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Influence of Spraying Different Amino Acids and Chitosan on Growth and Nutrient Statues of Alphonse Mango Trees

Ali, H. A.*; Hamdy, I. M. Ibrahim and Mohamed Gomaa Mahmoud Noaman

Hort. Dept. Fac. of Agric. Minia Univ., Egypt.

***Corresponding author:** ali.sayed1@mu.edu.eg

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Abstract: A primary component contributing to the success of sustainable food production is the accessibility of inexpensive fertilizers derived from natural sources and the minimization of mineral fertilizer usage. This study evaluated the effect of bio-stimulants as amino acids (tryptophan, cysteine and methionine) at (50, 100 and 200 ppm) and chitosan at (0.05, 0.1 and 0.2%) *via* foliar applying individually and in combination on the vegetative growth and nutritional status of 'Alphonse' mango trees. The experiment was carried out in a private orchard in Tunah Al-Jabal Village, Mallawi Center, Minia Governorate over 2 consecutive years, 2021 and 2022. Leaf treatments with bio-stimulants were applied in three phases (beginning of vegetative, after fruit set, and month interval). The results showed that there was no effect between the two highest concentrations. Foliar sprinkle with chitosan was more effective than amino acids especially at 0.2% followed by 0.1%. The highest mean values of vegetative growth parameters, leaf pigments and nutrient statues was observed with 200 ppm amino acids+ 0.2% chitosan followed by 100 ppm amino acids + 0.1% chitosan, lacking substantial distinction between them. So, under the same condition, it could be concluded that applying 100 ppm amino acids + 0.1% chitosan three times via foliar application enhanced the vegetative and nutrient statues of Alphonse mango.

Key words: : Amino acids, Chitosan, Vegetative, Nutrient and Mango.

1. Introduction

The mango (*Mangifera indica* L.), a member of the Anacardiaceae family, is considered one of the main important fruits in tropical and subtropical regions globally (**Lal *et al.*, 2022**). It thrives in diverse climatic and soil conditions (**Mohamed *et al.*, 2016**). In Egypt, mango is the second most cultivated fruit after citrus, with a total area of productive orchards measuring around 294100 fed. Yielding approximately 766128 tons of fruit (**Egyptian Ministry of Agriculture, 2021**). The reduction in yield of mango trees cultivated in the Minia region is deemed significant. The primary challenges confronting mango cultivators are diminished fruit set %, reduced yield, and substandard fruit quality. A primary factor contributing to low yield is insufficient pollination and reduced fertilization, resulting in diminished fruit set and increased fruit loss. Addressing this issue using bio-stimulants proved beneficial for enhancing fruit set, quality, and yield. Numerous studies endeavored to improve the productivity and quality of mangoes using foliar treatments of various amino acids and chitosan to augment the mango tree's resilience against diverse challenges that result in diminished yield.

Bio-stimulants are organic substances composed of amino acids and peptides that are easily accessible to plants (**Lobo *et al.*, 2019**). Prior research has underscored the significant impact of several bio-stimulants products on mango yield, fruit quality, and post-harvest longevity (**Momin *et al.*, 2016; Rana *et al.*, 2023 and El-Hoseiny *et al.*, 2024)**. Inadequate nutrient levels can result in diminished crop production, as plants lack essential nutrients. The application of suitable nutrient content can markedly enhance crop yields by providing critical minerals (**Mousavi *et al.*, 2022**). In addition to necessary macronutrients, bio-stimulants—natural or synthetic compounds that might boost plant growth—have garnered interest for their capacity to improve crop output and quality.

Amino acids function as bio-stimulants by promoting plant growth and improving the nutritional status and quality of plants (**Rouphael and Colla, 2018**). The utilization of amino acids enhances abiotic stress alleviation (**Khan *et al.*, 2019**), functions as a hormone precursor (**Calvo *et al.*, 2014; Rouphael and Colla, 2018**), facilitates specific physiological signaling factors, modulates nitrogen uptake, promotes root growth and development (**Weiland *et al.*, 2015**), and supports antioxidant metabolism (**Teixeira *et al.*, 2018**).

