

EFFECT OF CUTTING HEIGHTS AND MINERAL NPK AND/OR BIOFERTILIZATION TREATMENTS ON *MORINGA OLEIFERA*, L. PLANTS

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ABSTRACT: This study was conducted in Hort. Dept., Fac. Agric., Minia Univ. in the two successive seasons of 2015 and 2016 on *Moringa* to study the effect of cutting heights (10, 20, 30 and 40 cm) and fertilization on yield productivity and chemical constituents of the plants.

Data indicated that cut plant at 10 cm was superior than other treatments on increasing branch numbers, fresh and dry weights/plant/cut and total yield/plant/season, as well as, total carbohydrates, protein and vit. C %. All used six fertilization treatments significantly increased all vegetative growth parameters and chemical constituents as compared with control. The best treatments were NPK (100 %) and bio. + 75 % NPK.

It could be recommended to cut *Moringa oleifera* at 10 cm above soil surface and fertilizing plants with bio. + 75 % NPK dose to obtain a good production biomass and high quality.

Key words: *Moringa oleifera*, cutting, fertilization, NPK, bio-fertilization.

INTRODUCTION

Moringa oleifera, L. (Family Moringaceae) is the most widely cultivated species of the genus *Moringa*, it is fast growing, considered one of the world's most useful trees as every part of the tree can be used either for food or has other beneficial properties and as a fodder for livestock (Morton, 1991; Anwar *et al.*, 2007 and Nouman *et al.*, 2012).

Few studies about the height this plant should be harvested to get good yields and biomass quality are available. *Moringa* has high speed and regrowth capacity, further cuts are suggested to be 10 to 40 cm above soil surface to obtain a high yield in production of fresh biomass (Reyes, 2006; Foidl *et al.*, 2011; Santiesteban *et al.*, 2012 and Padilla *et al.*, 2014).

Biofertilizers are considered to be low cost, eco-friendly are renewable sources of

plant nutrients supplementing chemical fertilizers in sustainable agricultural system (Hedge *et al.*, 1999). A good number of researchers concluded that biofertilizers enhanced the growth and quality of mass production of *Moringa* (Dash and Gupta, 2009; Asaolu *et al.*, 2012; Zayed, 2012; Darwish, 2015 and Mosaad, 2016).

Chemical nutrients especially N, P and K are very important for plants, because NPK increased plant growth and chemical constituents as emphasized by Dash and Gupta (2009); Fagbenro *et al.* (2013); Abdullahi *et al.* (2013); Umar (2014); Darwish (2015) and Mosaad (2016) on *Moringa*.

The objective of this research was to determine the best height of cutting and *Moringa oleifera* fertilization.

MATERIALS AND METHODS

The experiment was carried out during the two successive seasons of 2015 and 2016 at the Floriculture Nursery at the Experimental Farm and in the Laboratory of Floriculture and Food Industries Department, Fac. of Agric., Minia Univ. to investigate the effect of cut height and bio. and/or mineral NPK fertilization treatments, as well as, their interaction on growth and chemical constituents of *Moringa oleifera* grown in sandy calcareous soil. The seeds of *Moringa oleifera* Lam. were obtained from Nursery of Ornamental Plants Division, Horticulture Department, Faculty of Agriculture, Minia University. Physical and chemical properties of the used soil in both seasons were determined according to Jackson (1973) and are shown in Table (a).

The experiment was arranged in a randomized complete block design in a split-plot design with three replicates each replicate containing 3 seedlings. The main plots (A) included four levels of cutting heights, while, seven biofertilizers and/or mineral NPK fertilization treatments (B) occupied the sub-plots, therefore, the interaction treatments (A×B) were 28 treatments.

Treatments:

The main-plots (A) were as follows: Cutting heights at 10, 20, 30 and 40 cm above soil surface.

The sub-plots (B) were as follows: Control (without fertilizer), 100 % NPK as recommended dose (Abdou *et al.*, 2016), 75% NPK, 50% NPK, biofertilizers (Minia Azotein + phosphorein), biofertilizers + 75% NPK and biofertilizers + 50% NPK.

Data recorded:

Number of branches per plant, fresh and dry weights of aerial parts/cut and yield of Moringa fresh and dry weights/season, as well as, total carbohydrates % according to (Michel *et al.*, 1956), protein % (Wilde *et al.*, 1985 to determined N %, then N % was multiplied by 6.25 to obtain protein %) and vit. C (Roe and Keuther, 1953).

