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RESEARCH ARTICLE

Influence of mineral fertilization and different growing media on the growth and chemical composition of *Inga edulis* Mart. tree seedling

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Abstract

This study was carried out during the 2019 and 2020 seasons at the Agricultural Research Station of Al-Marashda to study the effect of three types of growing media and four levels of NPK fertilization on the growth characteristics and chemical composition of the seedlings of *Inga edulis* trees. The experiment comprised four NPK treatments; 0 (control), 1.5, 3, and 4.5g NPK/ pot. The applied growing media; sand, clay, and sand: clay (1:1 v/v). It was set in a split-plot design with four replicates; each contained four plastic pots. The main plot included the three growing media, the sub-plot included the four mineral fertilization treatments; to give 12 treatments. It's obvious that planting of *I. edulis* seedlings in the sand: clay growing medium resulted in the highest values of growth parameters. Regarding the effects of the used treatments on the leaf content of nitrogen, phosphorous, potassium, chlorophyll a & b, phenols, and flavonoids, it is clear that growing seedlings in the sand: clay mixture; with 4.5 g/ pot of NPK fertilization gives the highest values of these components. It can be concluded that to obtain vigorous seedlings with a high content of nutrients, phenols, and flavonoids of *Inga edulis*, they should be grown in a mixture of sand and clay (1: 1 v/v) with monthly fertilizing by 4.5 g/ pot of NPK.

Keywords: *Inga edulis*; mineral fertilization; growing media; phytochemical analysis.

1. Introduction

Genus *Inga* Mel. belongs to the leguminous family, which includes many plant species and has economic uses for reforestation, and has medicinal benefits for treatment, energy, and food production (Fernandes *et al.*, 2019). Also, leguminous trees are essential for fertilizing, forage, and producing wood, tannins, oils, and resins in the manufacture of varnishes, coatings, and dyes (LPWG, 2017). *Inga edulis* Mart. (inga), a tree locally known as pronjuk in Aswan is highly valued by farmers and can be used to improve soil fertility, high biomass production, and the ability to provide economically beneficial products (fruit and firewood). Moreover, the previous research on this tree species has proven that it can be used successfully in agroforestry systems. This fast-growing, acid soil-tolerant, nitrogen (N)-fixing tree is used to shade perennial crops like coffee and cocoa, provide firewood and charcoal, and produce sweet pulp suitable for human consumption (Weber *et al*., 1997). Researchers have also shown that *I. edulis* tree also serves as a source of green manure for alleys and other agroforestry systems. However, leaf litter protects the surface of the soil and the roots of other plants help to retain nutrients in the topsoil and helps for weed control and protection from erosion (Lawrence, 1993). Meanwhile, *Inga edulis* use as a medicinal plant for the treatment of inflammation, diarrhea, rheumatism, and arthritis has

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aroused interest in the study of its chemical composition of phenols and flavonoids (Lima *et al*., 2019; Benjamim *et al*., 2020). Also, leaves, seeds, and fruits have shown high antioxidant activities (Benjamim *et al*., 2020).

The successful production of seedlings in greenhouse and nurseries depends greatly on the chemical and physical characteristics of the growing media. An ideal growing media should be free of weeds and diseases, heavy enough to avoid frequent tipping, and light enough to facilitate handling and shipping. However, the growing media should be well-drained and maintain sufficient water to reduce the frequency of irrigation. Other parameters to consider in a growing media include cost, availability, consistency of batches, and consistency over time. Meanwhile, the selection of appropriate media components is critical to the successful production of seedlings (James and Michael, 2009).

Recently, the growth of seedlings in polyethylene bags in the nursery has increased dramatically, and this requires fertile soil as a growing medium for each plant species. The goal of the seedling producer is to raise good quality seedlings at a lower cost. Meanwhile, growing high-quality seedlings at low cost can only are achieved through extensive research and development of all aspects of nursery production, especially regarding soil fertility and plant nutrition. Therefore, it is important to maintain adequate fertility in the nursery soil to ensure high-quality production. Nitrogen, phosphorous, and potassium are highly specific nutrients for the growth of forest seedlings (Graciano *et al*., 2006). Also, fertilization increases the vegetative and root growth of plants, changes tissue content of nutrients, and improves rooting and growth of seedlings after the transplanting (Oliet *et al*., 2004).

