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RESPONSE OF *MATRICARIA CHAMOMILLA*, L. PLANTS TO NANO AND CHEMICAL FERTILIZERS.

**Toaima, N. M.; H. A. Bosila and R.
S.Nada,**

*Department of Horticulture, Faculty of Agriculture,
Al-Azhar University, Nasr City, Cairo, Egypt.*

ABSTRACT

This study was carried out during two successive seasons of 2015/2016 and 2016/2017 on *Matricaria chamomilla*, L. plant at the Experimental Farm of Horticultural Department, Faculty of Agriculture, Al-Azhar University, Nasr City, Cairo, Egypt. Pot plants experiment was conducted to investigate the response of *Matricaria chamomilla*, L. plants to three rates of nano fertilizers (foliar spraying at 1.5, 3 and 4.5 g/L.) and chemical fertilizers (50, 100 and 150 % of a basic dose).

Results showed that all treatments of nano and chemical fertilizers

improved different vegetative growth characters, promoted flowering parameters and stimulated various chemical constituents compared with control.

The highest rate of nano and chemical fertilizers resulted in significant increases in vegetative growth, best quality and quantity of flower production and various chemical constituents such as chlorophyll a, b, carbohydrates and essential oil in the flowers as well as its content, nitrogen, phosphorus and potassium percentage.

Hence, these findings clearly indicated that, nano fertilizers could be used as effective tools instead of chemical fertilization, lowering the productive costs and consequently minimize the pollution of the agriculture environment.

Key words: chemical fertilizers, essential oil, *Matricaria chamomilla*.
L., nano fertilizers,

INTRODUCTION

Matricaria chamomilla, L. is an important ornamental plant belonging to family Asteraceae. It is considered to be one of the valuable medicinal plants. Chamomile has many medical attributes such as antiseptic, antispasmodic, antimicrobial and antiinflammatory (**Letchamo and Marquard 1993, Manifesto et al. 2001 Pourohit and Vyas 2004 Franke and Schilcher 2007**). One of the most commonly consumed single ingredient herbal tea is chamomile, prepared with dried flowers from *Matricaria chamomilla*, L. (**Crevin and Philpott 1990**). Infusions and essential oils from fresh or dried flower heads have aromatic, flavoring and coloring properties. Both are used in a number of commercial products including soaps, detergents, perfumes, lotions, ointments, hair products, baked goods, confections, alcoholic beverages and herbal teas. Chamomile flowers contain 0.24- to 2.0 percent volatile oil that is blue in color (**Wald and Brendler 1998**). European Pharmacopoeia recommends chamomile contains no less than 4 mL/kg of blue essential oil (**European Pharmacopoeia**). The actual tendency is to consider natural products as non-toxic and presenting few side effects than those used by conventional medicine (**Petronilho et al. 2012**).

The main objective of this study was to find out whether sufficient and high quality of the *Matricaria chamomilla*, L. crop can be produced without chemical fertilizers but only with the sources allowed by nano fertilizers. This experiment aimed to select the best rate of effective nano fertilizers.

MATERIALS AND METHODS

This investigation was carried out in the Experimental Farm of Horticultural Department, Faculty of Agriculture, Al-Azhar University, Nasr City, Cairo, Egypt, during the two successive seasons 2015/2016 and 2016/2016.

The soil used:

The soil used was sandy soil. Its chemical and physical characteristics are presented in **Table (1)**.

Table (1): Physical and chemical properties of the experimental soil.

A-Physical properties:-										
Soil Mixture		Clay%		Silt%		Fine sand%		coarse sand %		
Sand		11.00		6.00		10.10		73.30		
B-Chemical properties										
Chemical analysis	K	Na	Mg	Ca	SO ₄	Cl	HCO ₃	SP	pH	E.c
Sand	0.40	4.20	2.20	5.10	7.20	3.5	3.00	25.00	7.55	1.25

Plant Material:

Matricaria chamomilla, L. seeds were provided by Horticulture Research institute of Medicinal and Aromatic plants Section, Giza, Egypt. Seeds were sown in the nursery beds on October 15th of both seasons and regularly irrigated until emergence. At the suitable size of transplanting, seedlings were transferred after 30 days at 15th of November in to the field.

