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Impact of Vermicompost on Growth; Development and Green Peach Aphid *Myzus persicae* Sulzer (Hemiptera: Aphididae) Infestations in Pot Marigold

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A field experiments were carried out during two successive seasons of 2012/2013 and 2013/2014 at Giza Governorate, Egypt, to study the effect of different rates vermicompost on yield and chemical composition of herbs and flowers of *Calendula Officinalis* L. Results showed that the different application rates of vermicompost fertilizer (0.0, 4.0,8.0,12.0 ton/ fed^{-1}) gave a significant increase in growth parameters, N, P and K in herbs and flowers of *Calendula Officinalis* L. as compared with control treatment. The data indicated that adding vermicompost fertilizer at rate of 8.0 ton / fed^{-1} gave a significant effect on growth characters, N, P and K in both two seasons as compared with the application of 4 and 12 ton / fed^{-1}. Results confirmed clearly that using of vermicompost attributed to decrease the aphid populations. Also, pot marigold plant (herbs and flowers) contain volatile oils, which attractive highly numbers of the parasite of *Aphidius colemani* L. (endoparasitic) to attack the aphid, *Myzus persicae* Sulzer populations.

Keywords: Pot marigold, Vermicompost, *Myzus persicae* Sulzer , *Aphidius colemani* L.

INTRODUCTION

Calendula Officinalis L. (Pot Marigold) is a plant in the genus Calendula (marigolds), in the family Asteraceae. It is probably native to southern Europe through its long history of cultivation makes its precise origin unknown, and may be of garden origin. It is also widely naturalized further north in Europe (north to southern England) and elsewhere in warm temperate regions of the world. Different researches, indicated that significant

Increase *Calendula Officinalis* L. is used for the treatment of skin disorders and pain, and as a bactericide, antiseptic and anti-inflammatory (Bernath, 2000; Fuchs *et al.,* 2005**;** Bolderston *et al.,* 2006). The petals and pollen grains of pot marigold contain, triterpenoid esters (an anti-inflammatory); carotenoids, flavoxanthin; auroxanthin (antioxidants, and the source of the yellow-orange coloration) (Hamburger *et al.,* 2003; Bashir *et al.,* 2006**).**

The excessive use of chemical fertilizers and pesticides are being used by farmers to get a better yield of various field crops specially medicinal plants. It is caused a great damage to soil physical, chemical and biological properties which generated several environmental problems (Gyaneshwar et al., 2002). Some of these problems can

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be solve by using organic fertilizer (composts and vermicomposts) which are natural, beneficial and ecologically friendly (Hargreaves *et al*., 2008; Lazcano *et al*., 2009).

Vermicomposting produces a product that is natural designed to benefit plants in several different ways. The most important aspect of compost produced by earthworms is that it is 100% organic. There are no harmful vermicomposting is produced by biodegradation of organic material through interactions between earthworms and microorganisms. (Jesikha 2013).Vermicompost includes plant-growth regulators which increase plant growth and yield quantity (Canellas *et al*, 2002). Excreta of earthworm were rich of Micro-organism especially bacteria and contain large amounts of plant hormones (auxin, gibberellin and cytokinin) which effect of plant growth and development (Atiyeh *et al*., 2001).

Plant growth; yield quality in flower production of medicinal plants were shown to be strongly affected by soil conditions and amendments of earthworm worked compost on *Calendula Officinalis* L. and other ornamental plant species (Prabha, *et al*, 2007; Azarmi *et al.*2008; Lazcano and Dominguez, 2010; Paim *et al*, 2010 ; Tharmaraj *et al.,* 2011)

According to Sunitha (2000), application of recommended dose of fertilizer and vermicompost was significantly superior in increasing growth performance and lower pest incidence in Chilli nursery. Significantly lower number of leaf hoppers and thrips (Ramesh, 2000). Yardim *et al*. (2006) reported substitution of 20 and 40% vermicompost rate have decreased damage caused by adult striped cucumber beetle (*Acalymma vittatum*) and spotted cucumber beetles (*Diabotrica undecimpunctata*) on cucumber and larval hornworms on tomatoes (*Manduca quinquemaculata* Haworth). The low application of vermicompost have significant suppression effects on mealy bug (*Pseudococcus sp*.), two-spotted spider mite (*Tetranychus urticae* Koch) and aphids (*Myzus persicae* Sulzer.) which attacking cucumbers , tomatoes, bush beans , eggplants and cabbages plants (Arancon *et al*., 2007; Edwards *et al*., 2010). Also, Plants release volatile compounds varying quantitatively and qualitatively depending on plant species that causing repellent or dead of attacking specific pests, and able to attract predators and parasites (Dudareva & Pichersky, 2008). Pot marigold attracts a numbers of natural enemies that attacking a numbers of insect pests (Wei *et al*., 2007).