Several studies have demonstrated that fertilization promotes the establishment and increases biomass production of tree species (Raich *et al*., 1996; Vitousek and Farrington, 1997; Singh and Singh, 2001). Moreover, Mahmoud *et al.* (2019) concluded that planting seeds of *Pistacia vera* in growing media contains loamy soil: sandy soil: vermiculite (2:1:1) produced maximum germination and enhance growth characteristics of seedlings. Also, Singh (2015) revealed that the height, diameter, and tree volume of *Leucaena leucocephala* were significantly greater in NPK fertilized plots compared to control plots. The addition of nitrogen and phosphorus to *Melia azedarach* seedlings resulted in a significant increase in plant height, fresh and dry weight of stem, root, and leaves, the ratio of roots to shoot, number of leaves/plants, and stem diameter (Rahman *et al*., 2017). Therefore, the objective of this research is to choose the best level of the used mineral fertilization and the best growth media which can maintain the most vigorous growth and chemical compositions of *Inga edulis* trees.

2. Material and Methods

The present work was carried out at Al-Marashda Agricultural Research Station – Qena, Agricultural Research Center, Egypt (26°9' N, 32° 42’ E) from 15th February to 15th August of 2019 and 2020 seasons. This research aimed to study the effects of different growing media under different NPK fertilization rates on the growth characteristics and chemical constituents of *Inga edulis* seedlings. The chemical analysis of the media is shown in Table (1). Three-month-old seedlings were planted in mid-February of 2019 and 2020 seasons in plastic pots 20 cm diameter: one seedling/pot. The average height of seedlings was 10-12 cm and each pot filed with three different growing media according to the treatment i.e. sand, clay, or the mixture between them in proportion1: 1 (v/v). The experiment comprised four NPK treatments; 0, 1.5, 3, and 4.5g NPK/ pot. The commercial NPK fertilizer Hyper Feed (19 – 19 – 19) was obtained from BIO NANO TECH company, Egypt. After one month from planting, seedlings were subjected monthly to the fertilization treatments and watering was done regularly according to the need of the plant in the morning by using a fine spray, which does not harm the seedlings. The Statistical Analyses of the experiment were set in a split-plot design with four replicates; each replicate contained four plastic pots. The main plot consisted of the three different growing media, while the sub-plot consisted of four mineral fertilization treatments; 0 (control), 1.5, 3, and 4.5 g NPK/ pot to give 12 treatments with 4 replicates. After 6 months from the start of the experiment for each season (fertilization application was 5 times per season), the following measurements were recorded: the plant height (cm), stem diameter (mm), stem fresh and dry weight (g), root length (cm), root fresh and dry weight (g) and leaves number /plant.

Table 1. The chemical analysis of the clay and sandy soil used as media for growing *Inga edulis* seedlings.

Soil type	E.C. (m.mohs /cm^3)	pH	P_2O_5%	Anion (meq/L.)			Cation (meq/L.)		
				HCO_3^-	Cl^-	SO_4^-	Ca^{++}	Mg^{++}	K^+
Clay	1.4	7.8	0.17	5.2	17.6	4.3	26.4	8.4	6.0
Sand	1.7	7.4	0.12	6.4	20.5	3.1	4.2	3.5	5.2

2.1. Chemical analysis

Leaves samples of *I. edulis* were oven-dried at 70 ºC until constant weight then finely ground and were subsequently used for chemical determination according to AOAC (1963). The nitrogen was determined according to the micro-Kjeldahl method (Jackson *et al*., 1991). Meanwhile, the phosphorus percentage was determined calorimetrically according to the method of Murphy and Reily (1962). The potassium percentage was flame photometrically determined using the method outlined by Peach and Tracey (1968). Also, pigments (chlorophyll a and b content) were determined in leaf samples (mg/g F.W.) according to Nornai (1982). On the other hand, the phytochemical constituents as phenols and flavonoids content were determined in the dry leaves of *I. edulis*.

2.2. Total phenols determination

Total phenols content was determined according to Cheng and Hanning (1955). A quantity of 5 g of ground dry leaves was homogenized in 15 ml ethanol 95% and boiled for 15 minutes. The homogenate was filtrated through Whatman No.1 filter paper. A quantity of 0.5 ml Folin-Denis reagent was added to 1 ml of the alcoholic extract and after 5 minutes, 7 ml saturated sodium carbonate solution was added, shaken, and left for 30 minutes. Optical density was measured at 750 nm and total phenols were calculated from a standard curve of gallic acid. Data were expressed as the mg gallic acid equivalents per gram of dry weight basis.

