D	100.00d	87.00i	70.00o	85.67D
B_1Se_2	110.00c	90.00i	81.00l	93.67C	107.00c	92.00g	73.00n	90.67C
B_2Se_1	112.00b	97.00f	83.00k	97.33B	115.00b	98.00e	75.00m	96.00B
B_2 Se_2	117.00a	97.00f	86.00j	100.00A	121.00a	100.00d	77.00l	99.33A
Mean	102.33A	84.78B	72.22C		100.33A	83.00B	65.11C	

Se1(Selenium 2.0. mg/l), Se2 (Selenium4.0 mg/l), B 1(Boron 2.0 mg/l), B 2(Boron.4.0 mg/l).
Means values in the same row or column followed by the same letter are not significant at 5%.

Table 3: The effect of irrigation intervals and foliar application of Se and B on root length of *Tipuana speciosa* seedlings during 2018/2019 and 2019/2020

Treatments	Root length (cm) 4 day	8 day	16 day	Mean	4 day	8 day	16 day	Mean
	First season (2018/2019)				Second season (2019/2020)			
Control	30.00o	33.00n	39.00kl	34.00I	40.00o	45.00m	47.00m*	44.00I
B_1	35.00m	38.00l	42.00j	38.33H	42.00n	47.00m	49.00l	46.00H
B_2	38.00l	44.00i	47.00h	43.00G	45.00m	50.00l	52.00k	49.00G
Se_1	40.00k	45.00i	49.00g	44.67F	47.00p	54.00ij	52.00k	51.00F
Se_2	45.00i	48.00gh	49.00g	47.33E	50.00l	55.00i	57.00h	54.00E
B_1Se_1	48.00gh	51.00f	53.00e	50.67D	53.00jk	59.00g	61.00f	57.67C
B_1Se_2	54.00e	57.00d	63.00b	58.00C	57.00h	63.00d	65.00d	61.67D
B_2Se_1	57.00d	60.00c	63.00b	60.00B	60.00fg	65.00d	68.00c	64.33B
B_2 Se_2	60.00c	65.00a	65.00a	63.33A	68.00c	70.00b	73.00a	70.33A
Mean	45.22C	49.00B	52.22A		51.33C	56.44B	58.22A	

Se1(Selenium 2.0. mg/l), Se2 (Selenium4.0 mg/l), B 1(Boron 2.0 mg/l), B 2(Boron.4.0 mg/l).
Means values in the same row or column followed by the same letter are not significant at 5%.

Table 4: The effect of irrigation intervals and foliar application of B and Se on stem diameter of *Tipuana speciosa* seedlings during 2018/2019 and 2019/2020

Treatments	Stem diameter (cm) 4 day	8 day	16 day	Mean	4 day	8 day	16 day	Mean
	First season (2018/2019)				Second season (2019/2020)			
Control	0.96f	0.64no	0.60o	0.73G	0.98gh	0.90ij	0.70m	0.86G
B_1	1.11e	0.69mn	0.65no	0.82F	1.00g	0.95h	0.73m	0.89F
B_2	1.13e	0.71lm	0.68mn	0.84F	1.12ef	1.00g	0.77l	0.96E
Se_1	1.16de	0.73lm	0.73lm	0.87E	1.19d	1.11f	0.79l	1.03D
Se_2	1.19cd	0.79jk	0.75kl	0.91D	1.22cd	1.15e	0.80kl	1.06C
B_1Se_1	1.21cd	0.81h-j	0.80i-k	0.94C	1.25bc	1.15e	0.83k	1.08C
B_1Se_2	1.23bc	0.83h-j	0.80i-k	0.95C	1.25bc	1.20d	0.87j	1.11B
B_2Se_1	1.27b	0.86gh	0.82h-j	0.98B	1.27ab	1.23cd	0.89ij	1.13A
B_2 Se_2	1.34a	0.91fg	0.85hi	1.03A	1.30a	1.23cd	0.91i	1.15A
Mean	1.18A	0.77B	0.74C		1.18A	1.10B	0.81C	

Se1(Selenium 2.0. mg/l), Se2 (Selenium4.0 mg/l), B 1(Boron 2.0 mg/l), B 2(Boron.4.0 mg/l).
Means values in the same row or column followed by the same letter are not significant at 5%.