The current investigation was carried out to study the effect of different rates from vermicompost on yield and chemical composition of herbs and flowers of *Calendula Officinalis* L. Also, the role of pot marigold as plant traps in attracting the natural enemies and suppressing activity of aphids (*Myzus persicae* Sulzer) under field condition.

MATERIALS AND METHODS

Two field experiments were carried out during two successive seasons of 2012/2013 and 2013/2014, in Giza Governorate, Egypt, to study the effect of different rates vermicompost on yield and chemical composition of herbs and flowers of *Calendula Officinalis* L.*.* Prior to any practices, a composite soil sample was taken from the soil surface (0-30 cm) of the experimental site, air-dried, sieved by 2 mm sieve and analyzed (Table 1).

The treatments consisted of sheep manure vermicompost with different concentrations of rates are (0.0, 4.0,8.0,12.0 ton/ fed^{-1}).The analysis of sheep manure vermicompost consisted of PH 7.4; N 1.4; P 0.93; K 0.88%; Cu 30 ppm; Zn 154 ppm, Fe 680 ppm, Mn210ppm and EC=7.3dS/m. The required quantities of vermicompost were applied and incorporated to the top 5 cm layer of soil in the experimental beds before the plantation.

The seeds of *Calendula Officinalis* L. plants were kindly provided by the Department of Medicinal and Aromatic Plants, Ministry of Agriculture, Egypt. Seeds were sown on October 1st during both seasons. The experimental design was complete randomized blocks with five replicates. Each block was divided into 5 plots. The block was contained rows; and the distance between the hills was 25cm and 50 cm apart. Thinning for one plant/hill was done 45days after sowing. All agricultural practices other than experimental treatments were done according to the recommendations of Ministry of Agriculture. During the seedbed preparation, seedlings were transplanted to the experimental plots at November 27, 2013 and November 30, 2014, respectively at 0.3 m within rows and 0.8 m between rows. During the seedbed preparation super phosphate (15.5% P_2O_5) with rate of 31 kg /fed was used. All plots received a uniform application of 120 kg/fed. nitrogen fertilizer as ammonium nitrate (33.5% NH4O3) spitted three equal doses added at 30, 70 and 90 days after transplanting. The experimental plots were irrigated using surface irrigation system.

Plant samples and analysis

Fresh and dry weights (gm /plant) of herbs and flowers of *Calendula Officinalis* L. were collected, then, dried at 70 ^{O}C . The following chemical analyses were determined: nitrogen, phosphorus, and potassium according to the methods described by Cottenie *et al.,*(1982). Physical and chemical properties of the soil were determined according to Chapman and Pratt (1961).

Experimental Design for aphid, *Myzus persicae.*

At the beginning of flowering stage, for the second season period (2013/2014). twenty-five leaves were taken randomly from each five plants /treatment/ replicate for

Table 1: Some characteristics of the experimental site in two seasons.

seasons	Physical properties				Chemical properties					
	Sand	Silt	Clay	Texture	pH	EC dSm^{-1}	$CaCO_3$ %	N	P	K
	%							(ppm)		
2012/2013	9.1	56.4	34.5	Clay loam	7.7	1.4	2.3	88.0	2.3	155.6
2013/2014	7.8	57.1	35.1	Clay loam	7.56	1.5	2.3	95.0	3.4	160.1

inspection and counting the numbers of the aphids and mummies aphid individuals were collected weekly for 9 weeks period. In the laboratory the mummy's aphids were maintained till *Aphidius colemani* L. adults emerging. Each treatment replicated for five times. The parasite was counted and identified (Garantonakis et al., 2009).The percentage parasitism was calculated by the Equation of Kalule and Wright (2002).