Tryptophan, an aromatic amino acid, is synthesized via the shikimate route, initiated by chorismate (**Tzin and Galili, 2010**). **Maeda and Dudareva (2012)** have identified tryptophan acid as a critical factor in the regulation of auxin production and the promotion of plant development. **Abd-Elkader *et al.* (2020)** stated that the addition of tryptophan acid via spraying led to improved vegetative growth and increased production. When tryptophan was applied to the leaves, the plants' total content of carotenoids and chlorophyll increased. Tryptophan has a vital role in inhibiting premature abscission of flowers and fruits.

Cysteine is an essential amino acid that contains an amino group, a thiol group, and a carboxylic acid group as reactive centers. The distinctive structure of Cysteine enables it to serve as a potent antioxidant and efficient scavenger of reactive oxygen species (ROS). A thiol side chain mitigates oxidative damage from biotic and abiotic stimuli by promoting smooth oxidation (**Álvarez *et al.*, 2012 and Genisel *et al.*, 2015**). Cysteine plays a vital part in the synthesis of several vital and protective compounds, such as glutathione, proteins, phytoalexins, glucosinolates, phytochelatins thionins, and metallothioneins (**Rausch and Wachter, 2005; Takahashi *et al.*, 2011; Terzi and Yıldız, 2021).** Methionine is an additional critical amino acid that is involved in numerous biological processes. Proteins and carbon metabolism are dependent on it, and its sulfur-bound methyl group activates S-adenosylmethionine to generate methane (**Lenhart *et al.*, 2015**). It is also vital for the biosynthesis of chlorophyll, cell wall biosynthesis, polyamines, cellular energy glucosinolates, and a variety of secondary metabolites. Additionally, DNA methylation is dependent on it (**Mekawy, 2019**).

Chitosan is an industrially produced substance that is naturally occurring and is derived from crab shells (**Maleki *et al.*, 2022**). This material enhances vegetable and fruit growth and yields while serving as a safeguard barrier against bacteria, fungi, and viruses. The biopolymer "Chitosan" has garnered significant attention due to its remarkable biocompatibility, biodegradability, and bioactivity, indicating its potential for extensive applications in agriculture. In numerous plant taxa, chitosan functions as an inducer. It not only improves crop yields but also activates the immune system of plants. Chitosan increased plants' effectiveness by reducing the adverse effects of adverse circumstances and promoting plant growth (**Kazimi and Saxena, 2023**).

The aim of this investigation is to enhance the productivity of Alphonse mango by utilizing various concentrations of amino acids (tryptophan, cysteine, and methionine) and chitosan, either individually or in combination, through their effects on vegetative growth, chemical content of Alphonse mango under Minia conditions.

2. Materials and Methods

2.1. Experimental site and conditions

On 30 Alphonse mango trees with 15-years old grafted onto polyembryonic mango seedling rootstock and planted a spacing of 7 x 7 meters apart in clay soil with a surface irrigation system from Nile in a private orchard in Tunah Al-Jabal Village, Mallawi Center, Minia Governorate was chosen across 2021 and 2022 seasons, to improving its productivity by using some amino acids (tryptophan, cysteine, and methionine) and chitosan at various concentrations. The basal recommended fertilizer was applied to the chosen 30 trees, and they were subjected to annual agricultural practices. The trees that were selected were in good health and exhibited a nearly uniform vigor. Analysis of the orchard soil's physical and chemical properties (Table A) according to **Wilde *et al.* (1985).**

Table (A). Analysis of the orchard soil's physical and chemical properties

Soil characters		2021/2022
Particle size distribution (%)	Sand	2.29
	Silt	37.11
	Clay	60.60
	Texture class	Clay
EC ppm (1:2.5 extract)		292
pH (1:2.5 extract)		7.37
Organic matter %		2.15
$CaCO_3$ %		2.27
Soil nutrients	Total N (%)	0.18
	Available P (ppm)	5.29
	Available K (ppm)	501.5
	Zn (ppm)	2.6
	Fe (ppm)	2.9
	Mn (ppm)	3.7
	Cu (ppm)	0.11

