

Effect of Bio- and Mineral Fertilization and Number of Pickings on Seed Production of Okra (*Abelmoschus esculentus* (L.) Moench)

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Okra, bio-fertilizer, mineral fertilizer,

Number of Pickings

Seed production

Abstract

The present study was carried out during the summer seasons of 2015 and 2016 at Shandaweel Experimental Farm, Agriculture Research Station, Sohag Governorate, Egypt, to study the effect of bio- and mineral fertilization and pickings frequency on seed production of okra (*Abelmoschus esculentus* (L.) Moench). The experiment was conducted using a split-plot arrangement in a randomized complete block design with three replicates. The obtained results show that the interaction between bio-fertilizers plus 0.75 of recommended dose of NPK and first three pickings significantly increased most studied traits such as, weight of 100-seeds (g), number of dry fruits per plant, seed weight per plant (g), seed yield (kg/fed.), seed germination %, shoot length (cm), root length (cm) and germination rate (days) in the two experimental seasons. In addition, the highest values of number of seeds per dry fruit were obtained from the interaction between recommended dose of NPK and first three pickings in both seasons.

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench), is an important fruit vegetable crop of the tropical and subtropical regions of the world. In Egypt, it is one of the most popular vegetables and it is considered a valuable source of calcium, iron and vitamins. The total cultivated area in 2016 was estimated by 11308 fed. with total production of 56733 tons. The main

productivity was estimated by 5.017 ton/fed. Use of mineral fertilizers can improve fresh, seed yield productivity, soil pH, total nutrients content and nutrient availability. But its use is limited due to scarcity, high cost and nutrient imbalance, causing negative effect on soil properties and micro flora (Smil, 2000). Excessive nitrate can block iodide uptake of the sodium iodide symporter in a competitive

manner (Tonacchera *et al.*, 2005). Toxic effects of nitrate are related to its endogenous conversion to nitrite which is related to methaemoglobinaemia, gastric cancer and other diseases (Santamaria, 2006). Hence, there is need to reduce the use of mineral fertilizers and encourage the application of bio-fertilizers. Bio-fertilizer fix appreciable amount of atmospheric nitrogen in soil, enhance plant growth by production of organic acid and growth substances, and make availability of complex phosphorus to the plant (Bahadur and Manohar, 2001). *Azotobacter* and *Azospirillum* produced adequate amounts of IAA, GA3 and cytokinins, which enhance the root hair branching with an eventual increase in acquisition of nutrients from the soil (Jagnow *et al.*, 1991). Arbuscular mycorrhizal fungi (AMF) forming roots symbiotic associations. This association allows plants to explore larger volumes of soil to absorb more water and nutrients uptake and transport, and increases absorption of immobile mineral elements such as phosphorus (Al-Karaki, 2000). Potassium solubilizing bacteria (KSB) are able to solubilize potassium rock

through production and secretion of organic acids. (Bin Zakaria, 2009). Picking green fruit and seed yield give the best profit in okra cultivation. Green fruit picking is a significant factor in quality seed yield of okra (Moniruzzaman and Quamruzzaman, 2009). Picking of green fruits encourages vegetative growth, fruit characters and ultimate seed yield and seed quality in okra (Singh *et al.*, 1999; Khan and Jaiswal, 1988; and Velumani and Ramaswamy, 1980). The scope of this investigation was to: Study the effect of bio- and mineral fertilization and fruit pickings frequency on seed production of okra. Determine the best treatment combination to have the highest yield. Find out the level of substitution of mineral fertilizers with the use of bio-fertilizers.

Materials and Methods

The present study was carried out during the summer seasons of 2015 and 2016 at Shandaweel Experimental Farm, Agriculture Research Station, Sohag Governorate, Egypt. The physical and chemical characteristics of soil were determined before sowing and are shown in Table (1).

Table 1. Some soil physical and chemical properties of the experimental site.

Season	Texture	CaCO ₃ %	Soil pH	Organic matter (%)	Available nutrients in soil (mg kg ⁻¹)		
					N	P	K
2015	Clay loam	1.80	7.55	1.22	17.20	10.00	178
2016	Clay loam	1.75	7.76	1.32	18.70	9.50	170

The experiment was conducted using a split-plot arrangement in a randomized complete block design with three replicates. Pickings frequencies were randomly arranged in the main plots, i.e., (Non-picking, first three pickings, first five pickings, first seven pickings, and full pickings). While, the sub-plots received randomly the treatments combination of mineral- and bio-fertilization. Each experimental unit was 10.5 m² consisting of five ridges, 60 cm apart and 3.5 cm long. Seed sowing was done in 5th, 7th April in the first and second seasons, respectively.