2.3. Determination of total flavonoids

Total flavonoid content was determined by using aluminum chloride colorimetric assay (Zhishen *et al.*, 1999). 0.5 mL of test samples solution in methanol (5mg/100ml) was mixed with 2ml of distilled water and 0.3 ml 5 % $NaNO_2$. After 5 min., 0.3 ml 10 % $AlCl_3$ and 2ml of 1 M NaOH were added and left at room temperature for 15 min. The solution was mixed well, and the absorbance was measured against the prepared reagent blank at 510 nm. Total flavonoid content expressed as mg catechin equivalents (CE)/100 g dry weight.

The collected data on the different parameters were compiled and tabulated for statistical analysis. The means were compared by using the least significant difference test (L.S.D.) at 5% level according to Snedecor and Cochran (1980).

3. Results and Discussion

3.1. Growing media and NPK effects on Inga edulis seedling growth

Tables 2 to 8 showed the effects of growing media and NPK levels on the plant height, stem diameter, stem fresh and dry weight, root fresh and dry weight as well as leaves number during 2019 and 2020 seasons. The growing media types were showed significant effects on growth characters in both seasons. Obtained results in the same tables pointed out the differences of the significant effects of NPK levels on the growth characters in both seasons. Growth measurements were gradually increased with the increasing the level of fertilization up to the higher level (4.5 g/seedling) in the two seasons. Nitrogen, phosphorus, and potassium nutrition are the most important factors that increase plant growth and production. These results agree with that of the previous studies (Conover and Pool, 1983; Mohammad *et al*., 2004; Karam *et al*., 2009; El-Sayed and Ismail, 2017). The highest values of growth parameters were recorded from the mixture of sand: clay (1:1 v/v) medium, while the lowest values were recorded with the sand as a growing media. The previous studies have been conducted on the use of growing media for raising better seedlings of different tree species. A wide range of numerous materials is used and mixed in different ratios for obtaining an appropriate growing media including clay, silt, sawdust, and sand which could yield good results as observed in our study. These results agree partially with other studies because of variation in materials (Rafiq and Samad, 2007; Mhango, 2008; Gülcü, 2010; Tariq, 2013; Waziri, 2015). Interaction effects of media and NPK on the growth parameters were significant as shown in Tables (2-8). The greatest plant height, stem diameter, stem fresh and dry weight, root fresh and dry weight, as well as leaves number, were recorded in plants treated with the mixture medium (sand: clay 1:1 v/ v) combined with the level of 4.5 g/ pot NPK, followed by the same media with 3 g/ pot NPK. Meanwhile, the minimum values of these characters were obtained from the sand medium with 0 NPK in the two seasons. These results are consistent with previous studies of Demirkiran and Cengiz (2010); Sarker *et al*. (2012) and Shekhany (2017).

3.2. Growing media and NPK effects on the chemical constitutes of I. edulis leaves

It is proved from the Tables (9- 13) that the use of different growing media had a significant effect on nitrogen, phosphorus, potassium, and chlorophyll a and b content of *I. edulis* seedlings. The maximum contents of these constitutes were observed underplanting in the mixture media (sand: clay 1:1 v/v) compared to the other media. Whereas the minimum contents of these constitutes were observed underplanting in sandy soil alone. The combined application between sand and clay soil provides adequate nutrients for *I. edulis* seedlings and enhancements both the physical and biological properties of growing media and water uptake capacity with its content from nutrients which reflected on increase metabolic processes efficiency and improving the leaves mineral content of the seedlings. Sarhan *et al.* (2017) showed that the highest leaf contents of chlorophyll a, b, leaf N, P, and K % were obtained from the most suitable media (sand + clay at 1:1 v/v). Also, Abd El ghafour *et al*. (2009) revealed that all chemical fertilization treatments increased N, P, and K percent in leaves as compared with control plants. Our results are in harmony with those obtained by Shamet *et al*. (1994) and AbouRayya *et al.* (2019). However, the enhancement in mineral contents and photosynthesis pigments might be due to the benefits of interactions between NPK fertilization and growing media contained sand: clay on improving soil texture, porosity, water holding capacity, soil temperature, and nutrient status in the medium which caused increased the growth parameters and thus produced seedlings with more growth of leaves and increased the mineral contents and photosynthesis pigments. These results agree with the findings of Okunomo *et al.* (2009) and AbouRayya *et al.* (2019).