2.2. Examined designs and treatments

This study employed in a Randomized Complete Block Design with three duplicates, one tree per each. This study encompassed 10 treatments utilizing amino acids (tryptophan, cysteine, and methionine) and chitosan at varying doses, applied either singly or in combination three times; firstly, in the beginning of vegetative, secondly after fruit set, then month interval. The application was carried out using a hand sprayer, ensuring that the fruits were treated until they ran off, as follows:

1) Control (spray with tap water).
2) Amino acid (50 ppm).
3) Amino acid (100 ppm).
4) Amino acid (200 ppm).
5) Chitosan (0.05%).
6) Chitosan (0.1%).
7) Chitosan (0.2%).
8) Amino acid (50 ppm) + chitosan (0.05%).
9) Amino acid (100 ppm) + chitosan (0.1%)
10) Amino acid (200 ppm) + chitosan (0.2%)

Triton B was incorporated as a wetting agent at a concentration of 0.1%. A small quantity of 0.1 N NaOH was introduced to the measured amounts of chitosan to enhance its solubility. The spraying was conducted until there was runoff observed.

2.3. Data collection

The parameters listed below were assessed for each season:

a- Characteristics of vegetative growth

Main shoot length: During the spring growth cycle, each tree had four branches, one facing each direction with one-year-old across both seasons, measured the length of four shoots per branch and tagged them.

- Number of leaves/shoot.
- Leaf area: 20 leaves below the panicles of the spring growth cycle, as per **Sumner (1985),** were selected during the second week of June for the purpose of measuring leaf area in accordance with **Ahmed and Morsy (1999).**

$$\text{Leaf area} = 0.56\ (0.79 \times w^2) + 20.01$$

where, W = the maximum leaf width

b- Leaf pigments

Chlorophylls a and b, total chlorophylls, and total carotenoids (mg/100g F.W.) were quantified spectrophotometrically following the methodology of **Von-Wettstein, (1957)** as detailed below: 200 mg fresh leaf tissue were pulverized in 90% acetone. Absorbance measurements were conducted at 663 nm and 644 nm for chlorophylls, and at 452.5 nm for carotenoids, utilizing the equations established by **Wellburn and Lichtenthaler (1984**).

c- Leaf nutrient

In the first week of July during the spring development cycle of each tree (**Sumner, 1985**), 20 mature leaves (7 months-old) were selected from nonfruiting shoots. The standard methods detailed by **Wilde *et al.* (1985**) were employed to determine N, P, and K as percentages, Zn, Fe, and Mn as ppm.

2.4. Data analysis

The data were organized into tables and analyzed statistically, with treatment means compared using the New L.S.D. test at a significance level of 5% (**Mead *et al.*, 1993**).

3. Results and Discussion

3.1. Vegetative growth characteristics

It is quite evident from Table 1, that main shoot height, leaves number and leaf area were considerably altered by the studied treatments in both seasons. However, trees treated with both amino acids and chitosan exhibited A considerable rise in investigated qualities when compared to the untreated group, which received water spray. Treatments at the highest two consecutive levels exhibited insignificant differences between them across two seasons. The trees subjected to water spraying exhibited the lowest shoot height, leaves number and leaf area measurements, recorded (16.5 - 16.7 cm), (17.2 – 17.5) and (65.6 – 66.3 cm^2). Trees treated with chitosan demonstrated greater main shoot height compared to other treatments involving amino acids, with the maximum shoot length, leaves number and leaf area observed in trees sprayed with 0.2% chitosan, followed by those treated with 0.1% chitosan. However, the combination of the two materials resulted in a greater increase in main shoot height, leaves number and leaf area compared to their individual application. The trees treated with amino acid (200 ppm) and chitosan (0.2%) exhibited the highest mean values for main shoot height (23.5 and 23.7 cm), leaves number (24.0 and 24.3) and leaf area (72.0 and 72.7 cm^2). This was followed by the lower concentration, which recorded heights of (22.8 and 22.9 cm), (23.3 and 23.5) and (71.3

and72.1 cm^2), for main shoot height, leaves number and leaf area, respectively with no discernible change observed between the two treatments.

