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POTENTIAL IMPACTS OF DIFFERENT AQUEOUS COMPOST EXTRACTS ON GROWTH, YIELD, ENZYME ACTIVITIES AND CONTROLLING POWDERY MILDEW OF CUCUMBER PLANTS GROWN UNDER PLASTIC HOUSES

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ABSTRACT: ***The present study included the impacts of foliar application of aqueous compost extracts prepared from different vegetable wastes composts (onion, garlic, cabbage and their mixture) at two levels (25 and 50%) on vegetative growth, chlorophyll content, enzyme activities and yield as well as controlling powdery mildew of cucumber plants under plastic houses. All vegetative growth parameters, i.e., plant length, number of leaves/plant and leaf area/plant as well as chlorophyll content were significantly increased by all aqueous extracts as compared with the untreated plants. Spraying either the mixed compost or onion compost extracts at 25 and 50 % generally produced the best results of all growth parameters. However, using both of cabbage and garlic compost extracts alone showed intermediate values of most vegetative growth parameters. Compost extracts prepared from the mixed wastes followed by onion wastes were more effective than the other compost extracts in early and total cucumber yields. Enzyme activities in cucumber leaves (polyphenol oxidase and peroxidase) were increased by spraying with all compost extracts and the impact was more effective by the using of mixture extract in most cases. In addition, there are significant reductions of disease incidence and severity of powdery mildew by most of compost extracts, especially mixed compost extract followed by cabbage compost extract as compared with the untreated plants (control) which showed the highest severity of powdery mildew of cucumber plants.***

Key words: ***Cucumber, aqueous compost extracts, growth parameters, yield, enzyme activities, powdery mildew.***

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is an important vegetable crop for the greenhouse industry around the world. Cucumber growers are always looking for great early and total products with good quality.

There is a great interest among sustainable growers about the use of compost extracts for increasing crop health and soil fertility (Ingham, 2003)

and it becomes a part of healthy sustainable program. Compost extract is a highly concentrated microbial solution produced by leaching soluble nutrients and extracting beneficial microbes from compost. Consumers of organic food prefer fruits and vegetables to be organic compared to their food groups because of the perception that these products are more nutritious and safety (Hargreaves *et al*., 2009).

Compost extracts applied to soil or sprayed on plants provide similar amounts of most macro- and micronutrients essential for plant growth compared to compost or inorganic fertilizer treatments as well as suppress diseases which indirectly contribute to plant growth enhancement (Sylvia, 2004 and Heather *et al*., 2006). Therefore, compost extracts may enhance plant growth either indirectly by affecting pathogens on foliage and reducing the disease severity or directly on the plant by excreting plant regulating hormones, which may, in turn, increase the growth rate of plants or the efficiency of nutrients uptake and absorption by plants (Francesco *et al.,* 2004). Application of such extracts on plants produced growth regulators and biocontrol agents which will be environmentally began approach for proper management for nutrient of plants and ecosystem function (Hegazi *et al*., 2008). In this manner, Siddiqui *et al*. (2008) indicated that different compost extracts had significant effect on vegetative growth of okra plants; plants receiving rice straw compost extract with *Trichoderma* gave the best plant growth. Also, using the extract of compost was effective in nutrient amendments for strawberry which improve its growth and fruit quality (Hargreaves *et al*., 2009).

Foliar sprays with aerated and non-aerated compost extracts had a significant effect on growth and yields of some horticultural crops, as pumpkins, potatoes and grapes; they offered more measurable benefits in stimulating crop growth, yield and quality than in suppressing diseases (Ryan *et al*., 2005). Haggag and Saber (2007) reported that spraying tomato and onion crops with non-aerated compost extracts were most effective in this regard. However, foliar spray with green waste compost extract mixed with chicken manure gave the highest yields of tomato fruits and onion bulbs. In this respect, Arancon *et al.* (2007) treated tomato and cucumber plants grown under greenhouse by vermicompost teas ranging from 0, 0.5, 5, 10 and 20 %. They found that compost teas led to a significant increase in plant height and leaf area even the lowest concentration tested (0.5%).