% parasitism = (m/[a + m]) x 100

Where :(m) is the mean number of mummies and (a) is the mean number of live aphids. The data obtained were statistically analyzed using one-way analysis of variance (ANOVA) and the mean values were compared using the Least Significant Difference test (LSD; $p < 0.05$; Computer program Micro-stat version 2.5, 1991).

RESULTS AND DISCUSSION

The available data in Table (4) illustrate that application vermicompost fertilizer of different rates (0,4 , 8 and 12 ton/ $fed.^{-1}$) affected herbs and flowers of *Calendula Officinalis* L. as compared with the control (non-vermicompost). These results are in a good harmony and agreement with data recorded by , Atiyeh *et al*, 2001; Scheu , 2003;Azizi *et al.*, 2008; Pritam and Kaushik 2010 ; Sardoei, 2014 and Arguello *et al*.,(2006), they found that the application of vermicompost on *Allium sativum* caused greater yield amount as compared to the experimental plants with no-vermicompost application. Fresh and dry weights (herbs and flowers) were improved significantly affect with increasing compost rates up to 8 Ton / $fed.^{-1}$ compared without vermicompost addition in both seasons (Atiyeh *et al*., 2001). The improvements in plant growth could be due partially to large increases in soil microbial biomass after vermicompost applications, leading to production of hormones in the vermicomposts acting as plant-growth regulators independent of nutrient supply.

The maximum-recorded values were 15.7 and 16.8g / plant dry weight in flowers and 25.8 and 28.6g / plant in herbs in first and second seasons respectively. Similar trend noticed with fresh weight in herbs and flowers in both seasons.

Also, data presented in Table (2) demonstrated that application of vermicompost fertilizer at rate 8 ton/ fed^{-1} gave a significantly increased all growth characters in both two seasons as compared with the application of 4 and 12 ton/ fed^{-1}. It could be concluded that increasing organic matter to *Calendula Officinalis* L. plants induced more growth parameter. This may be due to the ability of organic manure to support the growth plants with micro and macronutrients need for their growth.

Chemical composition:

Data in Table (3) presented that the concentrations and the uptake of N, P and K as affected by application of different rates of (0, 4,8,12 ton/ fed^{-1}) of vermicompost in both, herbs and flowers of *Calendula Officinalis* L. plants as compared with control treatment. Generally, vermicompost was found to be rich in nitrogen and phosphorous and had good structure, low level of heavy metals, low conductivity, high humic acid contents as well as good stability and maturity.

It was observed that application of vermicompost at 8 ton /$fed.^{-1}$ generally increases the concentration of nitrogen in herbs and flowers. The average of increase was 0.51 and 0.46% & 0.33 and 0.45 % in flowers and herbs, respectively as compared with low rate of vermicomposting (4 ton/ $fed.^{-1}$) and control treatment (Table 3). Abbiramy, and Ross, (2012) found that Earthworms play a major role in nitrogen transformations in manure by enhancing nitrogen mineralization

Results noticed that nitrogen, phosphorus and potassium content and uptake in herbs and flowers were influenced by adopted treatments reflecting the magnitude variation due to organic material . Aracnon *et al*., (2006) showed

Table 2: Effect of vermicompost fertilizer on fresh and dry weight (gm / plant) on herbs and flowers of *Calendula Officinalis.* (In both seasons).

Treatments (Ton/Feddan)	Flowers								Herbs			
	Fresh weight (g / plant)		Dry weight (g / plant)		Flowers number		Flowers diameter (cm)		Fresh weight (g / plant)		Dry weight (g / plant)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
4.0	33.6	35.6c	9.8b	9.6b	2.8a	3.0ab	2.4a	2.4a	53.6a	55.8c	17.4b	19.2 ab
8.0	55.8 a	58.2a	15.8a	16.8a	3.20a	3.6a	2.8a	2.8a	89.8a	91.0a	25.8a	28.6c
12.0	47.2 b	50.0b	15.6a	15.8a	3.00a	3.2ab	2.8a	3.0a	68.6a	70.6b	20.8b	21.0 ab
Control	18.6 d	22.4d	4.0b	5.2c	1.0b	1.4b	1.8a	1.8a	37.6a	39.2d	10.4c	11.4b
L.S.D 0.05	6.04	3.92	1.91	2.5	1.27	1.64	1.48	2.08	5.86	7.94	4.1	7.45

Means within columns followed by the same letter are not significantly different.