The improvements in vegetative growth parameters are primarily connected to amino acids compounds present in addition bio-stimulants, which play essential roles in chlorophyll production and plant development (**Sowmya *et al.*, 2023). Mohammadipour and Souri (2019**) argued that amino acids are integral to protein biosynthesis, which is vital for multiple facets of plant growth, including stem and root growth, as well as leaf area and number expansion. Amino acids, as lysine, alanine, and serine, contribute to the synthesis of chlorophyll and carotenoids. Several studies have demonstrated that the application of amino acids can affect plant growth by enhancing various physiological processes, such as glucose metabolism, protein synthesis, and the hormone precursors generation (**El-Beltagi *et al.*, 2023**). Similar results were stated by **Aly *et al.* (2019); Kheir *et al.* (2021); Hussein (2023).**

The activation of enhancement of photosynthesis and the vital enzymes for the metabolism of nitrogen (nitrate reductase, protease and glutamine synthetase,) are the primary factors contributing to the significant impact of chitosan on the vegetative growth parameters of fruit trees (**Górnik *et al.*, 2008; Ibraheim and Mohsen, 2015**). In addition, chitosan stimulates the production of specific plant growth hormones, such as GA_3, and affects specific auxin biosynthesis signaling pathways through a tryptophan-independent mechanism (**Ferguson and O'Neill, 2011**). ABA plays a vital role in regulating water usage by promoting stomatal closure, thereby influencing water and nutrient absorption through osmotic pressure modifications in plant cells. It also affects water loss through transpiration (**Hadwiger *et al.*, 2002**) and reduces harmful free radical accumulation by increasing levels of antioxidant and activities of enzymatic (**Jail *et al.* 2014; Ibraheim and Mohsen, 2015**). These results agreed with those reported by **Mohamed and Ahmed (2019); Kumari *et al.* (2021); Almutairi *et al.* (2023).**

Table (1). Alphonse mango tree's main shoot height, leaves number/plant, and leaf area as affected by foliar spraying with mixture of amino acid and chitosan across 2021 and 2022 seasons

Characteristics / Treatments	Main shoots height (cm)		Leaves number/shoot		Leaf area (cm^2)	
	2021	**2022**	**2021**	**2022**	**2021**	**2022**
Control	16.5	16.7	17.2	17.5	65.6	66.3
Amino acid (50 ppm)	18.0	18.2	19.5	19.6	67.8	69.0
Amino acid (100 ppm)	19.6	19.7	20.8	21.0	68.8	70.1
Amino acid (200 ppm)	20.3	20.5	21.5	21.7	69.5	70.6
Chitosan (0.05%)	19.7	19.8	20.7	21.0	69.1	70.2
Chitosan (0.1%)	21.2	21.3	21.9	22.3	70.1	71.5
Chitosan (0.2%)	22.0	22.2	22.5	23.1	70.7	72.0
Amino acid (50 ppm) + chitosan (0.05%)	21.3	21.4	21.9	22.3	70.1	71.1
Amino acid (100 ppm) + chitosan (0.1%)	22.8	22.9	23.3	23.5	71.3	72.1
Amino acid (200 ppm) + chitosan (0.2%)	23.5	23.7	24.0	24.3	72.0	72.7
New LSD $_{at\ 5\%}$	**0.9**	**1.0**	**0.8**	**0.9**	**0.8**	**0.7**

3.2. Leaf pigments mg/100 g F.W

In contrast to the control treatment, the administration of amino acids and/or chitosan via foliar application, either alone or in combinations, led to substantial increases in pigments content (Table 2 and Fig 4, 5 and6). During both seasons, the interventions resulted in a substantial raise in the quantity of chlorophyll a, b, total chlorophyll and total carotenoid. Exceptionally, the two treatments with the maximum concentrations of amino acids, chitosan, or a combination of the two exhibited no significant difference in these parameters. The addition of chitosan was more effective in enhancing the content of pigments than the addition of amino acids, particularly at a concentration of 0.2%, followed by 0.1%. The dual application of amino acids and chitosan was more effective in increasing the amount of pigments content, particularly when applied in descending order. The trees that were treated with amino acid (200 ppm) + chitosan (0.2%) exhibited the highest values for chlorophyll a, b, total chlorophyll and total carotenoid. However, there was no discernible distinction between the trees that were treated with amino acid (100 ppm) + chitosan (0.1%). Conversely, the chick trees demonstrated the lowest values during two seasons.