Seeds were sown in the first day of March for both seasons in containers (25×25×35 cm) each filled with 20 kg of sandy calcareous soil plus 20 g of compost in the Nursery of Ornamental Plants, each container contain three seeds and seedlings were thinned to one seedling/container after four weeks from sowing date (28th March).

Fresh and active biofertilizers, Minia Azotein (M.A., containing N-fixing bacteria) and phosphorein (containing phosphate dissolving bacteria) were obtained from the Laboratory of Biofertilizers, Department of Genetic, Fac. of Agric., Minia University. Biofertilizers were applied three times to the soil beside the plants at the rate of 50 cm³/hill (1 ml=10⁷ cells of bacteria).

Table a. Physical and chemical properties of the used soil.

Character	Value		Character	Value	
	2015	2016		2015	2016
Sand %	88.00	89.00	Total N %	0.02	0.02
Silt %	8.30	7.40	Available P %	3.25	3.56
Clay %	3.70	3.60	Extr. K (mg/100 g soil)	0.90	1.01
Texture	Sandy	Sandy			
CaCO ₃ %	14.42	14.91	Fe	1.10	1.18
pH (1 : 2.5)	8.17	8.21	DTPA	0.39	0.43
Organic matter %	0.06	0.05	Ext. ppm	Zn	0.36
E.C. (m mhos/cm)	1.09	1.11		Mn	0.60
					0.71

The first dose, for both M.A. and phos. was added 32 days from sowing date (2nd April) and repeated 60 days thereafter (2nd June and 2nd August) and then plants were irrigated immediately. All other agricultural practices were performed as usual.

Mineral NPK was used as 6 g/container of ammonium sulphate (20.50% N) (equal 300 kg/fed), 3 g/container calcium superphosphate (15.5% P₂O₅) (equal 150 kg/fed) and 1.5 g/container potassium sulphate (48% K₂O) (equal 75 kg/fed) for the treatment of 100% mineral NPK. For 75% mineral NPK was represented by 4.5, 2.25 and 1.125 g/container. Also, 50% mineral NPK was 3, 1.5 and 0.75 g/container of the above mentioned three fertilizers.

The amounts of NK were divided to three equal batches and added after 7 days from each biofertilizers treatment (9 April, 9 June and 9 August). All amounts of P were added during preparing the soil to sow the seeds for each season.

During each experimental season the plants were harvested three times. In each harvest, the plants were cut leaving about 10, 20, 30 and 40 cm above the soil surface according to the treatments occupied in the main plots. The first cut was done on 1st of June. Meanwhile, the second cut was done on 1st of August and the third cut was done October 1st in the two growing seasons.

The obtained data were tabulated and statistically analyzed according to MSTAT-C (1986) and the L.S.D. test at 5 % was followed to compare between the means.

RESULTS AND DISCUSSION

1- Vegetative growth parameters:

Data presented in Tables (1 to 8) indicated that number of branches/cut, fresh and dry weights/cut and yield of aerial parts of *Moringa oleifera*/season) were statistically influenced by cutting height either during the three cuts or during the first and second seasons. The highest values were obtained when plants were cut at 10 cm high.

The increase in yield production with decreasing cutting height can possibly be attributed to the fact that plants harvested at 10 cm high contain much more branches. Hence, the 10 cm cut was the higher quality as reflected in the higher production. Similar results were obtained by Reyes (2006); Padilla *et al.* (2014) and Lawal *et al.* (2015) on *Moringa oleifera*.

Concerning the effect mineral NPK and/or biofertilization treatments, data in Tables (1 to 6) indicated that all used six treatments significantly increased number of branches/cut, aerial parts fresh and dry weights/plant comparing with control during the three cuts, consequently the total yield of *Moringa* either fresh or dry weights per season as shown in Tables (7 and 8). The highest values were obtained with mineral NPK (full dose) or bio. + 75% NPK in both seasons. Similar results were obtained by Dash and Gupta (2009); Fagbenro *et al.* (2013) and Mosaad (2016) on *Moringa*, Kohan *et al.* (2000) on poplar and Singh (2015) on *Leucaena leucocephala*, concerning the effect of mineral NPK. Biofertilization treatments were effective on increasing number of branches and fresh and dry weights production as reported by Dash and Gupta (2009), Zayed (2012) and Darwish (2015) on *Moringa*, Moustafa (2008) on *Chorisia speciosa*, Abdou and Ashour (2012) on jojoba and Soliman *et al.* (2015) on *Delonix regia*.