Hence, the objective of this study was to evaluate the potential effects of aqueous non-aerated compost extracts prepared from different plant residues (onion, garlic, cabbage and their mixtures) on vegetative growth, chlorophyll content, yield and enzymes activity of cucumber plants as well as the role of such extracts in controlling powdery mildew disease under plastic houses conditions.

MATERIALS AND METHODS

This investigation has been performed in two successive winter seasons of 2007/08 and 2008/09 at a private farm (Al-Barakah, Al-Riad District) Kafr El-Sheikh Governorate, Egypt. using cucumber hybrid (Dp Cu 1005 F_1, Holland) grown under plastic houses.

Seedlings were transplanted on 15th of November in both experimental seasons on two sides of the ridge at 50 cm spacing between plants within the row, 150 cm width and 4 m length. Plant density was 2.66 plants per square meter. Drip irrigation and all cultural practices including fertilization program were applied according to the recommendations of Ministry of Agriculture.

The aqueous compost extracts (non-aerated) were processed from different vegetables residues (onion, garlic, cabbage and/or their mixture) which prepared according to the bucket fermentation methods (Diver, 2007) and this method is also referred to in the European approach. Mature composts were taken from compost piles after three months old. Compost and tap water were mixed in the ratio of 1:1 (w:v) in plastic containers with covers for about 48 h. The mixtures were filtered through double layers of nylon before dilution with water again in the ratio of 1:4 (v:v) and 1:2 (v:v) to make solution of 25 and 50 % from each compost extracts source, respectively. These concentrations (25 and 50 %) were applied as a result of preliminary test using four levels (25, 50, 75 and 100 %) from each compost extract and it found that both of the two high levels (75 and 100 %) caused scorching the plant leaves. Therefore, we used only the two low levels (25 and 50 %). Main characteristics of different compost extracts were chemically estimated before their dilutions and applications (Table, 1): EC (dSm^{-1}) by EC-meter, pH by pH-meter, total N, P and K were determined according to Jackson (1967) meanwhile, Ca, Fe and humic acids were determined by using the methods of Page *et al*., (1984).

The experiment in each season included nine treatments as follows:

1- Control (untreated)
2- Onion compost extract, 25 %
3- Onion compost extract, 50 %
4- Garlic compost extract, 25 %
5- Garlic compost extract, 50 %
6- Cabbage compost extract, 25 %
7- Cabbage compost extract, 50 %
8- Mixed compost extract, 25 %
9- Mixed compost extract, 50 %

Four foliar applications of compost extracts were performed fortnightly for each source starting one month after transplanting. Spraying was carried out on the whole plants till run-off.

The following measurements were recorded:

1- Plant growth parameters: Plant length (cm), number of leaves and leaf area (cm^2 /plant) were determined at 60 days after transplanting.
2- Chlorophyll content in leaves (SPAD or mg/1oo g fw): Total green color reading (Total chlorophyll) was measured with SPAD meter (Minolta Corp,

Ramsey, N.J.) after 60 days from transplanting using the fifth leaf from the plant top.

Table (1): Main properties (average of two seasons) of different aqueous compost extracts.

Characters	Onion compost extract	Garlic compost extract	Cabbage compost extract	Mixed compost extract
pH	8.13	7.70	7.44	7.1
EC (dSm^{-1})	4.61	3.47	3.94	4.72
Total N (ppm)	197	144	116	380
Total P (%)	0.080	0.025	0.035	0.084
Total K (ppm)	6320	840	2920	5920
Ca (ppm)	222	44	120	244
Fe (ppm)	32	15	13	160
Humic acids (mg⁄g)	5.22	4.53	4.92	5.86
Seed germination test (%)	91.3	92.1	92.4	94.2

3-Fruit yield: Early yield was considered as the weight of fruits per square meter of the first two weeks of harvesting period. Total yield was the weight of all fruits /m^2 at all harvesting time.