Chemical Fertilizers:

The recommended chemical fertilizer dose was added according to ministry of agriculture. The mineral sources of N, P and K fertilizers were obtained from ammonium sulphate (20.6% N) 250 kg / fed. calcium super phosphate (15.5% P₂O₅) 200 kg/ fed. and potassium sulphate (48% K₂O) 100 kg / fed. (Recommended dose), respectively. NPK were added at three levels of 50, 100 and 150 % of a basic dose, respectively. The fertilizers application for N and K was done three times: the first addition was started after 15 days from transplanting, and repeated in 30 days for each, while the addition of calcium super phosphate was done as one dose during the soil preparation with various three levels of phosphorus.

Nano Fertilizers:

Nano fertilization of nitrogen, phosphorus and potassium fertilizers were obtained from National Research Center, Cairo Egypt.

Nano fertilizers were applied at three levels (foliar spraying at three levels 1.5, 3 and 4.5 g/L.). All of the treatments were sprayed in three stages, including 15 days after transplanting, spraying 30 days after first time of spraying and spraying 60 days after first time in flowering stages. All operations were done regularly during two seasons.

The experimental design:

The layout of the experiment was a complete randomized blocks design during the two seasons in three replicates for each treatment (7 treatments).

Statistical analysis:

The statistical analysis was performed according to (**Snedecor and Cochran 1980**) using M-state program version 4. analysis of variance (ANOVA) with Duncan's Multiple Range test ($P \leq 0.05$).

Treatments:

The fertilization treatments were used as follows:

- 1 - Control.
- 2 - Nano fertilizer at 1.5 g/L. (Foliar spraying).
- 3 - Nano fertilizer at 3 g/L. (Foliar spraying).
- 4 - Nano fertilizer at 4.5 g/L. (Foliar spraying).
- 5- NPK at 50 % of recommended dose.
- 6- NPK at 100 % of recommended dose.
- 7- NPK at 150 % of recommended dose.

Data recorded:

The following data were recorded at the end of experiment for the two seasons:

- 1-Plant height (cm), as the main plant stem.
- 2-Number of branches/ plant.
- 3-Dry weight (g/plant).
- 4 - Flowering date, considered at the first opened flowering head.
- 5 - Number of flowering heads/ plant.
- 6 - Diameter of flowering head (cm).
- 7 - Flowering period, recorded from the first opened flowering head until the end of the flowering.
- 8 - Chlorophyll a, b contents in the fresh leaves (mg/ g) were determined using the method of (**Rami and Dan porath 1980**).

- 9 - Total carbohydrates (%) was determined by using phenol-sulphuric acid method according to **(Dubois *et al.* 1956)**.
- 10-Total nitrogen (%) was determined according to the method described by **(A.O.A., 1995)**.
- 11- Potassium and phosphorus (%) were determined according to **(Cottenie *et al.* 1982)**.
- 12- Essential oil percentage: the essential oil percentage was determined in air dried head flowers according to **(Balbaa *et al.* 1981)**

RESULTS AND DISCUSSION

1. Effect of to nano and chemical fertilizers on some vegetative characters.

The data in **Table (2)** revealed that, in most cases, the studied vegetative growth characters, plant height (cm.), branches number/plant and herb dry weight (g) /plant of *Matricaria chamomilla*, L. plants were significantly increased in both seasons due to the use of nano and chemical fertilization in comparison to the untreated plants. Corresponding data showed an increase in plant height due to chemical fertilization treatments in comparison to nano fertilizers treatments and to the control especially, when chemical fertilization was used at the rate of NPK100% and NPK150% which produced 85.00 and 95.10 cm. in the 1st season, 81.70 and 94.40cm. in the 2nd season, respectively. However, application of chemical fertilization at NPK100%, NPK150% and nano fertilization at rate 4.5 g/L. gave the highest values for number of branches 123.53, 136.90 and 121.53 in the 1st season and 122.93, 133.80 and 120.30 in the 2nd season. Data illustrated showed that, the maximum value of herb dry weight (191.63 g/plant in the 1st season, 191.93 g/plant in the 2nd season.) was obtained as a result of chemical fertilization (NPK 150%). Then, treatments of chemical fertilization (NPK 100%) and nano fertilization (4.5 g/L.) gave high values of herb dry weight in the 1st and 2nd season recording 173.63, 170.43, 172.90 and 169.57 g/plant, respectively.