3.3. Growing media and NPK effects on phenols and flavonoids composition of I. edulis leaves

It is proved from Figures 1 & 2 that the mixture media (sand: clay 1:1 v/v) resulted in the highest values of total phenols and flavonoids compared to the other media. The use of NPK fertilizer at 4.5 g/ seedling produced the highest values of their composition compared to other levels. Also, planting *I. edulis* seedlings in the mixed media with 4.5 g/ seedling NPK was increased phenols and flavonoids composition compared to the other treatments in the two seasons.

Table 2. Effect of the growing media and NPK fertilization on the plant height (cm) of *I. edulis* seedling during 2019 and 2020 seasons.

Treatments	2019				2020			
	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)	Sand	Sand: Clay (1:1 v/v)	Clay	Mean (B)
0 NPK/plant	35.6	54.2	45.1	45.0	33.3	52.9	40.5	42.3
1.5 g NPK/plant	51.3	67.9	62.6	60.6	51.1	65.2	58.3	58.2
3 g NPK/plant	56.5	78.2	70.2	68.3	58.4	80.3	69.7	69.4
4.5 g NPK/plant	61.2	94.0	89.4	81.6	65.5	93.1	77.8	78.8
Mean(A)	51.2	73.6	66.8		52.1	72.9	61.6	
LSD 5%	A=2.2 B=2.6 AB=4.5				A=1.8 B=2.1AB=3.7			

A: refers to NPK fertilization, B: the growing media, and AB the interaction between them

Table 3. Effect of the growing media and NPK fertilization on the stem diameter (mm) of *I. edulis* seedling during 2019 and 2020 seasons.

Treatments	2019				2020			
	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)
0 NPK/plant	2.92	3.73	3.06	3.24	2.56	3.07	3.10	2.91
1.5 g NPK/plant	3.26	4.24	3.80	3.77	2.76	3.95	3.74	3.48
3 g NPK/plant	3.83	5.17	4.30	4.43	3.45	4.27	4.08	3.93
4.5 g NPK/plant	4.48	5.40	4.85	4.91	3.82	5.05	4.34	4.40
Mean(A)	3.62	4.63	4.01		3.15	4.08	3.81	
LSD 5%	A=0.15 B=0. 17AB=N.S				A=0.10 B=0.11 AB=0.19			

A: refers to NPK fertilization, B: the growing media, and AB the interaction between them

Table 4. Effect of the growing media and NPK fertilization on the stem fresh weight (g) of *I. edulis* seedling during 2019 and 2020 seasons.

Treatments	2019				2020			
	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)
0 NPK/plant	146.7	171.1	162.1	160.0	152.9	177.6	163.8	164.8
1.5 g NPK/plant	193.1	288.7	227.0	236.3	194.3	280.9	232.9	236.0
3 g NPK/plant	259.1	305.4	261.1	275.2	256.4	310.6	273.0	280.0
4.5 g NPK/plant	273.6	330.6	287.0	297.1	271.2	329.8	286.8	296.0
Mean(A)	218.1	274.0	234.3		218.1	274.0	234.3	
LSD 5%	A=5.84 B=6.74 AB=11.67				A=3.42 B=3.95 AB=6.85			

A: refers to NPK fertilization, B: the growing media, and AB the interaction between them

Table 5. Effect of the growing media and NPK fertilization on the stem dry weight (g) of *I. edulis* seedling during 2019 and 2020 seasons.

Treatments	2019				2020			
	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)
0 NPK/plant	59.6	74.3	61.9	65.3	53.9	69.8	59.8	61.2
1.5 g NPK/plant	66.2	83.2	66.8	72.1	58.3	78.8	64.4	67.1
3 g NPK/plant	72.2	95.5	76.3	81.3	66.3	91.5	70.9	76.3
4.5 g NPK/plant	77.2	104.7	83.3	88.4	73.6	100.7	83.4	85.9
Mean(A)	68.8	89.4	.721		63.0	85.2	69.6	
LSD 5%	A=1.85 B=2.14 AB=3.70				A=1.58 B=1.83 AB=3.17			

A: refers to NPK fertilization, B: the growing media, and AB the interaction between them

Table 6. Effect of the growing media and NPK fertilization on the root fresh weight (g) of *I. edulis* seedling during 2019 and 2020 seasons.