4- Polyphenol oxidase and peroxidase enzymes activity: Enzymes extraction and assay: Leaf samples of each treatment, healthy and infected, were collected after 24h of the spraying treatment for peroxidase and polyphenol oxidase enzymes activity assay. Enzymes extract was obtained by grinding leaf tissue in 0.1M sodium phosphate buffer at pH 7.1 (2ml/g leaf tissues) in a porcelain mortar. The extracted tissues were strained through four layers of cheese cloth. Filtrates were centrifuged at 3000 rpm for 20 min. at 6°C. The clear supernatants were collected and considered as crude enzyme extract. Peroxidase activity was determined according to the method of Allam and Hollis (1972) by measuring the oxidation of pyrogallol to pyrogalline in the presence of hydrogen peroxide. Peroxidase activity was measured following the changes in absorbance at 425 nm every 1 min. up to 4 minutes. Polyphenol oxidase was determined according to Maxwell and Batman (1976). The changes in absorbance following spectrophotometrically were measured at 495 nm, and recorded every 1 min. up to 4 min. All measurements were assayed using Beckman Spectrophotometer Du®7400.

5- Disease incidence (mean no. of spots/leaf) and severity (percent of surface infected area) of powdery mildew were determined after 7 days from the last spray according to the scale reported by Horsfall and Barrett (1945) and Biswas *et al*., (1992).

Experimental design and statistical analysis:

The experimental design was established as a complete randomized blocks design with 4 replicates. Each replicate consisted of 4 rows, 4 m long and 3 m wide including 32 plants. Data were analyzed by one - way analysis of variance (ANOVA) using statistical software SPSS 14.0 for windows. Duncan`s multiple range test was used for comparison among the treatment means (Duncan, 1965).

RESULTS AND DISCUSSION

1- Plant growth parameters:

Plant growth parameters as affected by different aqueous compost extracts sources and levels are shown in Table (2). All vegetative growth parameters (plant length, number of leaves/plant and leaf area/plant) were significantly increased as a sequence of the most treatments as compared with the untreated plants. Spraying either the mixed compost extract or onion compost extract at 50 and 25 % for each generally, produced the best results of all growth parameters in both seasons. The lowest growth values were resulted from the control plants followed by the plants sprayed with cabbage compost extracts at both levels with no significant differences between them in most cases. Using garlic compost extracts showed intermediate values of the most vegetative growth parameters in both seasons.

The favorable effect of compost extracts on plant growth might be due to improve the nutrient efficiency or indirectly by their effect on the cation exchange capacity of plants (Epstein *et al.*, 1976 and Ingham, 2003) and/or their suppressive effect on plant pathogens as observed in this study (Table, 4) through reducing the disease incidence and severity (Francesco *et al.,* 2004). The higher nutrient content and humic acids % in the mixed compost extract as shown in Table (1) could be also played an indirect role in improving plant growth by affecting pathogens on foliage, and reducing the disease severity by (Siddiqui, 2006), also compost extract maintained plant nutrient concentrations comparable to that in compost or inorganic fertilizers ((Hargreaves *et al*., 2009).

In addition, the vigorous growth of cucumber plants caused by the using of mixed compost extracts may be attributed to the good physiochemical properties of the extract and sufficient nutrients for both growth and bio-agents (Haggag and Saber, 2007) which improve cucumber growth. Also, the higher content of microorganisms of compost extract as a result to increase biological activity improved the plant growth (Siddiqui *et al*., 2008). Therefore, compost extract is used for inoculating microbial life onto the foliage of plants as well as for, adding soluble nutrients to the foliage to feed the organisms and the plants which improve uptake of nutrients.

Table (2): Effect of different sources and levels of compost extracts on some vegetative growth parameters of cucumber plants in both seasons.