Table (2): Effect of nano and chemical fertilizers on vegetative growth characteristics of *Matricaria chamomilla*, L. plants during 2015/2016 and 2016/2017 seasons.

Treatments	Plant height(cm.)		Branches number/plant		Herb dry weight (g/plant)	
	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season
Control	19.87 ^g	20.20 ^f	22.50 ^f	22.47 ^f	35.90 ^e	36.17 ^f
NPK 50%	69.63 ^d	68.33 ^c	114.23 ^c	113.00 ^c	151.27 ^c	150.33 ^c
NPK 100%	85.00 ^b	81.70 ^b	123.53 ^b	122.93 ^b	173.63 ^b	172.90 ^b
NPK 150%	95.10 ^a	94.40 ^a	136.90 ^a	133.80 ^a	191.63 ^a	191.93 ^a
Nano 1.5 g/L.	49.23 ^f	48.50 ^e	95.80 ^e	96.47 ^e	130.77 ^d	128.70 ^e
Nano 3 g/L.	66.07 ^e	60.90 ^d	107.87 ^d	105.03 ^d	145.63 ^c	142.17 ^d
Nano 4.5 g/L.	81.27 ^c	80.73 ^b	121.53 ^b	120.30 ^b	170.43 ^b	169.57 ^b

^{a to g} Means having different letters exponents in column are significantly different ($P \leq 0.05$).

The results had the same line with **Hammam (1996)** on *Pimpinella anisum*, **El-Sayed et al. (2002)** on *Origanum majoranum*, **Helmy and Zarad (2003)** on *Borago officinalis*, **Atta-Alla et al. (2005)** on *Capsicum annum*.

1. Effect of nano and chemical fertilizers on some flowering aspects.

Concerning the effect of nano and chemical fertilizers on flowering characters, it could be noticed that the studied flowering growth characters; number of flowering heads/plant, flowering head diameter/plant (cm.) (**Table (3)**), flowering start (days) and flowering period (days) (**Table (4)**) were significantly increased due to the use of nano and chemical fertilizers in both seasons in comparison to the unfertilized plants. Data presented in **Table (3)** showed that, the highest number of flowering heads was 130.43 in the 1st season and 125.43 in the 2nd season when chemical fertilization at rate 150% was applied, then the treatments chemical fertilization at rate 100% and nano fertilization at rate 4.5 g/L. recorded 104.10 and 102.83 in the 1st season and 102.53 and 98.55 in the 2nd season.

Diameter of flowering head character, All treatments recorded significantly increasing in both seasons in comparison to the unfertilized plants and there is no significant different between them in both seasons.

Data in **Table (4)** reveal that, all applications (chemical fertilization; NPK50%, NPK100% and NPK150% and nano fertilization at rate 1.5, 3 and 4.5 g/L) started to flowering earlier in both seasons in comparison to the unfertilized plants but the highest number of flowering earlier character was 30 days in the 1st season and 29 days in the 2nd season when chemical fertilization at rate 150% was applied, decreasing the start of flowering with 17 days as compared with the untreated plants.

The flowering period extended longer time in all treatments (chemical fertilization; NPK50%, NPK100% and NPK150% and nano fertilization at rate 1.5, 3 and 4.5 g/L) during the 1st season and the 2nd season as compared with untreated plants (104-105 days) but chemical fertilization at rate 150% recorded the highest number during the 1st season and the 2nd season (121 days in the 1st season and 122 days in the 2nd season).

Table (3): Effect of nano and chemical fertilizers on number of flowering heads and flower diameter (cm.) of *Matricaria chamomilla*, L. plants during 2015/2016 and 2016/2017 seasons.

Treatments	Number flowering heads / plant		Diameter flowering heads (cm.)	
	1 st season	2 nd season	1 st season	2 nd season
Control	19.50 ^e	20.53 ^f	1.03 ^b	0.97 ^b
NPK 50%	95.37 ^c	94.17 ^{cd}	1.37 ^a	1.37 ^a
NPK 100%	104.10 ^b	102.53 ^b	1.37 ^a	1.37 ^a
NPK 150%	130.43 ^a	125.43 ^a	1.53 ^a	1.43 ^a
Nano 1.5g/L.	86.17 ^d	83.23 ^e	1.37 ^a	1.30 ^a
Nano 3g/L.	92.80 ^c	91.43 ^d	1.37 ^a	1.33 ^a
Nano 4.5g/L.	102.83 ^b	98.55 ^{bc}	1.40 ^a	1.37 ^a

^{a to f} Means having different letters exponents in column are significantly different ($P \leq 0.05$).