Treatments	2019				2020			
	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)
0 NPK	52.9	57.6	54.8	55.1	53.5	63.0	58.2	58.2
1.5 g NPK/ plant	60.6	67.9	63.3	63.9	58.1	72.4	67.0	65.8
3 g NPK/ plant	63.3	78.9	71.8	71.3	65.1	82.5	74.5	74.0
4.5 g NPK/ plant	69.9	92.9	81.8	81.5	74.8	95.4	85.5	85.2
Mean(A)	61.7	74.3	67.9		62.9	78.3	71.3	
LSD 5%	A=2.09 B=2.41 AB=4.18				A=0.9 B=1.07 AB=1.85			

A: refers to NPK fertilization, B: the growing media, and AB the interaction between them

Table 7. Effect of the growing media and NPK fertilization on the root dry weight (g) of *I. edulis* seedling during 2019 and 2020 seasons.

Treatments	2019				2020			
	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)
0 NPK	20.0	25.5	23.4	23.0	22.4	27.2	24.1	24.6
1.5 g NPK/ plant	23.4	31.5	27.1	27.3	26.7	32.2	28.4	29.1
3 g NPK/ plant	26.3	39.6	32.0	32.6	31.8	38.4	34.8	35.0
4.5 g NPK/ plant	28.6	53.3	41.6	41.2	35.3	56.9	42.8	45.0
Mean(A)	24.6	37.5	31.0		29.1	38.7	32.5	
LSD 5%	A=1.30 B=1.50 AB=2.60				A=1.16 B=1.34 AB=2.33			

A: refers to NPK fertilization, B: the growing media, and AB the interaction between them

Table 8. Effect of the growing media and NPK fertilization on the leaves number of *I. edulis* seedlings during 2019 and 2020 seasons.

Treatments	2019				2020			
	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)
0 NPK	13.8	23.5	17.8	18.4	15.7	22.2	18.1	18.6
1.5 g NPK/ plant	16.8	31.9	23.8	24.2	19.3	28.6	22.1	23.3
3 g NPK/ plant	21.5	36.2	29.3	29.0	24.5	32.9	26.3	27.9
4.5 g NPK/ plant	24.5	41.4	32.4	32.8	26.4	37.3	32.8	32.2
Mean(A)	19.2	33.3	29.9		21.5	30.2	24.8	
LSD 5%	A=0.96 B=1.11 AB=1.92				A=1.22 B=1.41 AB=N.S			

A: refers to NPK fertilization, B: the growing media, and AB the interaction between them

Table 9. Effect of the growing media and NPK fertilization on nitrogen % in leaves of *I. edulis* seedling during 2019 and 2020 seasons.

Treatments	2019				2020			
	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)
0 NPK	0.71	0.95	0.85	0.84	0.64	0.85	0.73	0.74
1.5 g NPK/ plant	0.78	1.08	0.94	0.93	0.75	0.93	0.84	0.84
3 g NPK/ plant	0.89	1.28	1.06	1.08	0.85	1.21	0.95	1.00
4.5 g NPK/ plant	0.95	1.40	1.27	1.21	0.95	1.46	1.24	1.22
Mean(A)	0.83	1.18	1.03		0.79	1.11	0.94	
LSD 5%	A=0.03 B=0.04 AB=0.06				A=0.02 B=0.03 AB=0.04			

A: refers to NPK fertilization, B: the growing media, and AB the interaction between them

Table 10. Effect of the growing media and NPK fertilization on phosphorus % in leaves of *I. edulis* seedling during 2019 and 2020 seasons.