Treatments	Plant length (cm)	No. of leaves /plant	Leaf area /plant (cm^2)	Plant length (cm)	No. of leaves /plant	Leaf area /plant (cm^2)
	2007/08 season			2008/09 season		
Control	53.8 f	23.0 e	115.6 g	56.1 e	24.4 d	117.3 e
Onion extract, 25 %	64.8 c	28.1 cd	130.7 d	62.8 c	26.4 cd	130.0 c
Onion extract, 50%	65.6 c	30.6 ab	139.6 b	70.7 a	33.4 a	140.1 a
Garlic extract, 25%	62.7 d	26.6 d	135.3 c	61.5 cd	25.2 d	128.5 c
Garlic extract, 50%	62.9 d	23.8 e	135.6 c	66.8 b	26.4 cd	134.1 bc
Cabbage extract,25%	58.3 e	23.8 e	121.1 f	60.1 e	24.6 d	125.8 d
Cabbage extract, 50%	60.8 de	24.6 e	124.5 e	60.3 e	23.3 d	127.7 cd
Mixed extract, 25 %	68.9 b	29.2 bc	140.0 b	67.9 ab	27.8 c	137.9 b
Mixed extract, 50 %	70.3 a	32.0 a	145.8 a	69.8 a	31.6 b	141.6 a

Means designed by the same letter are not significantly difference at the 5% level according to Duncan`s test.

2- Chlorophyll content:

The data presented in Fig. (1) show that, the foliar application of all sources and levels of compost extracts caused a significant increase in chlorophyll content compared to that of the control plants in the first season, while the differences were non significant in the second one. Plants sprayed with compost extracts extracted from onion or mixed wastes solely had the highest chlorophyll content, while the untreated plants gave the lowest values in most cases. Using compost extracts of each of cabbage and garlic wastes composts gave the intermediate values in both seasons.

The superiority effect of most compost extracts on the chlorophyll content may be due to their higher nutrient contents, which stimulate the chlorophyll synthesis.

In this concern, Mengel and Kirkby (1987) stated that Mn and Fe play an important role of porphyrine structure of chlorophyll. So, this result may be attributed to the higher contents of humic acids in extracts (Table, 1) which consider the main component for hormone-like activators of humic acids through their involvement in cell respiration, photosynthesis, protein synthesis and various enzymatic reactions (Atiyeh *et al*., 2002).

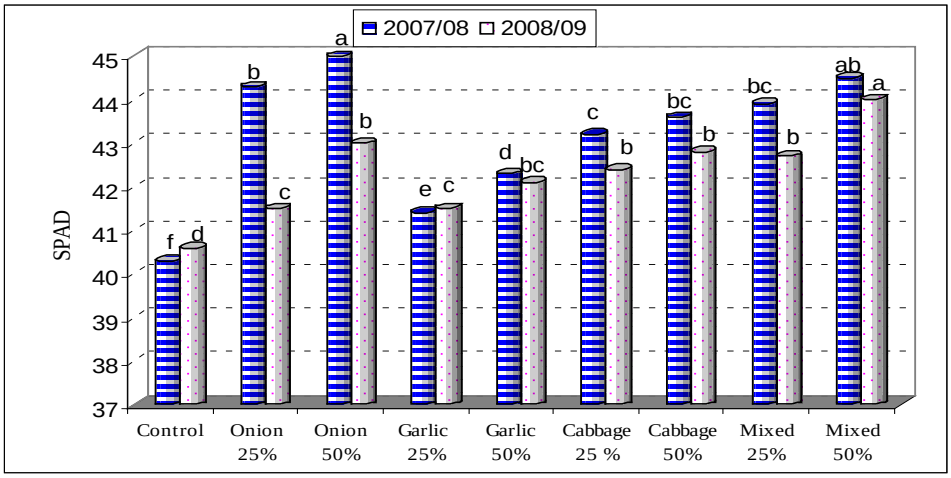

Fig. (1): Effect of different sources and levels of compost extracts on chlorophyll content (SPAD) of cucumber plants in both seasons.