Fresh and Dry Weights of Shoots and Roots: Data presented in Tables (5, 6, 7 and 8) indicated that prolonging irrigation intervals significantly decreased fresh and dry weights of shoots (43.05, 40.00, 30.7 and 11.87, 11.57, 10.62g/plant respectively) and roots (10.19, 9.37, 7.84 and 3.30, 2.96, 2.56 g/plant, respectively in descending order with the treatments of 4, 8and16 days irrigation intervals, in the first season.

Table 5: The effect of irrigation intervals and foliar application of Se and B on fresh weight of shoot of *Tipuana speciosa* plant during 2018/2019 and 2019/2020

	Fresh weight of shoots (g)							
Treatments	4 day	8 day	16 day	Mean	4 day	8 day	16 day	Mean
		First season (2018/2019)				Second season (2019/2020)		
Control	32.27ij	29.85kl	18.00o	26.71I	30.00op	27.00r	23.00t	26.67I
B_1	32.90hi	30.15kl	23.33n	28.79H	33.00lm	29.00pq	25.00s	29.00H
B_2	36.00g	34.00h	27.00m	32.33G	38.00ij	31.00no	28.00qr	32.33G
Se_1	39.30f	37.00g	29.00l	35.10F	40.00h	34.00l	30.00op	34.67F
Se_2	44.00e	40.00f	31.00jk	38.33E	42.00fg	37.00jk	30.90no	36.63E
B_1Se_1	47.00d	44.00e	33.00hi	41.33D	45.00e	40.00h	32.00mn	39.00D
B_1Se_2	50.00c	46.00d	37.00g	44.33C	49.00c	43.00f	36.00k	42.67C
B_2Se_1	52.00b	49.00c	39.00f	46.67B	51.00b	47.00d	39.20hi	45.73B
B_2Se_2	54.00a	50.00c	39.00f	47.67A	57.00a	49.00c	41.00gh	49.00A
Mean	43.05A	40.00B	30.70C		42.78A	37.44B	31.68C	

Se1(Selenium 2.0. mg/l), Se2 (Selenium4.0 mg/l), B 1(Boron 2.0 mg/l), B 2(Boron.4.0 mg/l).

Means values in the same row or column followed by the same letter are not significant at 5%.

Table 6: The effect of irrigation intervals and foliar application of Se and B on and dry weight of shoots of *Tipuana speciosa* seedlings during 2018/2019 and 2019/2020

	Dry weight of shoots (g.)							
Treatments	4 day	8 day	16 day	Mean	4 day	8 day	16 day	Mean
		First season (2018/2019)				Second season (2019/2020)		
Control	8.75k	6.90m	6.30n*	7.32G	7.00l	7.00l	5.70n*	6.57I
B_1	7.70l	7.05m	6.40n	7.05H	8.20k	7.00l	6.20m	7.13H
B_2	10.00i	9.33j	9.00jk	9.44F	10.66f	7.30l	6.33m	8.10G
Se_1	10.20i	11.40h	10.20i	10.60E	12.00e	9.33h	8.00k	9.78F
Se_2	12.67g	12.63g	10.33i	11.88D	13.00d	10.20g	8.30jk	10.50E
B_1Se_1	12.70g	13.30f	12.70g	12.90C	13.20d	11.00f	8.66ij	10.95D
B_1Se_2	14.60b-d	14.20de	12.33i	13.71B	13.40d	12.00e	9.00hi	11.47C
B_2Se_1	15.00ab	14.60b-d	14.30c-e	14.63A	15.00b	13.20d	9.40h	12.53B
B_2Se_2	15.20a	14.70bc	14.00e	14.63A	17.00a	14.30c	10.00g	13.77A
Mean	11.87A	11.57B	10.62C		12.16A	10.15B	7.95C	

Se1(Selenium 2.0. mg/l), Se2 (Selenium4.0 mg/l), B 1(Boron 2.0 mg/l), B 2(Boron.4.0 mg/l).