Application of bio-fertilizers:

Seeds were inoculated with the bio-fertilizers culture (Nitrobin, Mycorrhiza and Potassiumage) each 125g/ 1kg seeds. Bio-fertilizers were mixed with seeds by adding 20% of Arabic gum solution before planting and seeds were left for thirty minutes to dry in a shadow place, then three Seeds per hill were spaced 30 cm apart and irrigated directly.

Application of Mineral fertilizers:

Nitrogen levels: was added in the form of ammonium nitrate (33.5% N) at the rate of (67,

50.25, 33.50, and 16.75 Kg N/fed.) representing one, three fourth, half and one fourth of the recommended dose of nitrogen, respectively.

Phosphorus levels: was added in the form of calcium super phosphate (15.5 % P₂O₅) at the rate of (31, 23.25, 15.5, and 7.75 kg P₂O₅ /fed.), representing one, three fourth, half and one fourth of the recommended dose of phosphorus, respectively.

Potassium levels: was added in the form of potassium sulfate (50 % K₂O) at the rate of (50, 37.5, 25, and 12.50 kg K₂O/fed.), representing one, three fourth, half and one fourth of recommended dose of potassium, respectively.

The recorded data of the experiment were as follows:

- 1- Seed yield components:
 - a- Weight of 100- seeds (g).
 - b- Number of dry fruits per plant.
 - c- Number of seeds per dry fruit.
 - d- Seed weight per plant (g).
- 2- Total seed yield (kg/fed.).
- 3- Seed germination (%): It was calculated by following formula according to (ISTA, 2011).

$$\text{Seed germination (\%)} = \frac{\text{Number of germinated seeds} \times 100}{\text{Total number of sown seeds}}$$

- 4- Shoot and root length (cm):
Seeds were sown in plastic pots. After 21 days, seedlings were taken randomly to measure the shoot and root length (Anon, 1996).
- 5- Germination rate (day): The seedling emergence was daily

registered, starting on 5th day after sowing till 21th day. Germination rate was calculated according to Edmond and Drapala (1958).

$$\text{MDG} = \frac{(G_1 \times N_1) + (G_2 \times N_2) + (G_n \times N_n)}{G_1 + G_2 + \dots + G_n}$$

Where: MDG= Mean number of days required for germination
G = Number of germinated seeds in a certain day N = Number of days.

Statistical analysis:

The treatment means were compared using Duncan's multiple range test as described by Waller and Duncan (1969).

Results and Discussion

1- Seed yield components:

Data in Tables (2), (3), (4) and (5) show that seed yield components i.e., [weight of 100-seeds (g), number of seeds per dry fruit, number of dry fruits per plant and seed weight per plant (g)] were significantly affected by pickings frequency in both seasons. The highest values were produced by first three pickings in both seasons. These results are in harmony with Kumari *et al.*, (2013) and Sanganagoud *et al.*, (2014). Data in the same tables show that applying Mineral- and bio-fertilizers had a significant effect on seed yield components in both seasons. The highest

values were recorded by bio-fertilizers plus 0.75 of the recommended dose of NPK in two seasons, except, the highest number of seeds per dry fruit were achieved by recommend dose of NPK in the first and second seasons. This results are in agreement with those mentioned by El-Shaikh and Mohammed (2009), Bhushan *et al.*, (2013) and Bhende *et al.*, (2015). Concerning the effect of the interaction between the two studied factors. Results reveal that the highest values of seed yield components i.e., (7.08, 6.99(g); 10.00, 9.83 and 39.45, 40.67 (g)) were obtained by the interaction between first three pickings and the bio-fertilizers plus 0.75 of the recommended dose of NPK in two seasons, respectively. But, the highest number of seeds per dry fruit i.e., (77.00 and 93.93) were resulted in the interaction between first three pickings plus

recommended dose of NPK in the two experimental seasons. These results are in harmony with Moniruzzaman and Quamruzzaman (2009).