Treatments	2019				2020			
	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)
0 NPK	0.11	0.15	0.13	0.13	0.11	0.15	0.12	0.13
1.5 g NPK/ plant	0.12	0.18	0.14	0.14	0.12	0.17	0.14	0.14
3 g NPK/ plant	0.13	0.21	0.16	0.17	0.13	0.18	0.15	0.16
4.5 g NPK/ plant	0.14	0.26	0.18	0.19	0.14	0.24	0.17	0.18
Mean(A)	0.12	0.20	0.15		0.13	0.18	0.15	
LSD 5%	A=0.005 B=0.006 AB=0.010				A=0.003 B=0.004 AB=0.006			

A: refers to NPK fertilization, B: the growing media, and AB the interaction between them

Table 11. Effect of the growing media and NPK fertilization on potassium % in leaves of *I. edulis* seedling during 2019 and 2020 seasons.

Treatments	2019				2020			
	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)
0 NPK	1.19	1.39	1.30	1.29	1.15	1.33	1.26	1.24
1.5 g NPK/ plant	1.33	1.69	1.43	1.48	1.23	1.39	1.32	1.31
3 g NPK/ plant	1.54	1.80	1.62	1.65	1.33	1.51	1.41	1.42
4.5 g NPK/ plant	1.64	1.81	1.70	1.72	1.44	1.69	1.48	1.53
Mean(A)	1.42	1.67	1.51		1.28	1.48	1.37	
LSD 5%	A=0.035 B=0.041 AB=0.07				A=0.039 B=0. 045 AB=N.S			

A: refers to NPK fertilization, B: the growing media, and AB the interaction between them

Table 12. Effect of the growing media and NPK fertilization on chlorophyll an (mg/g fresh weight) in leaves of *I. edulis* seedling during 2019 and 2020 seasons.

Treatments	2019				2020			
	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)
0 NPK/ plant	0.350	0.473	0.403	0.409	0.390	0.480	0.423	0.431
1.5 NPK/ plant	0.417	0.577	0.470	0.488	0.570	0.683	0.603	0.619
3 NPK/ plant	0.530	0.733	0.593	0.619	0.627	0.793	0.703	0.708
4.5 NPK/ plant	0.683	0.837	0.763	0.761	0.717	0.870	0.747	0.778
Mean(A)	0.495	0.655	0.558		0.576	0.707	0.619	
LSD 5%	A=0.018 B=0.021 AB=0.036				A=0.017 B=0.020 AB=0.035			

A: refers to NPK fertilization, B: the growing media, and AB the interaction between them

Table 13. Effect of the growing media and NPK fertilization on chlorophyll b (mg/g fresh weight) in leaves of *I. edulis* seedling during 2019 and 2020 seasons.

Treatments	2019				2020			
	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)	Sand	Sand: clay (1:1 v/v)	Clay	Mean (B)
0 NPK	0.157	0.257	0.190	0.201	0.203	0.277	0.233	0.238
1.5 gNPK/plant	0.213	0.330	0.253	0.266	0.253	0.323	0.283	0.287
3 gNPK/plant	0.250	0.380	0.303	0.311	0.303	0.357	0.313	0.324
4.5g NPK/plant	0.313	0.420	0.347	0.360	0.323	0.417	0.360	0.367
Mean(A)	0.233	0.347	0.273		0.271	0.343	0.298	
LSD 5%	A=0.01 B=0. 019 AB=N.S				A=0.014 B=0. 016 AB=N.S			

A: refers to NPK fertilization, B: the growing media, and AB the interaction between them