Table 3: Effect of Vermicompost fertilizer on N, P and K content (%) on herbs and flowers of *Calendula Officinalis.* (In both seasons).

Treatments (Ton/Feddan)	N				P				K			
	Flowers		Herbs		Flowers		Herbs		Flowers		Herbs	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
4.0	1.55c	1.64b	1.22b	1.27c	0.33b	0.35b	0.20b	0.22b	1.41c	1.43c	2.33c	2.28b
8.0	2.01a	2.15a	1.55a	1.62a	0.44a	0.44a	0.28a	0.30a	1.62a	1.58a	2.54a	2.53a
12.0	1.76b	1.84b	1.41a	1.39b	0.37b	0.39b	0.25a	0.27a	1.53b	1.55b	2.40b	2.44a
Control	1.44d	1.38c	1.09c	1.14d	0.27b	0.25c	0.11c	0.13c	1.22d	1.18d	1.98d	2.00c
L.S.D 0.05	0.09	0.17	0.1	0.05	0.055	0.03	0.02	0.02	0.02	0.04	0.05	0.09

Means within columns followed by the same letter are not significantly different.

that application of vermicomposts improved nitrogen and phosphorus uptake .Also, data in Table (3) indicated that application of vermicompost fertilizer increased P and K content in herbs and flowers as compared with control treatment. These results may be due to continuous mineralization of organic manures. The same trend was observed with P and K uptake.

Effect of different vermicompost rates and pot marigold plants as traps and attractive to endoparasitism on aphid infestation.

The results indicated that the highest rate of vermicompost was caused to decrease in the populations of aphid, *Myzus persicae* Sulzer. However, at 12.0 ton/ fed., the aphids infestations were between 0.84 and 1.84 individual / leaf compared 2.12 to 10.64 individual/ leaf in control. The significant differences between the highly rate of vermicompost and control was achieved (Figure1). The other rates effects on the aphid numbers were moderately.

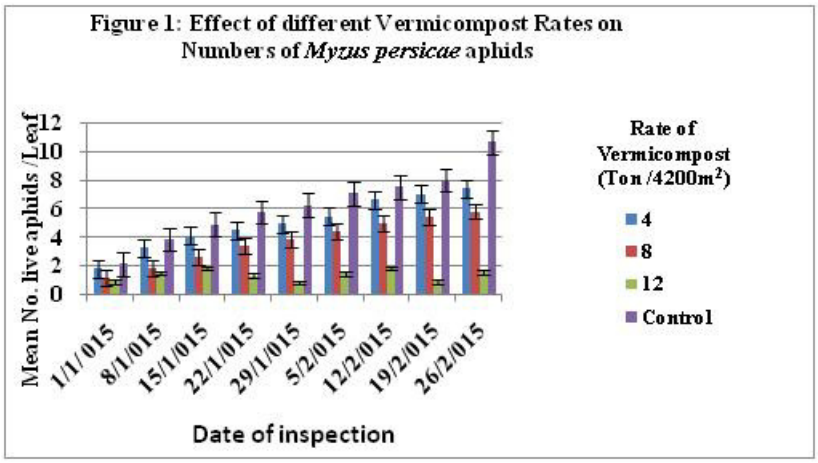
The vermicomposts have been shown to suppress populations and damage by arthropod pests, such as aphids and cabbage white caterpillars (Arancon *et al*., 2006). Other workers have reported that vermicomposts suppressed numbers of jassids, aphids and spider mites (Rao, 2002; Arancon *et al*., 2007; Edwards *et al*., 2010).