3- Fruit yield:

It is clear from Table (3) that, there were significant effects due to foliar sprays with tested compost extracts on early and total fruit yields in both seasons. The results show that compost extracts made from the mixed residues compost followed by onion residues compost extract were significantly more effective than the other compost extracts as compared to untreated plants which showed the lowest records in both seasons. However, foliar spray with both garlic and cabbage residues compost extracts gave the intermediate values.

The stimulative effect of compost extract prepared from the mixed wastes compost on yield may be due to its favourable effects on plant growth (Table, 2) and chlorophyll content (Fig., 1) which correlated positively with the productivity. Furthermore, the mixed extract contained some soluble nutrients that perform feed the plant, making it healthier and able to make more foods to feed the beneficial microbes that suppress disease causing organisms (Ingham, 2003). It has, also directly affecting the plant by excreting growth regulating hormones which may, in turn, increase the growth rate or the efficiency of nutrient uptake resulting in increase the early and total yields of cucumber (Siddiqui *et al*. (2008).

Table (3) Effect of different sources and levels of compost extracts on early and total yields of cucumber plants in both seasons.

Treatments	Early yield (kg/m^2)	Total yield (kg/m^2)	Early yield (kg/m^2)	Total yield (kg/m^2)
	2007/08 season		2008/09 season	
Control	2.6 d	10.1 e	2.4 c	10.4 e
Onion extract, 25 %	3.6 b	13.2 b	3.4 ab	12.8 b
Onion extract, 50%	3.8 a	13.8 ab	3.5 ab	13.3 a
Garlic extract, 25 %	2.9 c	11.9 d	3.2 b	12.1 c
Garlic extract, 50 %	3.1 c	12.9 b	3.0 c	12.5 bc
Cabbage extract, 25%	3.4 b	12.4 c	3.2 b	11.9 d
Cabbage extract, 50%	3.3 b	12.5 c	3.3 b	12.4 bc
Mixed extract, 25 %	3.8 a	13.8 ab	3.6 a	13.5 a
Mixed extract, 50 %	3.9 a	14.2 a	3.7 a	13.7 a

Means designed by the same letter are not significantly difference at the 5% level according to Duncan`s test.

4- Enzyme activities:

It is clear from data presented in Figs. (2 & 3) that, spraying cucumber plants with onion, garlic, cabbage and the mixed compost extracts separately caused an increase in the activity of polyphenol oxidase and peroxidase enzymes compared to untreated plants at all time courses. It is quite evidence that, the greatest enzyme activities were achieved by using either onion or mixed compost extract at the two levels followed by cabbage and garlic compost extracts. These results indicate that mixed compost extracts and onion compost extract were more effective to induce polyphenol oxidase and peroxidase activities than the other treatments. High activities of polyphenol oxidase and peroxidase in cucumber leaves reflect the high resistance of plant against diseases and this increase may be higher around the pathogen penetration sites or infection sites (Raghavendra *et al.,* 2007) which might be played a role in the inhibition of fungal establishment (Table, 4), thereby enhanced the vegetative growth, chlorophyll content and consequently increasing both of early and total cucumber yields (Table, 3). In this manner, Sivakumar and sharma (2003) showed higher induction of polyphenol oxidase in tea plants due to accumulation of higher phenolic compounds, which may play an important role in defense mechanism in plants against the pathogens.