2- Total seed yield (kg/fed.):

Results illustrated in Table (6) show that seed yield (kg/fed.) was significantly affected by pickings frequency in the first and second seasons. The highest values of seed yield were obtained from first three pickings in two seasons. Moreover, the lowest values were achieved by first seven pickings in both seasons. These results are in the same line with Kumari *et al.*, (2013) and Ghadge *et al.*, (2017). Regarding the effect of Mineral- and bio-fertilizers on seed yield (kg/fed.). The highest values of seed yield were recorded by the plants that fertilized with the bio-fertilizers plus 0.75 of the recommended dose of NPK in two seasons. These results support to the finding of El-Shaikh and Mohammed (2009) Bhushan *et al.*, (2013) and Ismail and Hoda (2014). Results in Table (6) show that the interaction between pickings frequency, bio- and mineral- fertilization significantly increased seed yield (kg/fed.) in both seasons. The highest values of seed yield *i.e.*, (834.42 and 841.60 kg/fed.) were achieved by first three pickings and the bio-fertilizers plus 0.75 of the recommended dose of NPK, in two seasons, respectively. While,

the lowest values *i.e.*, (173.66, 258.07 kg/fed.) were obtained from first seven pickings and control (without fertilizers) in the first and second seasons, respectively. These results may be due to the combination between bio and mineral fertilizers led to promote nitrogen fixation by *Azotobacter* and *Azospirillum*. Forming roots symbiotic associations by mycorrhizae fungi. In addition, increased seed yield components led to higher total seed yield. These results are in harmony with Moniruzzaman and Quamruzzaman (2009) and Singh *et al.*, (2012).

3- Seed germination (%):

Data presented in Table (7) show that seed germination (%) was significantly affected by pickings frequency in the two studied seasons. The highest values of seed germination were resulted in first three pickings in both seasons. Moreover, the lowest values were recorded from first seven pickings in both seasons. These results are agreement with those found by Kumari *et al.*, (2013) and Sanganagoud *et al.*, (2014). Concerning the effect of fertilization treatments, results in the mentioned table reveal that seed germination (%) significantly increased by fertilization in the two experimental seasons. The highest values of seed germination were recorded from the plants that fertilized with the bio-fertilizers plus 0.75 of the

recommended dose of NPK in two seasons. These results support to the finding of El-Warakly (2014) and Bhende *et al.*, (2015). Results in Table (7) show that the interaction effect between pickings frequency, bio- and mineral fertilization was significant on seed germination (%) in both seasons. The highest values *i.e.*, (90.00 and 90.00 %) were produced by first three pickings and bio-fertilizers plus 0.75 of the recommended dose of NPK, in the first and second seasons, respectively. While, the lowest values *i.e.*, (60.00 and 60.00 %) were obtained from first seven pickings and control in the two seasons, respectively. These results are in general trend with those found by Moniruzzaman and Quamruzzaman (2009).

4-Shoot and Root length (cm):

Results presented in Table (8) and (9) show that shoot and Root length (cm) were significantly affected by pickings frequency in both studied seasons. The highest values *i.e.*, (4.54, 4.53 cm and 5.86, 5.87 cm) were achieved by first three pickings in two seasons, respectively. On the other side, the lowest values *i.e.*, (3.47, 3.55 cm and 4.71, 4.72 cm) were resulted in first seven pickings in both seasons, respectively. These results may be due to less available nutrients for the seeds produced from the late picking. That led to weak seeds and seedlings. These results are in

agreement with those reported by Anitha *et al.*, (2001). Mineral- and bio-fertilizers treatments show a significant effect on shoot and root length (cm) in both seasons. The highest values *i.e.*, (5.20, 5.22cm and 6.89, 6.86 cm) were recorded from the plants that fertilized with the bio-fertilizers plus 0.75 of the recommended dose of NPK in two seasons, respectively. These results are in harmony with those reported by Singh *et al.*, (2011). Regarding the effect of interaction between the two studied factors results in Table (8) and (9) show that the interaction effect between first three pickings and the bio-fertilizers plus 0.75 of the recommended dose of NPK gave the highest values *i.e.*, (5.88, 5.77 cm and 7.28, 7.27 cm) in two seasons, respectively. On the other side the lowest values *i.e.*, (2.00, 2.10 cm and 2.83, 2.83 cm) were obtained from first seven pickings and control in the first and second seasons, respectively.

4- Germination rate (days):

Data in Table (10) show that germination rate was significantly affected by pickings frequency in the first and second seasons. The lowest days of germination rate (the best result) *i.e.*, (1.99 and 2.03 days) were recorded from first three pickings in both seasons, respectively. While, the highest one was resulted in first seven pickings in two seasons. Mineral- and bio-fertilizers show a significant

effect on germination rate (days) in both seasons. The lowest days (the best result) i.e., (2.07 and 2.13 days) were produced by the plants that fertilized with bio-fertilizers plus 0.75 of the recommended dose of NPK in the first and second seasons, respectively. These results are in harmony with those reported by Baliah and Muthulakshmi (2017). Results in Table (10) obviously show that the interaction between pickings frequency, bio- and mineral fertilization was

significant on germination rate (days) in both seasons. The lowest days (the best result) i.e., (1.70 and 1.77 days) were recorded from first three pickings and bio-fertilizers plus 0.75 of the recommended dose of NPK in both seasons, respectively. While, the highest one i.e., (3.60 and 3.62 days) was achieved by the interaction between first seven pickings and control in the two experimental seasons.