The interaction between main and sub plots (A×B) was significant for number of branches, fresh and dry weights/cut and yield of *Moringa oleifera* per season (Tables, 1 to 8). The best interaction treatments were obtained when *Moringa* was cut at 10 cm above soil surface and fertilized with bio. + 75 % NPK dose or mineral NPK at full dose.

2- Chemical constituents:

Data presented in Tables (9 and 10) indicated that cutting heights had no significant effects on total carbohydrates and protein % in *Moringa* leaves. For vit. C

Table 1. Effect of cutting heights and some bio. and/or mineral NPK fertilization treatments on number of branches/plant of moringa during 2015 season.

1st Cut					
Some bio. and/or mineral fertilization treatments (B)	Cutting heights (cm) (A)				Mean (B)
	10	20	30	40	
Control	6.0	4.3	2.3	2.0	3.7
NPK 100%	14.3	12.3	10.0	8.7	11.3
NPK 75%	12.3	9.7	8.0	6.0	9.0
NPK 50%	9.0	7.0	4.7	4.0	6.2
Bio.	7.7	5.7	3.7	3.0	5.0
Bio. + NPK 75%	13.3	11.0	9.0	7.7	10.3
Bio. + NPK 50%	10.0	8.3	6.0	5.0	7.3
Mean (A)	10.4	8.3	6.2	5.2	7.5
L.S.D. at 5%	A : 2.1		B : 0.5		AB : 1.0
2nd Cut					
Control	8.0	7.0	4.7	2.3	5.5
NPK 100%	16.0	14.3	13.0	10.7	13.5
NPK 75%	13.7	12.3	10.0	7.7	10.9
NPK 50%	11.0	9.7	8.0	5.3	8.5
Bio.	9.7	8.7	6.7	4.3	7.3
Bio. + NPK 75%	15.0	13.3	11.3	8.7	12.1
Bio. + NPK 50%	12.0	11.3	9.0	6.7	9.8
Mean (A)	12.2	11.0	9.0	6.5	9.7
L.S.D. at 5%	A : 1.5		B : 0.5		AB : 1.0
3rd Cut					
Control	10.0	9.0	7.0	4.3	7.6
NPK 100%	18.0	17.3	15.0	11.0	15.3
NPK 75%	16.0	15.0	12.7	9.0	13.2
NPK 50%	13.0	11.7	10.0	7.0	10.4
Bio.	12.0	10.7	9.0	6.0	9.4
Bio. + NPK 75%	17.0	16.0	13.7	10.0	14.2
Bio. + NPK 50%	14.0	13.0	11.3	8.0	11.6
Mean (A)	14.3	13.2	11.2	7.9	11.7
L.S.D. at 5%	A : 0.8		B : 0.3		AB : 0.6

Bio. : Biofertilizers (Minia Azotein + phosphorein)

Table 2. Effect of cutting heights and some bio. and/or mineral NPK fertilization treatments on number of branches/plant of moringa during 2016 season.

1st Cut					
Some bio. and/or mineral fertilization treatments (B)	Cutting heights (cm) (A)				Mean (B)
	10	20	30	40	
Control	5.7	4.0	2.3	1.7	3.4
NPK 100%	14.7	13.7	13.0	9.7	12.8
NPK 75%	12.0	10.0	7.7	7.0	9.2
NPK 50%	9.0	7.0	5.0	4.3	6.3
Bio.	7.7	6.0	3.7	3.0	5.1
Bio. + NPK 75%	13.3	11.0	9.7	8.0	10.5
Bio. + NPK 50%	10.0	8.7	6.3	6.0	7.8
Mean (A)	10.3	8.6	6.8	5.7	7.9
L.S.D. at 5%	A : 1.5		B : 0.8		AB : 1.6
2nd Cut					
Control	8.7	8.0	6.7	5.0	7.1
NPK 100%	18.0	16.7	14.7	12.0	15.3
NPK 75%	15.3	14.0	11.7	9.7	12.7
NPK 50%	12.3	11.3	9.7	7.3	10.2
Bio.	11.0	10.3	8.3	6.0	8.9
Bio. + NPK 75%	16.7	15.7	13.0	10.7	14.0
Bio. + NPK 50%	14.0	13.0	10.7	8.7	11.6
Mean (A)	13.7	12.7	10.7	8.5	11.4
L.S.D. at 5%	A : 0.9		B : 0.8		AB : 1.6
3rd Cut					
Control	10.7	9.7	7.3	5.0	8.2
NPK 100%	19.0	17.7	15.3	12.0	16.0
NPK 75%	16.7	15.0	13.3	10.0	13.8
NPK 50%	13.3	12.3	11.0	7.3	11.0
Bio.	12.3	11.0	10.0	6.3	9.9
Bio. + NPK 75%	18.0	16.0	14.3	11.0	14.8
Bio. + NPK 50%	14.7	13.7	12.0	9.0	12.3
Mean (A)	15.0	13.6	11.9	8.7	12.3
L.S.D. at 5%	A : 1.1		B : 0.4		AB : 0.8