Means values in the same row or column followed by the same letter are not significant at 5%.

Table 7: The effect of irrigation intervals and foliar application of Se and B on fresh weight of roots of *Tipuana speciosa* seedlings during 2018/2019 and2019/2020

	Fresh weight of roots (g)							
Treatments	4 day	8 day	16 day	Mean	4 day	8 day	16 day	Mean
		First season (2018/2019)				Second season (2019/2020)		
Control	8.00j	7.50kl	5.00p	6.83I	7.00n	6.25o	5.80p*	6.35I
B_1	8.25ij	7.30lm	5.70o	7.08H	7.70l	5.80p	7.00n	7.32H
B_2	8.40i	8.00j	6.75n	7.72G	9.50g	7.00n	7.40m	7.99G
Se_1	9.20g	8.25ij	7.20m	8.22F	9.80f	8.50j	7.50lm	8.60F
Se_2	9.80ef	8.70h	7.70k	8.73E	10.00ef	9.00i	7.73l	8.91E
B_1Se_1	10.75d	9.70f	8.20ij	9.55D	11.25d	9.30gh	8.00k	9.52D
B_1Se_2	11.50c	11.00d	9.00g	10.50C	11.70c	10.20e	8.25jk	10.05C
B_2Se_1	12.30b	11.40c	10.00e	11.23B	11.90c	11.30d	9.20jk	10.80B
B_2Se_2	13.52a	12.50b	11.00d	12.34A	12.70a	12.20b	11.40d	12.10A
Mean	10.19A	9.37B	7.84C		10.17A	8.97B	8.3C	

Se1(Selenium 2.0. mg/l), Se2 (Selenium4.0 mg/l), B 1(Boron 2.0 mg/l), B 2(Boron.4.0 mg/l).

Means values in the same row or column followed by the same letter are not significant at 5%.

Table 8: The effect of irrigation intervals and foliar application of Se and B on dry weight of roots of *Tipuana speciosa* seedlings during 2018/2019 and2019/2020

Treatments	Dry weight of roots (g)							
	4 day	8 day	16 day	Mean	4 day	8 day	16 day	Mean
	First season (2018/2019)				Second season (2019/2020)			
Control	2.70ij	2.30l	1.60n*	2.20H	2.40e-g	1.60kl	1.40l*	1.80G
B_1	2.75h-j	2.41kl	1.90m	2.35G	2.51ef	1.90ij	1.73jk	2.05F
B_2	2.80h-j	2.61jk	2.20l	2.54F	3.00d	1.94ij	1.80i-k	2.25E
Se_1	3.00f-h	2.65i-k	2.40kl	2.68E	3.30c	2.20gh	1.89ij	2.46D
Se_2	3.20ef	2.80h-j	2.57jk	2.86D	2.83d	2.35r-g	2.00hi	2.39D
B_1Se_1	3.50d	3.00f-h	2.77h-j	3.09C	3.90b	2.39e-g	2.20gh	2.83C
B_1Se_2	3.13e-g	3.30de	2.90g-i	3.11C	3.95b	2.55e	2.30fg	2.93BC
B_2Se_1	4.10b	3.77c	3.20ef	3.69B	4.00ab	2.80d	2.35e-g	3.05B
$B_2 Se_2$	4.50a	3.82c	3.50d	3.94A	4.20a	3.00d	2.85d	3.35A
Mean	3.30A	2.96B	2.56C		3.34A	2.30B	2.06C	

Se1(Selenium 2.0. mg/l), Se2 (Selenium4.0 mg/l), B 1(Boron 2.0 mg/l), B 2(Boron.4.0 mg/l).
Means values in the same row or column followed by the same letter are not significant at 5%.