Table 2. Weight of 100-seeds (g) as affected by pickings frequency, bio- and mineral- fertilization and their interactions during 2015 and 2016 seasons.

First season 2015					
Fertilization (B)	Pickings frequency (A)				Mean (B)
	0	3	5	7	
Control (without fertilizers)	5.39 ^l	5.97 ^j	6.29 ^{ghi}	5.71 ^k	5.84 ^E
Recommended dose of NPK (R.D NPK)	6.38 ^{ghi}	6.65 ^{cde}	6.58 ^{c-f}	6.08 ^{ij}	6.42 ^{BC}
Bio-fertilizers	5.99 ^j	6.48 ^{c-g}	6.35 ^{igh}	5.98 ^j	6.20 ^D
Bio-fertilizers + 0.75 (R.D NPK)	6.46 ^{d-g}	7.08 ^a	6.74 ^{bc}	6.27 ^{ghi}	6.64 ^A
Bio-fertilizers + 0.50 (R.D NPK)	6.39 ^{e-h}	6.95 ^{ab}	6.69 ^{cd}	6.09 ^{ij}	6.53 ^{AB}
Bio-fertilizers + 0.25 (R.D NPK)	6.14 ^{hij}	6.61 ^{c-f}	6.50 ^{c-g}	6.05 ^{ij}	6.33 ^C
Mean (A)	6.13 ^C	6.62 ^A	6.53 ^B	6.03 ^D	-----
Second season 2016					
Fertilization (B)	Pickings frequency (A)				Mean (B)
	0	3	5	7	
Control (without fertilizers)	5.52 ⁿ	5.86 ^l	5.68 ^m	5.60 ^{mn}	5.67 ^F
Recommended dose of NPK (R.D NPK)	6.27 ^{ghi}	6.49 ^{cd}	6.41 ^{def}	6.03 ^k	6.30 ^C
Bio-fertilizers	6.05 ^k	6.19 ^{ij}	6.03 ^k	5.78 ^l	6.01 ^E
Bio-fertilizers + 0.75 (R.D NPK)	6.57 ^c	6.99 ^a	6.73 ^b	6.37 ^{efg}	6.67 ^A
Bio-fertilizers + 0.50 (R.D NPK)	6.46 ^{de}	6.79 ^b	6.47 ^{cde}	6.24 ^{hi}	6.49 ^B
Bio-fertilizers + 0.25 (R.D NPK)	6.10 ^{jk}	6.24 ^{hi}	6.33 ^{igh}	6.02 ^k	6.17 ^D
Mean (A)	6.16 ^C	6.43 ^A	6.28 ^B	6.01 ^D	-----

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

Table 3. Number of seeds per dry fruit affected by pickings frequency, bio- and mineral- fertilization and their interactions during 2015 and 2016 seasons.

First season 2015					
Fertilization (B)	Pickings frequency (A)				Mean (B)
	0	3	5	7	
Control (without fertilizers)	40.12 ^m	55.20 ^j	47.33 ^l	41.12 ^m	45.94 ^D
Recommended dose of NPK (R.D NPK)	60.08 ^{gh}	77.00 ^a	73.87 ^b	66.97 ^d	69.48 ^A
Bio-fertilizers	57.90 ^{hi}	70.07 ^c	56.93 ^{ij}	56.13 ^{ij}	60.26 ^C
Bio-fertilizers + 0.75 (R.D NPK)	66.47 ^d	74.00 ^b	72.92 ^b	59.83 ^b	68.31 ^A
Bio-fertilizers + 0.50 (R.D NPK)	63.73 ^{ef}	73.13 ^b	65.43 ^{de}	56.80 ^{ij}	64.77 ^B
Bio-fertilizers + 0.25 (R.D NPK)	62.33 ^{fg}	67.67 ^d	57.08 ^{ij}	51.10 ^k	59.55 ^C
Mean (A)	58.44 ^C	69.51 ^A	62.26 ^B	55.33 ^D	-----
Second season 2016					
Fertilization (B)	Pickings frequency (A)				Mean (B)
	0	3	5	7	
Control (without fertilizers)	60.87 ^j	67.07 ⁱ	60.97 ^j	60.40 ^j	62.33 ^E
Recommended dose of NPK (R.D NPK)	82.60 ^{cd}	93.93 ^a	87.33 ^b	84.07 ^c	86.98 ^A
Bio-fertilizers	76.60 ^{fg}	78.60 ^{ef}	77.67 ^{ef}	68.20 ⁱ	75.27 ^D
Bio-fertilizers + 0.75 (R.D NPK)	86.67 ^b	92.20 ^a	84.53 ^c	81.53 ^d	86.23 ^A
Bio-fertilizers + 0.50 (R.D NPK)	84.07 ^c	82.93 ^{cd}	83.73 ^c	78.13 ^{ef}	82.22 ^B
Bio-fertilizers + 0.25 (R.D NPK)	76.77 ^{fg}	78.93 ^e	75.00 ^{gh}	74.30 ^h	76.25 ^C
Mean (A)	77.93 ^B	82.28 ^A	78.21 ^B	74.44 ^C	-----