Bio. : Biofertilizers (Minia Azotein + phosphorein)

Table 3. Effect of cutting heights and some bio. and/or mineral NPK fertilization treatments on fresh weight (kg) of moringa during 2015 season.

Some bio. and/or mineral fertilization treatments (B)	1 st Cut				Mean (B)
	Cutting heights (cm) (A)				
	10	20	30	40	
Control	4.25	1.66	1.62	0.74	2.07
NPK 100%	12.92	6.14	5.66	3.14	6.97
NPK 75%	8.56	3.75	3.56	2.28	4.54
NPK 50%	4.85	1.92	1.88	1.82	2.62
Bio.	4.54	1.83	1.80	1.60	2.44
Bio. + NPK 75%	13.16	5.56	5.38	3.61	6.93
Bio. + NPK 50%	6.68	3.10	2.91	2.19	3.72
Mean (A)	7.85	3.42	3.26	2.20	4.18
L.S.D. at 5%	A : 0.10		B : 0.12		AB : 0.24
	2 nd Cut				
	Cutting heights (cm) (A)				
	10	20	30	40	
Control	4.54	1.79	1.77	1.62	2.43
NPK 100%	11.41	7.48	7.31	4.37	7.64
NPK 75%	7.68	4.64	4.63	3.38	5.08
NPK 50%	5.40	2.86	2.83	2.75	3.46
Bio.	5.09	2.82	2.46	2.42	3.20
Bio. + NPK 75%	12.43	6.44	6.34	4.80	7.50
Bio. + NPK 50%	5.85	4.27	3.31	3.09	4.13
Mean (A)	7.49	4.33	4.09	3.20	4.78
L.S.D. at 5%	A : 0.20		B : 0.51		AB : 1.02
	3 rd Cut				
	Cutting heights (cm) (A)				
	10	20	30	40	
Control	5.54	2.69	2.46	2.03	3.18
NPK 100%	11.79	8.14	7.69	5.50	8.28
NPK 75%	8.68	5.36	5.25	4.82	6.03
NPK 50%	6.64	3.73	3.66	3.30	4.33
Bio.	6.38	3.23	3.06	2.85	3.88
Bio. + NPK 75%	12.64	6.86	6.72	5.90	8.03
Bio. + NPK 50%	7.46	4.62	4.22	3.94	5.06
Mean (A)	8.45	4.95	4.72	4.05	5.54
L.S.D. at 5%	A : 0.67		B : 0.43		AB : 0.86

Bio. : Biofertilizers (Minia Azotein + phosphorein)

Table 4. Effect of cutting heights and some bio. and/or mineral NPK fertilization treatments on fresh weight (kg) of moringa during 2016 season.