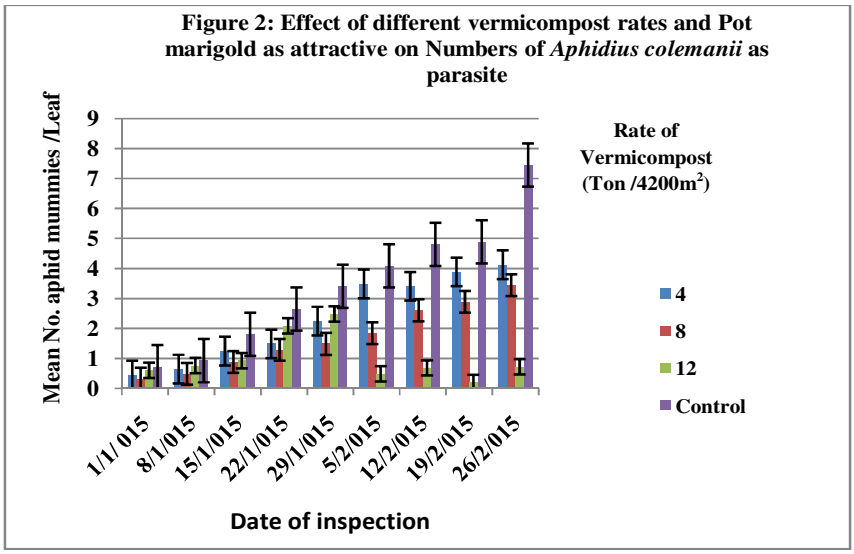
Getnet and Raja ,(2013) found that mean number of cabbage aphid, *Brevicoryne brassicae* population was

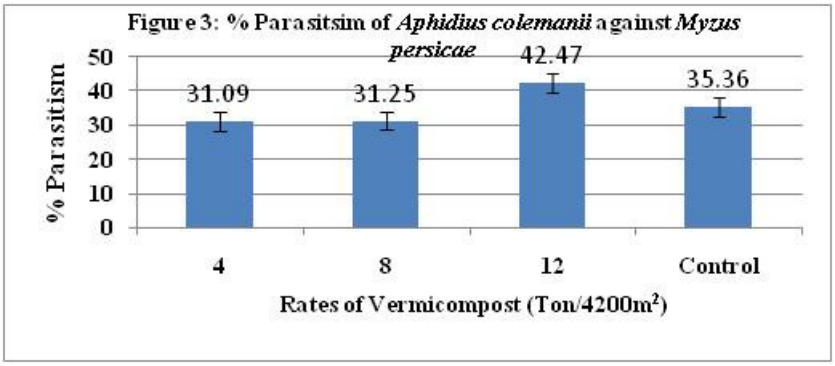
Table 4: Effect of Vermicompost fertilizer on N, P and K uptake (mg/plant) on herbs and flowers of *Calendula Officinalis.* (In both season)

Treatments (Ton/Feddan)	N				P				K			
	Flowers		Herbs		Flowers		Herbs		Flowers		Herbs	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
4.0	153.4c	155.8c	212.2c	243.8c	32.6c	33.2c	34.8c	42.2c	139.6c	135.8c	405.4c	437.8c
8.0	315.6a	352.8a	399.8a	429.0a	69.2a	73.8a	72.2a	85.8a	254.2a	265.4a	655.2a	723.4a
12.0	272.8b	292.4b	291.8b	291.8b	57.4b	62.0b	51.8b	56.6b	237.2b	246.4b	496.8b	512.4b
Control	57.6d	71.8d	112.2d	129.8d	10.8d	13.0d	11.2d	14.8d	48.8d	61.2d	203.8d	228.0d
L.S.D 0.05	14.47	12.22	14.95	8.97	6.01	7.8	8.21	5.45	7.9	8.8	4.85	7.68

Means within columns followed by the same letter are not significantly different.







higher in control plants compared to vermicompost applied plants. The integration of several pest management techniques can minimize the use of chemical pesticides.

As for as, numbers of *Aphidius colemani* L. was highest recording 0.2 to 2.48 individual/leaf (at 12.0 ton/feddan). In control, the numbers of the parasites was recorded 0.72 to 7.44 individual /leaf (Figure 2). The results indicated that the percentage parasitism was 31.09, 31.25 and 42.47% at 4.0, 8.0 , 12.0 ton/fed. , respectively, compared with 35.36 % in control (Figure 3). Balmer *et al.,* (2014) found that adding cornflowers (*Centaurea cyanus* L.) into cabbage (*Brassica oleracea* Linnaeus) fields significantly increased larval & egg parasitation and egg predation of the herbivore, reduced herbivory rates, and increased crop biomass in at least 1 year. These findings show that the flowering plant species can significantly increase natural top-down pest control. These flowering plant species may partially substitute pesticides in agriculture if the approach is optimized, reducing negative effects such as unspecific killing of non-target organisms, residues in food, contamination of soils and water-bodies and increasing pesticide resistances. Our results suggest that, from an agro-economical point of view, egg parasitoids or predators may be the best targets for habitat management because strong natural selection acts on larval parasitoids to keep their hosts alive for their own development.