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

Table 4. Number of dry fruits per plant as affected by pickings frequency, bio- and mineral- fertilization and their interactions during 2015 and 2016 seasons.

First season 2015					
Fertilization (B)	Pickings frequency (A)				Mean (B)
	0	3	5	7	
Control (without fertilizers)	4.67 ⁿ	5.47 ^m	4.87 ⁿ	3.67 ^o	4.67 ^E
Recommended dose of NPK (R.D NPK)	7.17 ^{efg}	8.67 ^b	7.20 ^{def}	6.93 ^{gh}	7.49 ^B
Bio-fertilizers	6.23 ^{jk}	6.87 ^{gh}	5.33 ^m	5.47 ^m	5.98 ^D
Bio-fertilizers + 0.75 (R.D NPK)	8.13 ^c	10.00 ^a	7.50 ^d	7.03 ^{e-h}	8.17 ^A
Bio-fertilizers + 0.50 (R.D NPK)	6.73 ^{hi}	7.33 ^{de}	6.53 ^{ij}	6.18 ^k	6.69 ^C
Bio-fertilizers + 0.25 (R.D NPK)	6.33 ^{jk}	6.93 ^{gh}	5.80 ^l	5.33 ^m	6.10 ^D
Mean(A)	6.54 ^B	7.55 ^A	6.21 ^C	5.77 ^D	-----
Second season 2016					
Fertilization (B)	Pickings frequency (A)				Mean (B)
	0	3	5	7	
Control (without fertilizers)	4.13 ⁿ	6.00 ^{hij}	4.90 ^m	3.10 ^o	4.53 ^E
Recommended dose of NPK (R.D NPK)	7.23 ^e	9.27 ^b	6.77 ^f	5.70 ^{jk}	7.24 ^B
Bio-fertilizers	6.07 ^{hi}	7.30 ^c	5.87 ^{ijk}	5.30 ^l	6.14 ^D
Bio-fertilizers + 0.75 (R.D NPK)	9.43 ^b	9.83 ^a	8.27 ^c	6.17 ^{ghi}	8.43 ^A
Bio-fertilizers + 0.50 (R.D NPK)	6.40 ^g	7.87 ^d	6.03 ^{hij}	5.60 ^k	6.48 ^C
Bio-fertilizers + 0.25 (R.D NPK)	6.30 ^{gh}	7.67 ^d	5.90 ^{ijk}	5.97 ^{hij}	6.46 ^C
Mean (A)	6.59 ^B	7.99 ^A	6.29 ^C	5.31 ^D	-----

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

Table 5. Seed weight per plant (g) as affected by pickings frequency, bio- and mineral-fertilization and their interactions during 2015 and 2016 seasons.