1st Cut					
Some bio. and/or mineral fertilization treatments (B)	Cutting heights (cm) (A)				Mean (B)
	10	20	30	40	
Control	5.29	2.74	2.10	1.84	2.99
NPK 100%	13.00	11.16	9.67	8.23	10.52
NPK 75%	9.59	7.67	7.00	4.73	7.25
NPK 50%	5.92	3.17	3.07	2.98	3.79
Bio.	5.61	2.94	2.80	2.69	3.51
Bio. + NPK 75%	12.22	11.60	9.60	5.96	9.85
Bio. + NPK 50%	7.74	6.33	6.00	4.15	6.06
Mean (A)	8.48	6.52	5.75	4.37	6.28
L.S.D. at 5%	A : 0.72		B : 0.53		AB : 1.06
2nd Cut					
Control	8.67	8.00	3.78	3.59	6.01
NPK 100%	12.52	8.38	8.15	6.11	8.79
NPK 75%	8.03	5.97	5.86	5.23	6.27
NPK 50%	6.31	5.22	4.53	4.52	5.15
Bio.	6.03	4.13	4.00	3.93	4.52
Bio. + NPK 75%	12.79	8.33	7.38	6.55	8.76
Bio. + NPK 50%	6.80	5.79	5.50	4.70	5.70
Mean (A)	8.74	6.55	5.60	4.95	6.46
L.S.D. at 5%	A : 0.38		B : 0.56		AB : 1.12
3rd Cut					
Control	5.61	3.97	3.91	3.81	4.33
NPK 100%	13.23	8.96	8.95	6.56	9.43
NPK 75%	8.54	6.14	5.84	5.24	6.44
NPK 50%	6.75	4.84	4.55	4.53	5.17
Bio.	6.40	4.53	4.26	4.08	4.82
Bio. + NPK 75%	14.03	7.99	7.03	8.21	9.32
Bio. + NPK 50%	7.62	5.44	5.24	4.95	5.81
Mean (A)	8.88	5.98	5.68	5.34	6.47
L.S.D. at 5%	A : 0.52		B : 0.40		AB : 0.80

Bio. : Biofertilizers (Minia Azotein + phosphorein)

Table 5. Effect of cutting heights and some bio. and/or mineral NPK fertilization treatments on dry weight (kg) of moringa during 2015 season.

Some bio. and/or mineral fertilization treatments (B)	1 st Cut				Mean (B)
	Cutting heights (cm) (A)				
	10	20	30	40	
Control	1.56	0.61	0.60	0.27	0.76
NPK 100%	3.83	2.63	2.45	1.34	2.56
NPK 75%	3.15	1.38	1.31	0.84	1.67
NPK 50%	1.78	0.71	0.69	0.67	0.96
Bio.	1.67	0.67	0.66	0.59	0.90
Bio. + NPK 75%	4.84	2.04	1.97	1.33	2.55
Bio. + NPK 50%	2.46	1.14	1.07	0.81	1.37
Mean (A)	2.76	1.31	1.25	0.84	1.54
L.S.D. at 5%	A : 0.26		B : 0.51		AB : 1.02
	2 nd Cut				
Control	1.67	0.66	0.65	0.60	0.90
NPK 100%	4.19	2.75	2.69	1.61	2.81
NPK 75%	2.82	1.71	1.70	1.24	1.87
NPK 50%	1.99	1.05	1.04	1.01	1.27
Bio.	1.87	1.04	0.90	0.89	1.18
Bio. + NPK 75%	4.56	2.37	2.33	1.77	2.76
Bio. + NPK 50%	2.15	1.57	1.22	1.14	1.52
Mean (A)	2.75	1.59	1.50	1.18	1.76
L.S.D. at 5%	A : 0.10		B : 0.19		AB : 0.38
	3 rd Cut				
Control	2.04	0.99	0.90	0.75	1.17
NPK 100%	4.33	2.99	2.83	2.02	3.04
NPK 75%	3.19	1.97	1.93	1.77	2.22
NPK 50%	2.44	1.37	1.35	1.21	1.59
Bio.	2.35	1.19	1.13	1.05	1.43
Bio. + NPK 75%	4.64	2.52	2.47	2.17	2.95
Bio. + NPK 50%	2.74	1.70	1.55	1.45	1.86
Mean (A)	3.10	1.82	1.74	1.49	2.04
L.S.D. at 5%	A : 0.12		B : 0.16		AB : 0.32

Bio. : Biofertilizers (Minia Azotein + phosphorein)

Table 6. Effect of cutting heights and some bio. and/or mineral NPK fertilization treatments on dry weight (kg) of moringa during 2016 season.