The results revealed that pot marigold plant was attractive to *Aphidius colemani* L. parasite. The results illustrated in Figure (2), showed that the numbers of mummies per leaf was ranged between 0.48 to 2.08 at the plots of 12.0 ton vermicompost /feddan compared to 0.72 to 7.44 mummies /leaf in control. The results indicated that the highly numbers of aphids and *Aphidius colemani* L. was in control. This is explanation when the finding pest is the specific natural enemies find. However, there is no use of chemical pesticides, fertilizer and using of organic waste in the farm. It is currently widely accepted that the development of more sustainable agricultural production systems depends on a reduction in the use of pesticides and, consequently, the introduction of cropping systems that promote biodiversity and make use of the natural services provided by agro-ecosystems ((Altieri and Östman and Ives, 2003; Madsen et al., 2004; Ratnadass et al., 2012).Many of the plant species in this trial have already been identified as being potentially suitable sources of pollen or nectar for beneficial insects. Kopta et al., (2012) found that flowering plants *Anathalli graveolens; C. cyanus*; *Clendula officinalis* L.; *Filipendula vulgare* and *F. esculentum* were found to be the most attractive for the beneficial insects. Also, the authors concluded that *F. esculentum* (mid season), *Anathallis graveolens; Calendula officinalis* L.; *C. cyanus* L. and *Filipendula. vulgare* (late season) could be recommended for creating flowering strips to increase these beneficial insect populations. It can be expected that especially the aphid population would be reduced by attracted beneficial insect. In the mid season blooming plants, *S. sativu* L. *A. graveolens* show the most promise for use in habitat management in Tajikistan, followed by *A. interrupta* Dung, Zheng & Wei 2006 *C. officinalis* L. *and O. basilice.*

Vermicompost is a low-technology, environmentally-friendly process used to treat organic waste. The resulting vermicompost has been shown to have several positive impacts on plant growth and health. This organic fertilizer is therefore increasingly considered in agriculture and horticulture as a promising alternative to inorganic fertilizers and/or peat in greenhouse potting media. Abd El-Salam *et al.*(2015) found that the addition of vermicompost of pot marigold significantly increased natural enemies densities of *Trichogramma sp* and *Diadegma sp* or repellent and improved for tomato moth control.

Vermicompost can be described as a complex mixture of earthworm faeces, humified organic matter and microorganisms, which when added to the soil or plant growing media, increases germination, growth, flowering, fruit production and accelerates the development of a wide range of plant species. The enhanced plant growth may be attributed to various direct and indirect mechanisms,

including biologically mediated mechanisms such as the supply of plant-growth regulating substances, and improvements in soil biological functions. Use of this type of organic fertilizer therefore has great potential; however some recent studies raise serious doubts about the general applicability of these results and propose a more complex model of action for these types of effects. Stimulation of plant growth may depend mainly on the biological characteristics of vermicompost, the plant species used, and the cultivation conditions. Extensive research on inorganic fertilization and plant breeding, carried out within the framework of conventional agriculture, has allowed agricultural producers to fine-tune nutrient inputs and plant needs in order to maximize yields. However, such detailed knowledge has not yet been attained as regards the interactions between plants and organic fertilizers in sustainable agriculture. Given the complex and variable composition of vermicompost in comparison with inorganic fertilizers and the myriad of effects that it can have on soil functioning, a clear and objective concept of vermicompost is required, and the complex interactions between vermicompost-soil-plant must be unraveled in order to maintain consumer confidence in this type of organic fertilizer.

This study suggests the use of Pot marigold as trap cropping for the enhancement of biological control agents. However, Pot marigold was attractive to highly numbers of natural enemies for example, *Aphidius colemani* L. as endoparasitism.

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