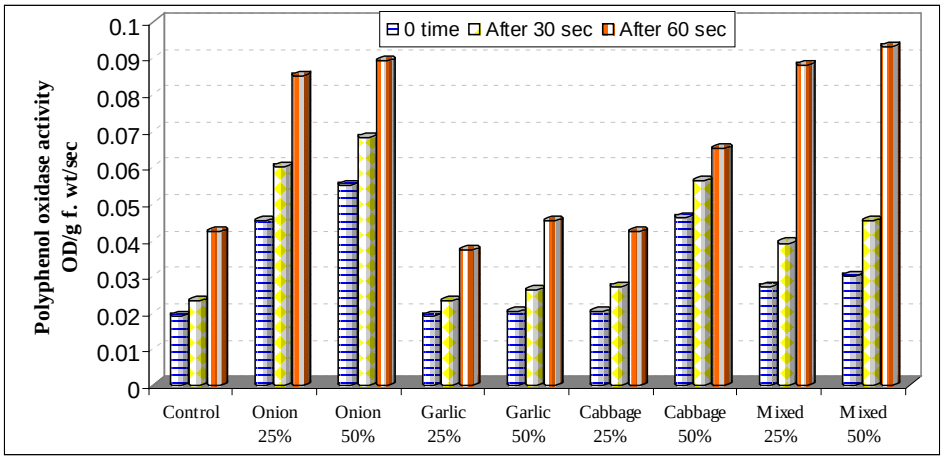

Fig. (2): Effect of compost extracts on polyphenol oxidase activity/30 second of cucumber leaves.

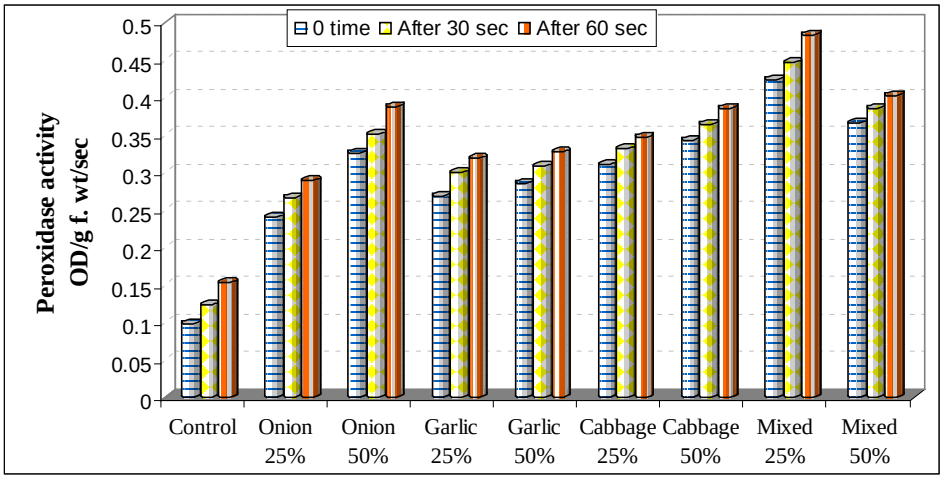

Fig. (3): Effect of compost extracts on peroxidase activity/30 second of cucumber leaves.

5- Disease severity and incidence %:

Data in Table (4) show that, disease incidence and severity of cucumber plants were significantly influenced by spraying different compost extracts in comparison with the control (untreated plants) in both seasons. All aqueous compost extracts significantly reduced both of disease incidence and severity, the best reduction was achieved by spraying the mixed compost

extract followed by cabbage compost extract, onion compost extract and finally garlic compost extract. However, untreated plants (control) gave the highest disease incidence and severity in both seasons.

Compost extracts affect the plant surface through coating with actual live microorganisms. There is no single mechanism explaining effects of compost extracts against pathogens. To date, the effects of compost extracts have been divided into several categories (Beicht, 1981 and Budde and Weltzien, 1990): Inhibition of spore germination, antagonism and competition with pathogens induced resistance against pathogens. In this concern, Daves et al., (2007) reported that the composted wastes have been shown to provide some degrees of control of a number of plant pathogens. Against Allium white rot disease, composted wastes of onion, garlic and cabbage were also successfully used by Shalaby and El-Kot (2009).

Table (4): Effect of different compost extract sources and levels on disease severity of cucumber plants in both seasons.