Increasing the vegetative growth of plants which, supplied with the highest rate of chemical fertilization and nano fertilization is reflected in increasing flowers yield and improving quality and nutritive value. The enhancement of number of flowers/ plant and flower diameter may be due to beneficial effect of the role of increasing nitrogen in the initiation of new cells (Rademacher 1994).

These results were in harmony with those found by El-Maadawy (2007) on *Tagetes erecta*, Vieira *et al.* (1999) on *Calendula officinalis*

Table (4): Effect of nano and chemical fertilizers on flowering start (days) and flowering period (days) of *Matricaria chamomilla*, L. plants during 2015/2016 and 2016/2017 seasons.

Treatments	Flowering start (days)		Flowering period (days)	
	1 st season	2 nd season	1 st season	2 nd season
Control	47 ^a	46 ^a	105 ^f	104 ^e
NPK 50%	34 ^{bc}	34 ^c	116 ^{cd}	116 ^{cd}
NPK 100%	32 ^{de}	31 ^e	118 ^b	117 ^b
NPK 150%	30 ^e	29 ^f	121 ^a	122 ^a
Nano 1.5g/L.	35 ^b	35 ^b	114 ^e	115 ^d
Nano 3g/L.	34 ^{bc}	34 ^c	116 ^d	116 ^c
Nano 4.5g/L.	33 ^{cd}	32 ^d	117 ^{bc}	118 ^b

^{a to f} Means having different letters exponents in column are significantly different ($P \leq 0.05$)

3. Effect of nano and chemical fertilizers on chemical composition.

a.Effect of nano and chemical fertilizers on leaves pigments and carbohydrates percentage.

The effect of nano and chemical fertilizers treatments on photosynthetic pigments Chlorophyll a & b in the leaves of *Matricaria chamomilla*, L. plants are displayed in **Table (5)**. The results showed that, photosynthetic pigments (mg/g fresh weight) were significantly increased due to the application of nano and chemical fertilization in both seasons, in comparison to the unfertilized plants (control). The highest values of Chlorophyll a were 3.19 and 3.34 mg/g fresh weight

in the 1st season when chemical fertilizer was applied at 100% and 150% while the highest values of Chlorophyll a were 3.22, 3.35 and 3.16 mg/g fresh weight in the 2nd season when chemical fertilizer was applied at 100% and 150% and nano fertilizer applied at 4.5 g/L., respectively. Moreover, the application of chemical fertilizer at rate 150% and nano fertilizer at rate 4.5 g/L. gave the highest values of Chlorophyll b which recorded 1.20 and 1.14 mg/g fresh weight in the 1st season, respectively. The same application of chemical fertilizer and nano fertilizer resulted in the highest values of Chlorophyll b which recorded 1.16 and 1.11 mg/g fresh weight in the 2nd season, respectively.

Carbohydrates percentage was greatly and significantly increased in response to chemical fertilizers and nano fertilizers in comparison to the unfertilized plants in the two seasons. The highest values of carbohydrates percentage were 62.40, 60.18 and 60.08 % in the 1st season,, respectively; when chemical fertilizers was applied at 150%, 100% and nano fertilizers at 4.5 g/L. while, The highest values of carbohydrates percentage were 64.21 and 61.36 % in the 2nd season,, respectively; when chemical fertilizers was applied at 150% and nano fertilizers was applied at 4.5 g/L.

From the physiological view, the obtained results could be attributed to the role of the chemical fertilizers as a constituent of pyridines, which are in turn constituents of chlorophyll and cytochromes (**Joo et al. 1999; Magda Mostafa 2002**). These results were in agreement with those obtained by **Hammam (1996)** on *Pimpinella anisum*, **Jacoup (1999)** on *Thymus vulgaris*, **El-Sherbeny et al. (2005)** on *Sideritis montana*, **Swaefy et al. (2007)** on peppermint and **Matter (2009)** on *Hibiscus subdariffa* plant.