Amino acids applied to vine leaves can increase photosynthesis rates and chlorophyll production. This improves plant development, especially in difficult climates (**Ertani *et al.*, 2009 and Garcia *et al.*, 2011**). The superior nutritional value of plants is generally indicated by the increased levels of sucrose, protein, and other nutrients that they exhibit when they receive amino acids as a supplement. Additionally, plants that exhibit this characteristic demonstrate increased resilience in the face of water scarcity, elevated salt levels, and temperature fluctuations (**Tantawy *et al.*, 2009 and Cerdán *et al.*, 2013**). The enhancement in the content of leaf photosynthesis pigments can be ascribed to the advantageous properties of amino acids, which encompass both major and minor elements, growth regulators and vitamins. These components improve metabolism, cell division, and various biological reactions. They also encourage the creation of vital biological components like DNA and RNA, which are necessary for cell division, and they trigger photosynthesis (**Attoa *et al.*, 2002; EL-Naggar *et al.*, 2013 and Souri, 2016**). These results came in line with those of **Abd-Elall (2022); Hussein (2023); Hussein and Abd EL-all (2024).**

Many authors, such as **Crimi and Lichtfause (2019**), have conducted recent studies that have shown the effectiveness of chitosan in increasing the chlorophyll content of leaves. Chitosan has been recognized as a substantial regulator of plant photosynthesis and metabolic processes. Furthermore, the chlorophyll content is elevated as a consequence of the enhancement of nitrogen transmission to the foliage and the increased absorption of NPK (**Abd EL-Gawad and Bondok, 2015**). These results align with those previously reported by **Mohamed and Ahmed (2019); Kumari *et al.* (2021) andAlmutairi *et al.* (2023).**

Table (2). Alphonse mango tree's leaves content of pigments as affected by foliar spraying with mixture of amino acid and chitosan across 2021 and 2022 seasons

Characteristics / Treatments	Chlorophyll a mg/100 g FW		Chlorophyll b mg/100 g FW		Total chlorophyll mg/100 g FW		Total carotenoid mg/100 g FW	
	2021	2022	2021	2022	2021	2022	2021	2022
Control	5.5	5.7	2.4	2.5	7.9	8.2	4.2	4.4
Amino acid (50 ppm)	6.5	6.8	3.5	3.5	10.0	10.3	5.3	5.4
Amino acid (100 ppm)	7.0	7.4	3.9	4.1	10.9	11.5	5.9	6.0
Amino acid (200 ppm)	7.2	7.7	4.2	4.5	11.4	12.2	6.3	6.4
Chitosan (0.05%)	6.9	7.3	4.0	4.1	10.9	11.4	5.8	6.1
Chitosan (0.1%)	7.4	7.3	4.5	4.7	11.9	12.0	6.4	6.7
Chitosan (0.2%)	7.5	8.1	4.7	5.0	12.2	13.1	6.7	7.1
Amino acid (50 ppm) + chitosan (0.05%)	7.5	7.7	4.6	4.2	12.1	11.9	6.3	6.8
Amino acid (100 ppm) + chitosan (0.1%)	8.1	8.4	5.0	5.3	13.1	13.7	6.9	7.4
Amino acid (200 ppm) + chitosan (0.2%)	8.3	8.6	5.3	5.6	13.6	14.2	7.3	7.9
New LSD at 5%	**0.3**	**0.4**	**0.4**	**0.5**	**0.6**	**0.8**	**0.5**	**0.6**