As regard to the effect of foliar application of B and Se, data illustrated that all treatments significantly increased fresh and dry weights of shoots and roots as compared to control. On the other hand, increasing concentration of both B and/or Se significantly increased fresh and dry weights of shoots and roots in an ascending order as follows: B_1, B_2, Se_1, Se_2, B_1Se_1 , B_1Se_2 , B_2Se_1 and B_2Se_2, respectively in the same season.

The interaction between irrigation intervals and foliar application revealed that the treatment of B_2Se_2 significantly increased fresh and dry weights of shoots and roots as compared to all other treatments. These results were hold true in the second season.

Finally, these results showed that, reduced water content will interfere with normal physiological plant processes, so roots try to extend more deeply in the soil [26]. While, the reduction in other growth characters as result of prolonging irrigation regime might be expected since water deficit inhibited stem elongation and leaf enlargement, which in turn affect the size of photosynthesizing surface causing a reduction in growth of plants [27]. Also, these results are in harmony with Shafiq *et al.* [28] and Luo *et al*. [29] who mentioned that the plant height and all growth characters were found to be decreased under drought stress. Moreover, Farooq *et al*. [30] stated that the drought severely affects plant growth and development and this effect depends on the severity of stress and the crop growth stage.

About the significant positive effect of foliar application of (Se and/ or B) on all growth parameters compared with control non- sprayed, results of this research agreed with Djanagureaman *et al.* [31] and Yao *et al.* [32] who reported that the highest values in all growth parameters were recorded in plants sprayed with Se treatment of 4.0 mg/l either alone or combined with boron in all levels of irrigation. Also, in this respect, Valadabadi *et al.* [33] noted a significant increase in total dry weight of rapeseed cultivars when foliar sprayed with Se under water stress conditions. He mentioned that, this increase in root length and dry weight by Se application supports the fact that a significant relation exists between root length and seedling dry weight of water stressed seedlings [34]. The Se efficiency by foliar application may be due to its direct absorption and accumulation in the plants by diffusion from the surface of leaves to epidermal cell, but its high concentration can cause damage to leaf surface. Therefore concentration of solution at fertigation and foliar application of Se should be chosen with care based on r ecommendation of Habibi [13]. As regard boron as an essential micronutrient, it is responsible for stimulating cell division, biosynthesis and translocation of sugars, water and nutrients uptake and IAA biosynthesis [9].

Effect of Irrigation Intervals and Foliar Application of B and Se on Chemical Composition of *Tipuana speciosa*

Total Chlorophylls, Total Sugars (mg/g F.W) and Proline Content (mg/g D.W): Data in Table (9) exhibit the depressive effect of late irrigation (every 16 days) on total chlorophylls, which recorded (0.57mg/g F.W), compared to (0.66 mg/g F.W) in plants grown at 8 days irrigation interval, meanwhile irrigation every 4days recorded the highest content (0.72 mg/g F.W).This might be attributed to the depressive effect of stress conditions on the absorption of some ions which are involved in the chloroplast formation such as Mg and Fe which needed for chlorophyll formation [35].

Table 9: The effect of irrigation intervals and foliar application of B and Se on total chlorophylls, total sugars (mg/g F.W) and proline content (mg/g D.W) in shoots of *Tipuana speciosa* seedlings during 2019/2020