First season 2015					
	Pickings frequency (A)				
Fertilization (B)	0	3	5	7	Mean (B)
Control (without fertilizers)	11.27 ^k	18.00 ^{hi}	14.04 ^j	8.65 ^l	12.99 ^E
Recommended dose of NPK (R.D NPK)	27.86 ^d	34.10 ^b	25.37 ^e	22.71 ^{lg}	27.51 ^B
Bio-fertilizers	21.20 ^g	24.84 ^e	18.97 ^{hi}	17.09 ⁱ	20.53 ^D
Bio-fertilizers + 0.75 (R.D NPK)	34.04 ^b	39.45 ^a	28.84 ^{cd}	24.11 ^{ef}	31.61 ^A
Bio-fertilizers + 0.50 (R.D NPK)	25.21 ^e	29.69 ^c	21.98 ^g	22.54 ^{lg}	24.86 ^C
Bio-fertilizers + 0.25 (R.D NPK)	21.66 ^g	25.44 ^e	19.38 ^h	17.67 ^{hi}	21.04 ^D
Mean (A)	23.54 ^B	28.58 ^A	21.43 ^C	18.79 ^D	-----
Second season 2016					
	Pickings frequency (A)				
Fertilization (B)	0	3	5	7	Mean (B)
Control (without fertilizers)	14.10 ^l	19.43 ^l	16.20 ^k	12.03 ^m	15.44 ^E
Recommended dose of NPK (R.D NPK)	29.86 ^{de}	35.33 ^b	30.00 ^{de}	28.38 ^{ef}	30.89 ^B
Bio-fertilizers	23.31 ⁱ	26.69 ^g	22.08 ⁱ	18.71 ^j	22.70 ^D
Bio-fertilizers + 0.75 (R.D NPK)	33.91 ^{bc}	40.67 ^a	33.35 ^c	28.65 ^e	34.15 ^A
Bio-fertilizers + 0.50 (R.D NPK)	27.09 ^{lg}	31.22 ^d	28.68 ^e	25.71 ^{gh}	28.18 ^C
Bio-fertilizers + 0.25 (R.D NPK)	24.93 ^h	26.98 ^{fg}	22.22 ⁱ	19.40 ^j	23.38 ^D
Mean (A)	25.55 ^B	30.05 ^A	25.42 ^B	22.15 ^C	-----

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

Table 6. Total seed yield (kg/fed.) as affected by pickings frequency, bio- and mineral- fertilization and their interactions during 2015 and 2016 seasons.

First season 2015					
	Pickings frequency (A)				
Fertilization (B)	0	3	5	7	Mean (B)
Control (without fertilizers)	216.21 ^l	371.38 ^{jl}	286.75 ^k	173.66 ^m	262.00 ^F
Recommended dose of NPK (R.D NPK)	560.60 ^d	724.14 ^b	526.14 ^e	470.37 ^f	570.31 ^B
Bio-fertilizers	437.29 ^g	510.05 ^e	385.00 ⁱ	357.32 ^g	422.42 ^E
Bio-fertilizers + 0.75 (R.D NPK)	719.01 ^b	834.42 ^a	608.51 ^c	512.93 ^e	668.72 ^A
Bio-fertilizers + 0.50 (R.D NPK)	479.47 ^f	611.93 ^c	440.72 ^g	428.32 ^g	490.11 ^C
Bio-fertilizers + 0.25 (R.D NPK)	438.46 ^g	526.13 ^e	405.45 ^h	359.09 ^j	432.28 ^D
Mean (A)	475.17 ^B	596.34 ^A	442.10 ^C	383.62 ^D	-----
Second season 2016					
	Pickings frequency (A)				
Fertilization (B)	0	3	5	7	Mean (B)
Control (without fertilizers)	327.22 ^p	418.37 ^m	352.40 ^o	258.07 ^q	339.02 ^F
Recommended dose of NPK (R.D NPK)	610.67 ^{fg}	737.47 ^b	648.13 ^d	605.87 ^g	650.54 ^B
Bio-fertilizers	443.68 ^l	526.31 ^j	441.28 ^l	398.37 ⁿ	452.41 ^E
Bio-fertilizers + 0.75 (R.D NPK)	729.96 ^b	841.60 ^a	693.69 ^c	610.05 ^{fg}	718.82 ^A
Bio-fertilizers + 0.50 (R.D NPK)	577.26 ^h	624.47 ^e	620.35 ^{ef}	523.57 ^j	586.41 ^C
Bio-fertilizers + 0.25 (R.D NPK)	523.65 ^j	561.84 ⁱ	451.49 ^l	468.15 ^k	501.28 ^D
Mean (A)	535.41 ^B	618.34 ^A	534.56 ^B	477.35 ^C	-----

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

Table 7. Seed germination (%) as affected by pickings frequency, bio- and mineral- fertilization and their interactions during 2015 and 2016 seasons.