Table (5): Effect of nano and chemical fertilizers on Chlorophyll a & b in the leaves (mg/g) and Carbohydrate percentage (%) of *Matricaria chamomilla* L. plants during 2015/2016 and 2016/2017 seasons.

Treatments	Chlorophyll a (mg/g fresh weight)		Chlorophyll b (mg/g fresh weight)		Carbohydrate percentage (%)	
	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season
Control	2.38 ^d	2.34 ^d	0.89 ^d	0.91 ^e	42.50 ^d	41.80 ^d
NPK 50%	3.03 ^{bc}	2.99 ^{bc}	0.90 ^{cd}	0.94 ^{de}	56.79 ^{bc}	57.57 ^{bc}
NPK 100%	3.19 ^{ab}	3.22 ^{ab}	1.10 ^{ab}	1.07 ^{abc}	60.18 ^{ab}	60.57 ^{abc}
NPK 150%	3.34 ^a	3.35 ^a	1.20 ^a	1.16 ^a	62.40 ^a	64.21 ^a
Nano 1.5g/L.	2.83 ^c	2.84 ^c	1.11 ^{ab}	1.02 ^{bcd}	54.89 ^c	55.59 ^c
Nano 3g/L.	3.01 ^{bc}	2.99 ^{bc}	1.01 ^{bc}	0.99 ^{cde}	58.01 ^{abc}	58.84 ^{abc}
Nano 4.5g/L.	3.09 ^b	3.16 ^{ab}	1.14 ^a	1.11 ^{ab}	60.08 ^{ab}	61.36 ^{ab}

^{a to e} Means having different letters exponents in column are significantly different ($P \leq 0.05$).

3.2. Effect of nano and chemical fertilizers on minerals percentage:

Relevant data in **Table (6)** showed the percentage of nitrogen, phosphorus and potassium in dry herb of *Matricaria chamomilla*, L. plants as affected by nano and chemical fertilizers. The three elements were significantly increased due to the use of all nano and chemical fertilizers treatments in the two seasons in comparison to control plants. When chemical fertilizers was used at 150%, 100% and nano fertilizers was used at 4.5 g/L. the values of nitrogen percentages were 3.79, 3.60 and 3.75 % in the 1st season, and 3.92, 3.72 and 3.80 % in the 2nd season, respectively. However, application of chemical fertilizers at 100%, 150% and nano fertilizers at 3 g/L. gave the highest value of phosphorus (0.38, 0.35 and 0.35% , respectively) in the 1st season and (0.38, 0.35 and 0.32 %, respectively) in the 2nd season. In case of potassium the maximum values were obtained as a result of nano fertilizers at 4.5 g/L. and chemical fertilizers at 100% (2.29 and 2.27 % for 1st season) and (2.33 and 2.30 % for 2nd season, respectively).

The previously obtained results were in harmony with those reported by, **Sakr (2001)** on *Menta piperita*, **Abd El-Latif (2002)** on *Carum carvi*, **Haroun and Hussein (2003)** on *Lupinus termis*, **Zaied et al. (2003)** on wheat, **Atta-Alla et al. (2005)** on *Capsicum annum*, **Abdelaziz et al. (2007)** on *Rosmarinus officinalis*.

Table (6): Effect of nano and chemical fertilizers on nitrogen, phosphorus and potassium percentage in dry herb of *Matricaria chamomilla* L. plants during 2015/2016 and 2016/2017 seasons.

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	1 st	2 nd	1 st	2 nd	1 st	2 nd
	season	season	season	season	season	season
Control	1.94 ^d	1.95 ^d	0.17 ^d	0.19 ^c	1.10 ^d	1.15 ^e
NPK 50%	2.65 ^c	2.41 ^c	0.27 ^c	0.28 ^b	1.25 ^d	1.30 ^d
NPK 100%	3.60 ^a	3.72 ^a	0.38 ^a	0.38 ^a	2.27 ^a	2.30 ^a
NPK 150%	3.79 ^a	3.92 ^a	0.35 ^{ab}	0.35 ^{ab}	1.87 ^{bc}	1.90 ^b
Nano 1.5g/L.	2.55 ^c	2.59 ^c	0.30 ^{bc}	0.28 ^b	1.65 ^c	1.69 ^c
Nano 3g/L.	3.14 ^b	3.18 ^b	0.35 ^{ab}	0.32 ^{ab}	1.94 ^b	1.90 ^b
Nano 4.5g/L.	3.75 ^a	3.80 ^a	0.33 ^{abc}	0.33 ^{ab}	2.29 ^a	2.33 ^a

^{a to e} Means having different letters exponents in column are significantly different ($P \leq 0.05$).