Character	Total chlorophyll (mg/g F.W)				Total sugars (mg/g F.W)				Proline (mg/g D.W)			
Treatments	4 day	8 day	16 day	Mean	4/day	8/day	16/day	Mean	4 day	8 day	16 day	Mean
Control	5.62E	0.55jk	0.50lm*	0.44n	5.40j	5.70d-g	5.75c-f	5.62E	0.24o	0.31l	0.35j*	0.30H
B_1	0.65gh	0.55jk	0.47mn	0.56H	5.50ij	5.72d-g	5.77b-f	5.66DE	0.25o	0.33k	0.39h	0.32G
B_2	0.67fg	0.63hi	0.51l	0.60G	5.55hi	5.75c-f	5.79b-f	5.70D	0.27n	0.35j	0.41g	0.34F
Se_1	0.70ef	0.66gh	0.53kl	0.63F	5.60g-i	5.75c-f	5.81a-f	5.72CD	0.29m	0.37i	0.43ef	0.36E
Se_2	0.72de	0.67fg	0.57j	0.65E	5.66f-h	5.78b-f	5.85k	5.43F	0.31l	0.39h	0.45cd	0.38D
B_1Se_1	5.82B	0.75cd	0.70ef	0.61i	5.88a-c	5.75c-f	5.83a-r	5.82B	0.33k	0.35j	0.47b	0.38D
B_1Se_2	0.77bc	0.72de	0.65gh	0.71C	5.70e-g	5.79b-f	5.86a-d	5.78BC	0.37i	0.38hi	0.46bc	0.40C
B_2Se_1	0.79b	0.75cd	0.67fg	0.74B	5.72d-g	5.82a-e	5.90a-c	5.81B	0.39h	0.41g	0.49a	0.43B
$B_2 Se_2$	0.79b	0.75cd	0.67fg	0.74B	5.88a-c	5.91ab	5.95a	5.91A	0.42fg	0.44de	0.50a	0.45A
Mean	0.72A	0.66B	0.57C		5.65C	5.77A	5.83 B		0.32C	0.37B	0.44A	

Se1(Selenium 2.0. mg/l), Se2 (Selenium4.0 mg/l), B 1(Boron 2.0 mg/l), B 2(Boron.4.0 mg/l).

Means values in the same row or column followed by the same letter are not significant at 5%.

Concerning the foliar application effect of B and Se on total chlorophylls, it is obvious that chlorophyll content increased in plants subjected to B and Se treatments either alone or together as compared to control. On the other hand, increasing concentration of both B and/or Se significantly increased chlorophyll content in an ascending order as the treatments were B_1, B_2, Se_1, Se_2 , B_1Se_1, B_1Se_2, B_2Se_1 and B_2Se_2 respectively in the same season. The positive effect of selenium in both water optimum and water deficit stress on increasing chlorophyll content, seemed that it can regulate the water status of plant under condition of water deficiency and thereby has a protective effect of water stress. It has been reported that selenium prevents chlorophyll degradation under stress conditions [10]. Also Fahad *et al*. [36] reported an enhanced leaf chlorophyll content as a result of foliar application of the micronutrients including B whereas, Mohsen *et al.* [37] reported that foliar application of B improved metabolism of the nutrients involved in chlorophyll biosynthesis and enhanced photosynthesis, they also, concluded that foliar application of B under different irrigation treatments was observed to improve the physiological characteristics and to enhance the drought-tolerance of plants.

For the interaction between irrigation intervals and foliar application, the combined treatment with B_2Se_2 significantly increased chlorophyll content as compared to all other treatments.

As regard total sugars (mg/g F.W) and proline (mg/g D.W) content, data in Table (9) revealed that, there is a general tendency to a progressive increase in total sugars and proline contents as a result of delayed irrigation interval at 16 days, which recorded 5.83 mg/g F.W of total sugars and 0.44 mg/g D.W of proline as compared to that of 8 days irrigation interval (5.77 mg/g F.W total sugars and 0.37 mg/g D.W proline) meanwhile at the 4 days irrigation interval the corresponding values were (5.65 and 0.32) .This finding is confirmed by the findings of other researchers who reported that drought stress played a direct role in raising leaf proline concentration Sinclair *et al*. [38] who observed more accumulated proline during drought stress as an avoidance mechanism to counteract the declining pressure potential in plant due to water deficiency. Proline plays a significant role in scavenging free radicals and in stabilizing biological membranes to regulate cell metabolism and growth in response to drought stress [39].