First season 2015					
Fertilization (B)	Pickings frequency (A)				Mean (B)
	0	3	5	7	
Control (without fertilizers)	66.67 ^{fg}	70.00 ^{ef}	60.00 ^{gh}	60.00 ^h	64.17 ^E
Recommended dose of NPK (R.D NPK)	86.67 ^{ab}	86.67 ^{ab}	80.00 ^{bcd}	76.67 ^{cde}	82.50 ^{AB}
Bio-fertilizers	73.33 ^{def}	76.67 ^{cde}	70.00 ^{ef}	66.67 ^{fg}	71.67 ^D
Bio-fertilizers + 0.75 (R.D NPK)	86.67 ^{ab}	90.00 ^a	83.33 ^{abc}	80.00 ^{bcd}	85.00 ^A
Bio-fertilizers + 0.50 (R.D NPK)	76.67 ^{cde}	83.33 ^{abc}	80.00 ^{bcd}	73.33 ^{def}	78.33 ^{BC}
Bio-fertilizers + 0.25 (R.D NPK)	73.33 ^{def}	80.00 ^{bcd}	73.33 ^{def}	70.00 ^{ef}	74.17 ^{CD}
Mean (A)	77.22 ^{AB}	81.11 ^A	74.44 ^B	70.56 ^C	-----
Second season 2016					
Fertilization (B)	Pickings frequency (A)				Mean (B)
	0	3	5	7	
Control (without fertilizers)	66.67 ^{gh}	73.33 ^{efg}	63.33 ^{gh}	60.00 ^h	65.83 ^D
Recommended dose of NPK (R.D NPK)	86.67 ^{ab}	90.00 ^a	83.33 ^{abc}	80.00 ^{bcd}	85.00 ^{AB}
Bio-fertilizers	76.67 ^{cde}	80.00 ^{bcd}	70.00 ^{efg}	73.33 ^{def}	75.00 ^C
Bio-fertilizers + 0.75 (R.D NPK)	90.00 ^a	90.00 ^a	86.67 ^{ab}	83.33 ^{abc}	87.50 ^A
Bio-fertilizers + 0.50 (R.D NPK)	83.33 ^{abc}	86.67 ^{ab}	80.00 ^{bcd}	80.00 ^{bcd}	82.50 ^B
Bio-fertilizers + 0.25 (R.D NPK)	80.00 ^{bcd}	83.33 ^{abc}	76.67 ^{cde}	73.33 ^{def}	78.33 ^C
Mean (A)	80.22 ^B	83.89 ^A	76.67 ^C	75.00 ^C	-----

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

Table 8. Shoot length (cm) as affected by pickings frequency, bio- and mineral- fertilization and their interactions during 2015 and 2016 seasons.

First season 2015					
Fertilization (B)	Pickings frequency (A)				Mean(B)
	0	3	5	7	
Control (without fertilizers)	2.07 ^m	2.49 ^l	2.33 ^l	2.00 ^m	2.22 ^F
Recommended dose of NPK (R.D NPK)	5.17 ^c	5.42 ^b	4.47 ^{de}	4.10 ^g	4.79 ^B
Bio-fertilizers	3.83 ^h	4.02 ^{gh}	3.32 ^g	2.83 ^k	3.50 ^E
Bio-fertilizers + 0.75 (R.D NPK)	5.37 ^b	5.88 ^a	5.15 ^c	4.40 ^{de}	5.20 ^A
Bio-fertilizers + 0.50 (R.D NPK)	4.46 ^{de}	5.11 ^c	4.53 ^d	4.17 ^{fg}	4.57 ^C
Bio-fertilizers + 0.25 (R.D NPK)	3.86 ^h	4.30 ^{ef}	3.63 ⁱ	3.30 ^j	3.77 ^D
Mean(A)	4.12 ^B	4.54 ^A	3.91 ^C	3.47 ^D	-----
Second season 2016					
Fertilization (B)	Pickings frequency (A)				Mean (B)
	0	3	5	7	
Control (without fertilizers)	2.10 ^o	2.53 ^m	2.30 ⁿ	2.10 ^o	2.26 ^F
Recommended dose of NPK (R.D NPK)	5.10 ^d	5.43 ^b	4.53 ^{ef}	4.23 ^g	4.82 ^B
Bio-fertilizers	3.77 ⁱ	4.00 ^h	3.37 ^k	2.87 ^l	3.50 ^E
Bio-fertilizers + 0.75 (R.D NPK)	5.37 ^{bc}	5.77 ^a	5.20 ^{cd}	4.53 ^{ef}	5.22 ^A
Bio-fertilizers + 0.50 (R.D NPK)	4.53 ^{ef}	5.10 ^d	4.60 ^e	4.27 ^g	4.63 ^C
Bio-fertilizers + 0.25 (R.D NPK)	3.80 ⁱ	4.37 ^{fg}	3.50 ^j	3.27 ^k	3.74 ^D
Mean (A)	4.11 ^B	4.53 ^A	3.92 ^C	3.55 ^D	-----

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

Table 9. Root length (cm) as affected by pickings frequency, bio- and mineral- fertilization and their interactions during 2015 and 2016 seasons.