3.3. Nutrient status of leaves

Regarding the impact of foliar application of amino acids and / or chitosan either individually or in combination on leaf nutrients of mango trees "Alphonse" (N, P, K (%), Zn, Fe, and Mn (ppm)), data presented in Table (3) indicated that, chitosan was more effective than amino acids and gave the high value in this respect during the two seasons as individual applying especially at 0.2% followed by 0.1% without notable distinction between them. On the contrary the least values were obtained from ‘Alphonse’ mango trees spray with water only. The other treatments were intermediate during both seasons. As for the interaction between the treatments, it was found that foliar sprinkle with amino acid (200 ppm) + chitosan (0.2%) scored the highest mean value of N, P, K (%), Zn, Fe, and Mn (ppm) followed by amino acid (100 ppm) + chitosan (0.2%) with no notable distinction between them. The rate of increase with the highest concentrations in comparison to the control was (20.0 - 20.25%), (77.27 - 88.00%), (16.43 - 19.58%), (17.56 - .69%), (13.63 - 11.32%) and (14.49 – 13.04%), for N, P, K (%), Zn, Fe, and Mn (ppm) in two seasons, respectively.

According to the findings of **Mohammadipour and Souri (2019**), the addition of amino acids to the leaves can improve the uptake and levels of nutrients within the leaves. The impact of micronutrients, especially zinc and iron, has been clearly established (**Zhou *et al.*, 2007 and Souri *et al.*, 2018**). Some amino acids exhibit a particular affinity for various nutrients, and certain amino acids are capable of forming chelates with other nutrients. **Souri and Hatamian (2019**) observed that this attribute has been extensively employed to enhance the absorption and movement of micronutrients in plants, including iron. Amino acid-bound nutrients confer greater advantages in plants (**Sadak *et al.*, 2015 and Pranckietienė *et al.*, 2015**). Additionally, as previously noted, enhanced photosynthesis can lead to greater production of assimilates, improved plant growth, and increased yield due to better nutritional conditions of the leaves (**Galili and Amir, 2013 and Ma *et al.*, 2017**). A study conducted by **Lobo *et al.* (2019)** demonstrated that bio-stimulants comprising nutrients and L-a-amino acids influenced the leaf levels of mango as N, K, Mn, Fe, and Zn, and also enhanced the fruit count per panicle compared to untreated plants. The rise in these quantities can be linked to alterations in the levels of specific proteins and amino acids, which facilitate cell elongation and division. The results align with the findings of **Kheir *et al.* (2021); Abd-Elall (2022); Hussein (2023).**

Chitosan's advantageous effect on the mineral content of adult leaves of 'Alphonse' mango may be attributed to its favourable bio-stimulation function, which may lead to an increase in mineral elements and enhanced photosynthesis (**Ahmed *et al.*, 2016; El-Kenawy, 2017 and Ayed, 2018**). Furthermore, it has been documented that chitosan facilitated the movement of specific elements, such as nitrogen (**Gornik *et al.*, 2008**). Chitosan enhances the activity of specific essential enzymes within plant tissues (**Ortmann and Moerschbacher, 2006 and Kafagy, 2019**). The increased biosynthesis of plant pigments and nutrients is indicative of the influence of chitosan on the assimilation of water and various elements (**Hadwiger *et al.*, 2002**). Similar results were obtained by **Zagzog *et al.*, (2017); Aly *et al.* (2022) and Almutairi *et al.* (2023).**

4. Conclusion

The most favorable outcomes in terms of vegetative growth parameters and leaf mineral content were achieved by treating Alphonse mango trees grown under Minia climatic conditions with 200 ppm amino acids + 0.2% chitosan three times at the onset of growth, once immediately following setting, and again one month later. There were no discernible differences with the next lower concentrations. So, the most cost-effective treatment under Minia conditions was the application of 100 ppm amino acids and 0.1% chitosan to Alphonse mango three times.

Table (3). Alphonse mango tree's leaf content of N, P, K %, Zn, Fe and Mn (ppm) as affected by foliar spraying with mixture of amino acid and chitosan across 2021 and 2022 seasons.