Also, data in Table (9) showed that foliar application of (Se and/or B) had a significant positive effect either individually or in combinations on, total sugars and proline content compared with control(non- sprayed). The best results were obtained with the mixture of $B_{2+}Se_2$ which recorded the highest values of both total sugars and proline. Moreover, foliar application of boron and selenium, due to their effects on increasing proline production, contributes to plant tolerance to drought stress and helps to maintain cell osmotic pressure. The role of selenium in increasing proline concentration might be due to the modifications induced by selenium in nitrogen assimilation [40]. Whereas, Badawy *et al.* [41] mentioned that increasing the concentration of proline in the Se treated potato plants could be attributed to the effect of selenium on altering the activity of some enzymes involved in the biosynthesis of proline.

In spite of increasing total sugars and proline contents with using mixed spray of B_{2+} Se_2 to the highest value, this increment is not considered significant when compared to other spray combinations or even to the lowest irrigation interval (4 days).

Table 10: The effect of irrigation intervals and foliar application of B and Se on N, P and K% in shoots of *Tipuana speciosa* seedlings during 2019/2020

Character	Nitrogen (%)				Phosphorus (%)				Potassium (%)			
Treatments	4day	8day	16day	Mean	4 day	8 day	16 day	Mean	4 day	8 day	16 day	Mean
Control	3.62i	3.22k	3.00l*	3.28G	0.31o	0.26q	0.21s	0.26I	2.92k	2.75l	2.20o*	2.62H
B_1	3.85h	3.50ij	3.3jk	3.56F	0.45ij	0.43k	0.24r	0.37H	3.15i	2.75l	2.23no	2.71G
B_2	4.40 b-d	4.25ef	3.23k	3.96E	0.46hi	0.44jk	0.25qr	0.38G	3.21hi	2.79l	2.27no	2.76F
Se_1	4. 50c-e	4.18fg	3.50ij	4.06E	0.47h	0.45ij	0.28p	0.40F	3.48d	3.25gh	2.30n	3.01E
Se_2	4.55bc	4.30d-f	4.00gh	4.28D	0.51f	0.49g	0.30o	0.43 E	3.62c	3.29fg	2.60m	3.17D
Be $_1Se_1$	4.56bc	4.35c-f	4.20ef	4.37CD	0.56 cd	0.53e	0.35n	0.48D	3.49d	3.33ef	2.77l	3.20D
B_1Se_2	4.56bc	4.41c-e	4.33d-f	4.43BC	0.57c	0.55d	0.39m	0.50C	3.71b	3.35ef	3.00j	3.35C
B_2Se_1	4.70ab	4.51b-d	4.35c-f	4.52AB	0.59b	0.56cd	0.41l	0.52B	3.79a	3.39e	3.15i	3.44B
B_2 Se_2	4.80a	4.56bc	4.40c-e	4.59A	0.70a	0.60b	0.45ij	0.58A	3.80a	3.60c	3.24gh	3.55A
Mean	4.39A	4.14B	3.81C		0.51A	0.48B	0.32C		3.46A	3.17B	2.64C	

Se1(Selenium 2.0. mg/l), Se2 (Selenium4.0 mg/l), B 1(Boron 2.0 mg/l), B 2(Boron.4.0 mg/l).
Means values in the same row or column followed by the same letter are not significant at 5%.

Table 11: The effect of irrigation intervals and foliar application of B and Se on Na and Cl % in shoots of *Tipuana speciosa* seedlings during 2019/2020

Character	Sodium (%)				Chloride (%)			
Treatments	4 day	8 day	16 day	Mean	4 day	8 day	16 day	Mean
Control	1.60d	1.82b	1.92a	1.78A	0.29bc	0.30b	0.33a	0.31A
B_1	1.50e	1.62d	1.80bc	1.64B	0.24ef	0.25e	0.30b	0.26B
B_2	1.47e	1.60d	1.75c	1.61C	0.24ef	0.25e	0.29bc	0.26B
Se_1	1.33gh	1.40f	1.60d	1.44D	0.23fg	0.24ef	0.28cd	0.25C
Se_2	1.24ij	1.30hi	1.40f	1.31E	0.22gh	0.24ef	0.28cd	0.25C
B_1Se_1	1.20jk	1.27ij	1.37fg	1.27F	0.23fg	0.23fg	0.27d	0.24C
B_1Se_2	1.15 jk	1.20hi	1.30hi	1.26F	0.21hi	0.22gh	0.24ef	0.22D
B_2Se_1	1.19kl	1.25jk	1.32gh	1.22G	0.20i	0.21hi	0.17j	0.19E
B_2 Se_2	1.11l	1.14kl	1.20jk	1.15H	14kl	0.15k	0.13l	0.14F
Mean	1.31C	1.40B	1.52A		0.22C	0.23B	0.25A	