3.3. Effect of of nano and chemical fertilizers on Essential oil Percentage:

Essential oil percentage in the flowering heads of *Matricaria chamomilla*, L. (**Table 7**) was greatly and significantly increased in response to nano and chemical fertilizers in comparison to the unfertilized plants at three cuts date in the two seasons. The highest values of volatile percentage were 0.84, 0.82 and 0.82 % in the 1st season; and 0.85, 0.83 and 0.83 in the 2nd season, respectively; when chemical fertilizers was used at 150%, 100% and nano fertilizers was used at 4.5 g/L. (the First cut). While, at the second cut the highest values of volatile percentage were 0.88, 0.85 and 0.86 % in the 1st season, respectively; when chemical fertilizers was used at 150%, 100% and nano fertilizers was used at 4.5 g/L. but the treatment of chemical fertilizers at 150% gave the highest value of volatile

percentage in the 2nd season (0.89%). The same rate of chemical fertilizers (150%) (the third cut) gave the highest values (0.97% in the 1st season and 0.95 % in the 2nd season).

these results were in harmony with those found by **Kassi *et al.* (2014)** on *Matricaria chamomilla* L.

Table (7): Effect of nano and chemical fertilizers on essential oil Percentage of *Matricaria chamomilla*, L. plants during 2015/2016 and 2016/2017 seasons..

Treatments	First cut		second cut		Third cut	
	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season
Control	0.30 ^d	0.31 ^d	0.32 ^d	0.33 ^e	0.35 ^e	0.36 ^e
NPK 50%	0.71 ^b	0.74 ^b	0.77 ^b	0.78 ^c	0.80 ^c	0.81 ^c
NPK 100%	0.82 ^a	0.83 ^a	0.85 ^a	0.87 ^b	0.91 ^b	0.90 ^b
NPK 150%	0.84 ^a	0.85 ^a	0.88 ^a	0.89 ^a	0.97 ^a	0.95 ^a
Nano 1.5g/L.	0.65 ^c	0.66 ^c	0.68 ^c	0.69 ^d	0.70 ^d	0.71 ^d
Nano 3g/L.	0.73 ^b	0.72 ^b	0.78 ^b	0.76 ^c	0.81 ^c	0.80 ^c
Nano 4.5g/L.	0.82 ^a	0.83 ^a	0.86 ^a	0.87 ^b	0.90 ^b	0.91 ^b

^{a to e} Means having different letters exponents in column are significantly different ($P \leq 0.05$).

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استجابة نبات البابونج للأسمدة النانو والكيمائي

نبيل محمد طعيمة – حسين عبد الحق بصيلة – رامي سند ندا

قسم البساتين – كلية الزراعة- جامعة الأزهر - مدينة نصر

أجريت هذه الدراسة في قسم البساتين - كلية الزراعة - جامعة الأزهر - مدينة نصر خلال موسمين متتاليين 2016/2015 و 2017/2016 بهدف دراسة استجابة نبات البابونج لثلاث معدلات من التسميد النانو (1.5 - 3 - 4.5 جرام/ لتر) والتسميد الكيمائي عند ثلاث معدلات من الجرعة الرئيسية (50%- 100%- 150%) وتأثير هذه الأسمدة على الصفات الخضرية والزهرية والمكونات الكيميائية ومحصول الزيت لنبات البابونج.

وأوضحت النتائج ان كل معاملات التسميد النانو والكيمائي أدت الي تحسين في المحصول كما ونوعا مقارنة بالكنترول ويمكن ملاحظة أن الاحتياجات السمادية لنبات البابونج مرتفعة، وبناء علىية يمكن التوصية بأن التسميد الكيمائي (150% من الجرعة الرئيسية) أوالتسميد النانو (4.5 جرام / لتر) هما أفضل المعاملات لإنتاج نبات البابونج تحت ظروف التجربة. ويفضل استخدام التسميد النانو 4.5 جرام/لتر لتقليل الاثار الجانبية الغير مرغوبة للتركيز العالي من التسميد الكيمائي (150%)