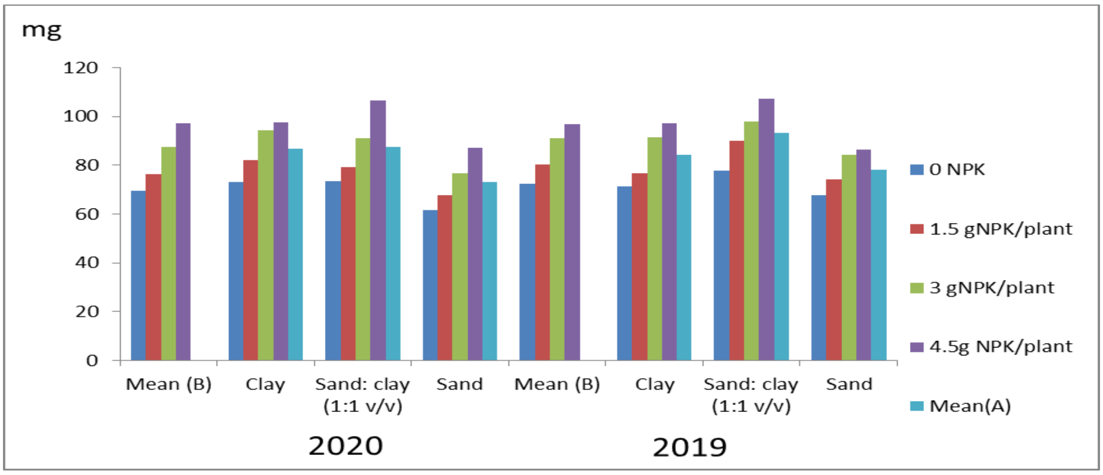

Fig 1. Effect of the growing media and NPK fertilization on phenols content (mg/g dry weight) in leaves of *I. edulis* seedling during 2019 and 2020 seasons.

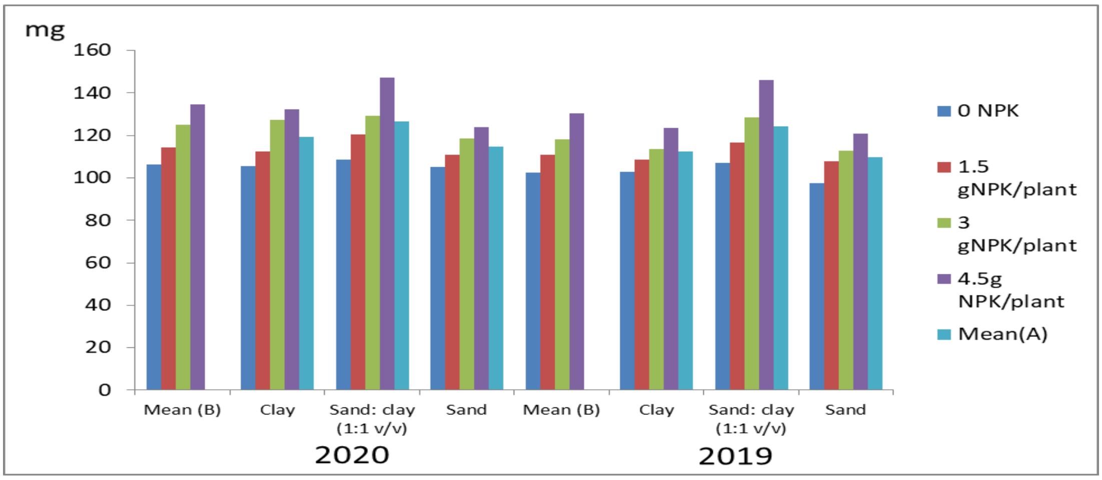

Fig 2. Effect of the growing media and NPK fertilization on flavonoid content (mg/100g dry weight) in leaves of *I. edulis* seedling during 2019 and 2020 seasons.

The application of NPK fertilizers significantly increased total phenols and flavonoids compared to those of control. However, the increment was gradually increased with NPK levels up to 4.5 g/ seedlings. Similar results were recorded by Heimler *et al.* (2006). These results indicated that fertilization has a stimulatory effect on the accumulation of phenols and flavonoids in plant leaves and these results agreed with those obtained by Kwami *et al*. (2003); Ogbunugafor *et al*. (2011); Singh *et al*. (2015); Sousa *et al*. (2008). On the other hand, in winter grain (Ma *et al*., 2015), total phenolic content decreases concerning the absence of nitrogen fertilization, while when N-fertilization is applied, increasing nitrogen amount involved increased polyphenols content. Total phenolic and flavonoids were enhanced with the organic and inorganic fertilizer treatment compared to the control (Ibrahim *et al*., 2013). Attia *et al*. (2014) studied the effect of mineral, organic, and bio-fertilization on the productivity of moringa and pointed out that the yield components of moringa trees increased with the increase of NPK fertilizers rates and integration between fertilization types. This result was a positive reflex on nutrients, total antioxidants, and total phenols in leaves and seeds of moringa trees.

4. Conclusion

From our results, it could be concluded that to produce vigorous seedlings with a good quality of *Inga edulis* trees for the different purposes showed be grown in the mix of sand: clay (1: 1 v/v) and applying 4.5g/pot NPK fertilizer (19 – 19 – 19) during the growing season.

5. References

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