Se1(Selenium 2.0. mg/l), Se2 (Selenium4.0 mg/l), B 1(Boron 2.0 mg/l), B 2(Boron.4.0 mg/l).
Means values in the same row or column followed by the same letter are not significant at 5%.

N, P and K (%D.W): Data presented in Table (10) indicated that prolonging irrigation intervals from 4 day to 8 and 16 days significantly decreased N, P and K % from (4.39, 0.51 and 3. 46%) , to (4.14., 0.48 and 3.17% D.W) and (3.81 , 0.32 and 2.64 % D.W) respectively.

As regard foliar application of B and Se application data illustrated that all treatments significantly increased N, P and K % as compared to control. On the other hand, increasing concentration of both B and/or Se significantly increased N, P and K % in an ascending order with following treatments B_1, B_2, Se_1, Se_2 , B_1Se_1, B_1Se_2, B_2Se_1 and B_2Se_2, respectively in the same season.

For the interaction between irrigation intervals and foliar application, the combined treatment of $B_{2+}Se_2$ significantly increased N, P and K % as compared to all other treatments.

Na and Cl (% D.W): Data presented in Table (11) indicated that, subjecting the seedlings to the prolonged irrigation intervals significantly increased Na and Cl % in an ascending order as Na recorded (1.40, 1.52%) and Cl recorded (0.23, 0.25%) with the treatments of 8 and16 days irrigation interval, respectively. As regard foliar application of B and Se data illustrated that all treatments significantly decreased Na and Cl% as compared to control. On the other hand, increasing the concentration of both B and/or Se significantly decreased Na and Cl% in a descending order as the treatments were B_1, B_2, Se_1, Se_2 , B_1Se_1, B_1Se_2, B_2Se_1 and B_2Se_2 respectively in the same season.

For the interaction between irrigation intervals and foliar application, the treatment of B_2Se_2 significantly decreased Na and Cl% as compared to all other treatments.

The previous results as shown in Tables (10 and11) were in agreement with that finding by Shallan *et al.* [42]; Zhang *et al.* [43] on cotton plants and Neseim *et al.* [44] on sugar beet plant, they reported that the Na concentration increased significantly in response to drought treatment compared to control plants, while N, P and K concentrations were decreased under drought conditions, as plants alter metabolic and physiological functions to minimize negative impacts and to maximize survival [45]. Also, it might be suggested that, drought reduced nutrient uptake among which N, P and K by roots and their transport from roots to shoots because of restricted transpiration rates impaired active transport and membrane permeability [46].

The obtained results, about foliar application of B and/or Se, that inhibited Na and Cl uptake and accelerated the accumulation of N, P and K were in agreement with Badawy *et al.* [41].

Finally, from all the previous results it can be mentioned that increased irrigation interval for the plants sprayed with Se_2 and B_2 resulted in improving all growth parameters and also its chemical composition, so water can be saved.

CONCLUSION

In this research we can conclude that prolonged irrigation time decreased all growth parameters of *Tipuana speciosa* except root length as well as total chlorophyll content and N, P, K percentages. But increased the contents of total sugars, proline, Na and Cl percentages. This reduction can be compensated with foliar application of selenium and/or boron which improved all growth parameters and the chemical composition. Generally, from the above mentioned results, of both seasons, we suggest that, selenium and boron combination each at 4.0mg/l can be used in water stress conditions to alleviate the hazardous effect of lack of water on *Tipuana speciosa* and to increase its ability to withstand drought stress.

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