1st Cut					
Some bio. and/or mineral fertilization treatments (B)	Cutting heights (cm) (A)				Mean (B)
	10	20	30	40	
Control	1.94	1.01	0.77	0.68	1.10
NPK 100%	4.78	4.10	3.56	3.03	3.87
NPK 75%	3.53	2.82	2.57	1.74	2.67
NPK 50%	2.18	1.17	1.13	1.10	1.40
Bio.	2.06	1.08	1.03	0.99	1.29
Bio. + NPK 75%	4.49	4.27	3.53	2.20	3.62
Bio. + NPK 50%	2.85	2.33	2.21	1.53	2.23
Mean (A)	3.12	2.40	2.11	1.61	2.31
L.S.D. at 5%	A : 0.08		B : 0.07		AB : 0.14
2nd Cut					
Control	3.19	2.94	1.39	1.32	2.21
NPK 100%	4.60	3.08	3.00	2.25	3.23
NPK 75%	2.95	2.19	2.15	1.92	2.30
NPK 50%	2.32	1.92	1.67	1.66	1.89
Bio.	2.22	1.52	1.47	1.44	1.66
Bio. + NPK 75%	4.70	3.06	2.71	2.41	3.22
Bio. + NPK 50%	2.50	2.13	2.02	1.73	2.10
Mean (A)	3.21	2.41	2.06	1.82	2.37
L.S.D. at 5%	A : 0.13		B : 0.08		AB : 0.16
3rd Cut					
Control	2.06	1.46	1.44	1.40	1.59
NPK 100%	4.86	3.29	3.29	2.41	3.46
NPK 75%	3.14	2.26	2.15	1.93	2.37
NPK 50%	2.48	1.78	1.67	1.67	1.90
Bio.	2.35	1.67	1.57	1.50	1.77
Bio. + NPK 75%	5.16	2.94	2.58	3.01	3.42
Bio. + NPK 50%	2.80	2.00	1.93	1.82	2.14
Mean (A)	3.26	2.20	2.09	1.96	2.38
L.S.D. at 5%	A : 0.32		B : 0.37		AB : 0.74

Bio. : Biofertilizers (Minia Azotein + phosphorein)

Table 7. Effect of cutting heights and some bio. and/or mineral NPK fertilization treatments on total fresh weight (kg/plant/season) of moringa during 2015 and 2016 seasons.

1 st season (2015)					
Some bio. and/or mineral fertilization treatments (B)	Cutting heights (cm) (A)				Mean (B)
	10	20	30	40	
Control	14.33	6.14	5.85	4.39	7.68
NPK 100%	36.12	21.76	20.66	13.01	22.89
NPK 75%	24.92	13.75	13.44	10.48	15.65
NPK 50%	16.89	8.51	8.37	7.87	10.41
Bio.	16.01	7.88	7.32	6.87	9.52
Bio. + NPK 75%	38.22	18.86	18.44	14.31	22.46
Bio. + NPK 50%	19.99	11.99	10.44	9.22	12.91
Mean (A)	23.78	12.70	12.07	9.45	
L.S.D. at 5%	A : 0.63		B : 1.09		AB : 2.18
2 nd season (2016)					
Control	19.57	14.71	9.79	9.24	13.33
NPK 100%	38.75	28.50	26.77	20.90	28.73
NPK 75%	26.16	19.78	18.70	15.20	19.96
NPK 50%	18.98	13.23	12.15	12.03	14.10
Bio.	18.04	11.60	11.06	10.70	12.85
Bio. + NPK 75%	39.04	27.92	24.01	20.72	27.92
Bio. + NPK 50%	22.16	17.56	16.74	13.80	17.57
Mean (A)	26.10	19.04	17.03	14.66	
L.S.D. at 5%	A : 0.32		B : 0.37		AB : 0.74

Bio. : Biofertilizers (Minia Azotein + phosphorein)

Table 8. Effect of cutting heights and some bio. and/or mineral NPK fertilization treatments on total dry weight (kg/plant/season) of moringa during 2015 and 2016 seasons.