Treatments	Disease* incidence	Disease** severity	Disease incidence	Disease severity
	2007/08 season		2008/09 season	
Control	30.6 a	42.1 a	31.9 a	44.6 a
Onion extract, 25 %	3.1 d	5.4 b	3.6 bc	6.0 b
Onion extract, 50%	2.8 e	4.2 bc	3.1 bc	4.7 c
Garlic extract, 25 %	4.6 b	5.0 bc	5.1 b	5.4 bc
Garlic extract, 50 %	3.8 c	4.2 bc	3.9 bc	4.4 c
Cabbage extract, 25%	2.4 f	4.7 bc	2.6 c	5.1 bc
Cabbage extract, 50%	2.1 g	4.2 bc	2.2 c	4.5 c
Mixed extract, 25 %	2.0 g	5.7 b	2.2 c	6.4 b
Mixed extract, 50 %	1.4 h	3.3 c	1.5 d	4.1 d

Means designed by the same letter are not significantly difference at the 5% level according to Duncan`s test.
*** = Mean number of powdery mildew spots/leaf ** = Percent of surface infected area**

Conclusion

Compost extracts look rather promising as foliar sprays in organic agriculture in supplying plants by sufficient nutrients and beneficial bio-agents which improve plant growth and suppress certain foliar diseases. Using extracts made from the mixed compost was more effective for plant growth and total yield of cucumber plants than the other tested compost extracts.

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تأثير مستخلصات الكمبوست المختلفة على النمو ، المحصول ، النشاط الانزيمى و مقاومة البياض الدقيقى لنباتات الخيار النامية تحت الصوب البلاستيكية

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الملخص العربى

يعتبراستخدام مستخلصات الكمبوست في انتاج المحاصيل البستانيه كمواد طبيعية وامنة على البيئة من الاتجاهات الحديثه لزيادة الانتاج. تهدف هذه الدراسة الى تقييم تأثيرات الرش ببعض المستخلصات المائية للكمبوست المصنعة من مخلفات بعض محاصيل الخضر (البصل– الثوم– الكرنب– خليط منها جميعا) بتركيزين (٢٥ – ٥٠ %) على النمو، الكلوروفيل، المحصول، النشاط الانزيمى ومقاومة البياض الدقيقى لنباتات الخيار النامية تحت ظروف الصوب البلاستيكية.

أدى الرش بمستخلصات الكمبوست المختلفة إلى زيادة صفات النمو الخضري للخيار مثل طول النبات و عدد الاوراق و المساحة الورقية/نبات ومحتوى الكلوروفيل بالاوراق زيادة معنوية مقارنة بالكنترول.

ادى الرش بمستخلص كمبوست الخليط أو كمبوست البصل (٢٥ ،٥٠ %) للحصول على أفضل نمو خضرى فى الموسمين، بينما أدى استخدام مستخلصات كمبوست الثوم والكرنب الى اعطاء قيم وسطية للنمو الخضري. بينما تعتبر مستخلصات الكمبوست المصنعة من الخليط تلتها المصنعة من البصل أكثر المستخلصات فعالية وتاثيرا على المحصول المبكر والكلى للخيار، حيث ادوا لزيادة معنوية فى المحصول.

أدى استخدام مستخلصات الكمبوست المختلفة لزيادة محتوى الاوراق من الانزيمات (البولى فينول اوكسيديز ، البيروكسيديز) خاصة عند استخدام مستخلص كمبوست الخليط فى معظم الحالات. بالاضافة لذلك فقد أدى استخدام مستخلصات الكمبوست المختلفة الى خفض الشدة والنسبة المرضية للبياض الدقيقى على الخيار وخصوصا عند استخدام مستخلص الخليط تلاه مستخلص الكرنب مقارنة بالنباتات الغير معاملة (الكنترول) والتى أظهرت أعلى نسبة وشدة مرضية للبياض الدقيقى فى الخيار.