Characteristics / Treatments	Leaf N%		Leaf P%		Leaf K%		Leaf Zn ppm		Leaf Fe ppm		Leaf Mn ppm	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Control	1.65	1.63	0.22	0.25	1.40	1.43	45.0	44.7	52.1	53.0	55.2	56.0
Amino acid (50 ppm)	1.74	1.70	0.28	0.32	1.46	1.50	48.7	48.5	53.4	54.5	57.3	57.8
Amino acid (100 ppm)	1.81	1.78	0.31	0.37	1.50	1.55	50.2	49.9	55.0	55.8	58.9	59.3
Amino acid (200 ppm)	1.84	1.82	0.32	0.39	1.52	1.58	51.2	50.8	56.2	56.9	60.2	60.5
Chitosan (0.05%)	1.80	1.78	0.32	0.36	1.52	1.56	49.5	49.8	55.0	55.1	58.8	59.2
Chitosan (0.1%)	1.86	1.85	0.36	0.40	1.57	1.61	50.7	51.0	56.6	56.5	60.5	60.7
Chitosan (0.2%)	1.90	1.90	0.37	0.41	1.60	1.65	51.6	52.0	57.8	57.7	61.7	61.8
Amino acid (50 ppm) + chitosan (0.05%)	1.88	1.85	0.36	0.41	1.56	1.62	50.8	51.2	56.5	56.5	60.4	60.7
Amino acid (100 ppm) + chitosan (0.1%)	1.95	1.92	0.38	0.45	1.61	1.67	51.9	52.4	58.1	57.9	61.9	62.1
Amino acid (200 ppm) + chitosan (0.2%)	1.98	1.96	0.39	0.47	1.63	1.71	52.9	53.5	59.2	59.0	63.2	63.3
New LSD at 5%	**0.05**	**0.06**	**0.02**	**0.03**	**0.04**	**0.05**	**1.1**	**1.2**	**1.4**	**1.3**	**1.5**	**1.4**

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تأثير رش الأحماض الأمينية المختلفة والكيتوزان على النمو والحاله الغذائية لأشجار المانجو ألفونس

على حسن على ، حمدى إبراهيم محمود و محمد جمعة محمود نعمان

قسم البساتين – كلية الزراعة – جامعة المنيا – مصر

الملخص العربى

البحث عن أسمدة من مصادر طبيعيه غير مكلفة لتقليل إستخدام الأسمده المعدنية تعتبر أحد المكونات الأساسية التى تساهم فى نجاح الإنتاج الغذائى المستدام. لذلك أجريت الدراسة الحالية لتقييم تأثير المحفزات الحيوية مثل الأحماض الأمينيه (تربتوفان، سيستين ، ميثيونين) بتركيزات (٥٠، ١٠٠ ، ٢٠٠ جزء فى المليون) و الشيتوزان بتركيزات (٠,٠٥، ٠,١، ٠,٢%) عن طريق الرش الورقى إما بصوره فرديه أو مركبه على النمو الخضرى و الحاله الغذائية لأشجار مانجو "ألفونس". أجريت التجربه بقريه تونه الجبل – مركز ملوى – محافظة المنيا خلال موسمى الدراسه ٢٠٢١ و ٢٠٢٢م. تم الرش ثلاث مرات "بداية النمو، بعد العقد مباشرة ، و بعدها بشهر". أظهرت النتائج عدم وجود فرق معنوي بين أعلى تركيزين متتاليين ، و كان الرش بالشيتوزان أكثر فعاليه عن الرش بالأحماض الأمينيه و خاصة عند تركيز ٠,٢% يليها ٠,١%. سجلت أعلى القيم من الصفات الخضريه و محتوى الأوراق من الصبغات و العناصر عند الرش المزدوج بتركيز ٢٠٠ جزء فى المليون أحماض أمينيه + ٠,٢% شيتوزان يليهها ١٠٠ جزء فى المليون أحماض أمينيه + ٠,١% شيتوزان دون وجوج فرق معنوي بين المعاملتين. لذلك يمكن التوصيه بالرش بتركيز ١٠٠ جزء فى المليون أحماض أمينيه + ٠,١% شيتوزان ثلاث مرات على مانجو "ألفونس" لتعزيز الصفات الخضريه و الحاله الغذائيه تحت نفس ظروف التجربه.

الكلمات المفتاحيه: أحماض أمينيه، شيتوزان، صفات خضريه، حاله غذائية، مانجو