1 st season (2015)					
Some bio. and/or mineral fertilization treatments (B)	Cutting heights (cm) (A)				Mean (B)
	10	20	30	40	
Control	5.27	2.26	2.15	1.62	2.83
NPK 100%	12.35	8.37	7.97	4.97	8.42
NPK 75%	9.16	5.06	4.94	3.85	5.75
NPK 50%	6.21	3.13	3.08	2.89	3.83
Bio.	5.89	2.90	2.69	2.53	3.50
Bio. + NPK 75%	14.05	6.93	6.77	5.27	8.26
Bio. + NPK 50%	7.35	4.41	3.84	3.40	4.75
Mean (A)	8.61	4.72	4.49	3.50	
L.S.D. at 5%	A : 0.23		B : 0.85		AB : 1.70
2 nd season (2016)					
Control	7.19	5.41	3.60	3.40	4.90
NPK 100%	14.44	10.27	9.85	7.69	10.56
NPK 75%	9.62	7.27	6.87	5.59	7.34
NPK 50%	6.98	4.87	4.47	4.43	5.19
Bio.	6.63	4.27	4.07	3.93	4.73
Bio. + NPK 75%	14.35	10.27	8.82	7.62	10.27
Bio. + NPK 50%	8.15	6.46	6.16	5.08	6.46
Mean (A)	7.19	5.41	3.60	3.40	4.90
L.S.D. at 5%	A : 0.44		B : 0.50		AB : 1.00

Bio. : Biofertilizers (Minia Azotein + phosphorein)

Table 9. Effect of cutting heights and some bio. and/or mineral NPK fertilization treatments on total carbohydrates (% d.w.) of moringa during 2015 and 2016 seasons.

1 st season (2015)					
Some bio. and/or mineral fertilization treatments (B)	Cutting heights (cm) (A)				Mean (B)
	10	20	30	40	
Control	14.18	14.10	13.90	13.85	14.01
NPK 100%	21.80	21.74	20.53	19.49	20.89
NPK 75%	18.02	17.94	17.76	17.69	17.85
NPK 50%	17.20	17.13	16.94	16.88	17.04
Bio.	19.19	19.12	18.92	18.87	19.03
Bio. + NPK 75%	21.59	21.53	20.32	19.27	20.68
Bio. + NPK 50%	20.09	20.02	19.82	18.77	19.68
Mean (A)	18.87	18.80	18.31	17.83	
L.S.D. at 5%	A : N.S.		B : 0.31		AB : 0.62
2 nd season (2016)					
Control	14.17	14.13	13.94	13.88	14.03
NPK 100%	24.81	24.78	24.51	24.50	24.63
NPK 75%	18.08	18.05	17.86	17.70	17.92
NPK 50%	17.23	17.20	16.66	16.95	17.09
Bio.	19.24	19.21	18.99	18.97	19.10
Bio. + NPK 75%	24.66	24.63	24.40	24.39	24.52
Bio. + NPK 50%	20.15	20.12	19.90	19.88	20.01
Mean (A)	19.76	19.73	19.51	19.49	
L.S.D. at 5%	A : N.S.		B : 0.14		AB : 0.28

Bio. : Biofertilizers (Minia Azotein + phosphorein)

Table 10. Effect of cutting heights and some bio. and/or mineral NPK fertilization treatments on total protein (% d.w.) of moringa during 2015 and 2016 seasons.

1 st season (2015)					
Some bio. and/or mineral fertilization treatments (B)	Cutting heights (cm) (A)				Mean (B)
	10	20	30	40	
Control	15.94	15.81	15.69	15.69	15.78
NPK 100%	22.56	22.31	22.38	22.00	22.31
NPK 75%	19.25	19.19	18.88	18.81	19.03
NPK 50%	17.81	17.69	17.56	17.50	17.64
Bio.	21.13	20.94	20.81	20.75	20.91
Bio. + NPK 75%	22.31	22.31	22.25	21.94	22.21
Bio. + NPK 50%	21.88	21.69	21.63	21.50	21.68
Mean (A)	20.13	19.99	19.89	19.74	
L.S.D. at 5%	A : N.S.		B : 0.16		AB : 0.32
2 nd season (2016)					
Control	16.13	16.00	15.88	15.69	15.93
NPK 100%	23.31	23.13	23.13	22.81	23.10
NPK 75%	19.88	19.75	19.69	19.56	19.72
NPK 50%	18.50	18.38	18.25	18.19	18.33
Bio.	21.75	21.63	21.75	21.44	21.64
Bio. + NPK 75%	23.00	23.00	23.00	22.69	22.92
Bio. + NPK 50%	22.50	22.38	22.50	22.19	22.39
Mean (A)	20.72	20.61	20.60	20.37	
L.S.D. at 5%	A : N.S.		B : 0.19		AB : 0.38

Bio. : Biofertilizers (Minia Azotein + phosphorein)

content it was significantly affected by the treatments of cutting heights (Table, 11). In general, cut plant at 10 cm was superior than other treatments. The present results in this investigation agreed with those obtained by Petroudi *et al.* (2011); Mendieta *et al.* (2013) and Ramos-Trejo *et al.* (2015).