First season 2015					
Fertilization (B)	Pickings frequency (A)				Mean (B)
	0	3	5	7	
Control (without fertilizers)	3.37 ⁱ	3.85 ^h	3.23 ⁱ	2.83 ^j	3.32 ^F
Recommended dose of NPK (R.D NPK)	6.30 ^c	6.80 ^b	6.18 ^c	5.77 ^d	6.26 ^B
Bio-fertilizers	4.90 ^{ef}	5.50 ^d	4.80 ^f	4.10 ^{gh}	4.83 ^E
Bio-fertilizers + 0.75 (R.D NPK)	7.07 ^{ab}	7.28 ^a	6.93 ^b	6.27 ^c	6.89 ^A
Bio-fertilizers + 0.50 (R.D NPK)	5.77 ^d	6.08 ^c	5.20 ^e	5.00 ^{ef}	5.51 ^C
Bio-fertilizers + 0.25 (R.D NPK)	5.12 ^e	5.65 ^d	5.07 ^{ef}	4.30 ^g	5.04 ^D
Mean (A)	5.42 ^B	5.86 ^A	5.24 ^C	4.71 ^D	-----
Second season 2016					
Fertilization (B)	Pickings frequency (A)				Mean (B)
	0	3	5	7	
Control (without fertilizers)	3.43 ^m	3.77 ^l	3.27 ^m	2.83 ⁿ	3.33 ^F
Recommended dose of NPK (R.D NPK)	6.27 ^c	6.77 ^b	6.17 ^c	5.93 ^d	6.29 ^B
Bio-fertilizers	4.93 ^{gh}	5.43 ^e	4.70 ⁱ	4.03 ^k	4.77 ^E
Bio-fertilizers + 0.75 (R.D NPK)	6.93 ^b	7.27 ^a	6.93 ^b	6.30 ^c	6.86 ^A
Bio-fertilizers + 0.50 (R.D NPK)	5.77 ^d	6.20 ^c	5.27 ^{ef}	4.53 ^{hi}	5.44 ^C
Bio-fertilizers + 0.25 (R.D NPK)	5.10 ^{fg}	5.77 ^d	5.10 ^{fg}	4.33 ^j	5.08 ^D
Mean (A)	5.41 ^B	5.87 ^A	5.24 ^C	4.72 ^D	-----

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

Table 10. Germination rate (days) as affected by pickings frequency, bio- and mineral- fertilization and their interactions during 2015 and 2016 seasons.

First season 2015					
Fertilization (B)	Pickings frequency (A)				Mean (B)
	0	3	5	7	
Control (without fertilizers)	2.94 ^{bc}	2.29 ^j	3.08 ^{bc}	3.60 ^a	2.98 ^A
Recommended dose of NPK (R.D NPK)	2.32 ^{hij}	1.75 ^{lm}	2.55 ^{fg}	2.55 ^{fg}	2.29 ^D
Bio-fertilizers	2.43 ^{ghl}	2.22 ^{jk}	2.92 ^{cd}	3.11 ^b	2.67 ^B
Bio-fertilizers + 0.75 (R.D NPK)	1.90 ^l	1.70 ^m	2.18 ^{ik}	2.49 ^{fgh}	2.07 ^E
Bio-fertilizers + 0.50 (R.D NPK)	2.35 ^{hij}	1.88 ^l	2.57 ^{fg}	2.64 ^{ef}	2.36 ^D
Bio-fertilizers + 0.25 (R.D NPK)	2.41 ^{ghi}	2.07 ^k	2.62 ^{ef}	2.76 ^{de}	2.47 ^C
Mean (A)	2.39 ^C	1.99 ^D	2.65 ^B	2.86 ^A	-----
Second season 2016					
Fertilization (B)	Pickings frequency (A)				Mean (B)
	0	3	5	7	
Control (without fertilizers)	3.01 ^d	2.22 ^k	3.09 ^c	3.62 ^a	2.99 ^A
Recommended dose of NPK (R.D NPK)	2.34 ^j	1.85 ⁿ	2.56 ^g	2.65 ^f	2.35 ^E
Bio-fertilizers	2.48 ^h	2.20 ^k	2.99 ^d	3.35 ^b	2.76 ^B
Bio-fertilizers + 0.75 (R.D NPK)	1.93 ^m	1.77 ^o	2.24 ^k	2.58 ^g	2.13 ^F
Bio-fertilizers + 0.50 (R.D NPK)	2.38 ^{ij}	1.98 ^m	2.64 ^f	2.85 ^e	2.46 ^D
Bio-fertilizers + 0.25 (R.D NPK)	2.41 ⁱ	2.14 ^l	2.69 ^f	3.12 ^c	2.59 ^C
Mean (A)	2.43 ^C	2.03 ^D	2.70 ^B	3.03 ^A	-----

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

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