Concerning the effect of mineral NPK and/or biofertilization treatments, data presented in Tables (9 to 11) indicated that all used treatments significantly increased total carbohydrates and protein %, as well as, vit. C content comparing with control in both seasons. The best values were obtained with either mineral NPK (100%) or bio. + 75% NPK for both total carbohydrates and protein %, while, bio. + 75% NPK followed by biofertilizers and then mineral NPK (100 %) recorded the highest values of vit. C.

The positive effect of mineral NPK on increasing total carbohydrates, protein and vit. C content were recorded by Darwish (2015) on *Moringa oleifera*, Mansour (2002)

on *Senna sulfurea*, while, Zayed (2012); Darwish (2015) and Abdou *et al.* (2016) on *Moringa oleifera*, Al-Hadad *et al.* (2014) on Eucalyptus and Soliman *et al.* (2015) on *Delonix regia* concerning the effect of biofertilization treatments.

The interaction between main and sub plots (A×B) was significant for total carbohydrates, protein and vit. C % in both seasons (Tables, 9 to 11). The highest values of total carbohydrates % were obtained with cutting at 10 and 20 cm in combination with mineral NPK (100 %) or bio. + 75% NPK (Table, 9). The best interaction over all were cutting at 10, 20 and 30 cm with NPK (100%) or bio. + 75% NPK (Table, 10). The interaction treatments of cutting at 10 cm × bio. + 75% NPK or cutting at 10 cm × biofertilizers or cutting at 10 cm × mineral NPK (100%) resulted the best content of vit. C as shown in Table (11).

Table 11. Effect of cutting heights and some bio. and/or mineral NPK fertilization treatments on vitamin C content (% f.w.) of moringa during 2015 and 2016 seasons.

1 st season (2015)					
Some bio. and/or mineral fertilization treatments (B)	Cutting heights (cm) (A)				Mean (B)
	10	20	30	40	
Control	161	158	154	151	156
NPK 100%	215	209	203	197	206
NPK 75%	201	196	191	185	193
NPK 50%	174	170	165	161	168
Bio.	216	211	205	200	208
Bio. + NPK 75%	219	214	208	203	211
Bio. + NPK 50%	189	185	180	176	183
Mean (A)	196	192	187	182	
L.S.D. at 5%	A : 4		B : 3		AB : 6
2 nd season (2016)					
Control	165	162	158	153	160
NPK 100%	218	214	205	201	209
NPK 75%	204	198	195	190	197
NPK 50%	177	172	168	163	170
Bio.	222	217	211	205	214
Bio. + NPK 75%	226	221	215	210	218
Bio. + NPK 50%	192	187	183	179	185
Mean (A)	201	196	191	186	
L.S.D. at 5%	A : 3		B : 4		AB : 8

Bio. : Biofertilizers (Minia Azotein + phosphorein)

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تأثير إرتفاعات الحش ومعاملات التسميد المعدني و/أو الحيوي على نباتات المورنجا

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أجريت التجربة بقسم البساتين – كلية الزراعة – جامعة المنيا خلال موسمي ٢٠١٥ و ٢٠١٦ على المورنجا لدراسة تأثير أربع مستويات حش (١٠ - ٢٠ - ٣٠ و ٤٠ سم) والتسميد على انتاجية والتركيب الكيماوي للنباتات. أشارت النتائج إلى تفوق معاملة الحش على إرتفاع ١٠ سم عن المعاملات الأخرى في زيادة عدد الفروع والوزن الطازج والجاف/نبات/حشة والمحصول للنبات/موسم وكذلك الصفات الكيماوية (كربوهيدرات – بروتين – فيتامين ج كنسبة مئوية). كل المعاملات الستة السمادية أدت إلى زيادة معنوية في صفات النمو الخضري والصفات الكيماوية مقارنة بمعاملة الكنترول. أحسن المعاملات كانت التسميد المعدني NPK ١٠٠ % والحيوي + ٧٥ % NPK. يمكن التوصية بحش نباتات المورنجا على إرتفاع ١٠ سم وتسميدها بالسماد الحيوي + ٧٥ % NPK للحصول على إنتاجية جيدة وبنوعية عالية.

