Effect of Different Potting Mixes on Germination and Vegetative Growth of Sweet Pepper Plant (*Capsicum Annum* L.) Under Greenhouse Conditions

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Abstract:

Sweet pepper is a high nutrient demanding vegetable crop. Fertilizer use and management is therefore of highly important to sustain growth and high yield. However, this study aimed to evaluate the effect of using different types of organic fertilizer on germination and vegetative growth of sweet pepper plant, that have bell-shaped (*Capsicum annum* L), grown in pots culture under greenhouse condition. The study was conducted at the College of Agriculture, Duhok Governorate, Kurdistan region, Iraq during March 15th, 2015, to June 25th, 2015. The treatments that have been compared in this study were: T1 (Control 100% soil); T2 Municipal Solid Waste compost taken from Kashe factory (1:1 V/V); T3 Sheep manure (1:1 V/V); and T4Peat moss (1:1 V/V).The experiment was randomized complete design with three replicate. The parameters that have been measured were: germination percentage, plant height; number of leave per plant; leaf area and plant fresh and dry weight per pot. In most cases all the studied growth parameters were significantly higher in pot treated by peatmoss and sheep manure compared to control and Municipal Solid Waste compost. Germination percentage was also significantly enhanced in treatment amended by peatmoss and sheep manure. Municipal waste compost was significantly reduced the all the plant growth parameter and germination percentage as well. Depending on these results it can be suggested that organic fertilizers particularly peatmoss and sheep manure can be used to enhance growth and productivity in plant pepper. It was also claimed that the amount of municipal waste compost that was used in this experiment might be too high so further study should be conducted with different ratio on the quality of this type of organic fertilizer.

Keywords: *Compost, Germination, Organic fertilizer, Sweet Pepper, Peatmoss, Yield production,*

1. Introduction

Pepper (Capsicum sp.) is a member of the Solanaceous family and commonly divided into two groups, pungent and non - pungent, which also called hot and sweet pepper. According to Zayed *et al.,* (2013) sweet pepper includes different cultivars and the most commonly used ones, in greenhouse production, are hybrids that have bell-shaped (*Capsicum annum* L.). Bell pepper (*Capsicum annum* L.), which belongs to the Solanacea family, is one of the most popular vegetable crop and widely used foods in almost every part of the world (Abu-Zahra, 2012). In addition, sweet pepper has gained popularity probably due to its additional importance as it also contains a large amount of phytochemicals that have exceptional antioxidant activity and the production and consumption therefore has increased worldwide (Komla, 2013). Sweet pepper can be used as cooked or raw salad. In spite of its low energy value, it has a high nutritional value especially for vitamin A and vitamin C (Roy *et al.,* 2011). However, High yield production of pepper is urgently needed to meet the increasing population and Growing demand for food. Therefore, appropriate grain production technology is highly important to be adopted to fulfill world food demands.

Use of suitable growing media or substrate is essential for production of horticultural crops quality (Bhardwaj, 2014). Previous studies showed that seed germination, quality and crop yield production in growing medium depend on the plants species as well as the types and amount of organic amendments being applied such poultry manure, animal waste, and use of compost or with the use of inorganic fertilizers (Abdrabbo and Farag, 2008; Jalaluddin et al., 2011; Jahromi *et al.*, 2012). However, numerous organic materials can be used for the production of horticultural crops but these organic materials vary in their potential capacity to improve soil and plant growth characteristics. Due to their different production processes, organic amendment might exhibit different physical and chemical features which might influence plant

growth and morphology in diverse ways. Therefore, selecting the effective organic material used as mixture for plant production is very important for sustainable agriculture production.

In recent years, environmental pressures on peat extraction and cost of peat have escalated (Jahromi *et al.,* 2012). Compost is another inexpensive organically based material is being used for vegetable production systems. Researchers have reported beneficial effects of compost on vegetable crops growths and yields (Abul-Soud *et al.,* 2014; Nguyen & Shindo, 2011; Jahromi *et al.,* 2012; Ikeh *et al.,* 2012;). Application of compost increases soil fertility which enhances food security (Abul-Soud *et al.,* 2014). Nevertheless, some of the compost types used had salinity unsuitable physical properties, and variable quality and composition of substrate, which are pointed out as limiting factors (Jahromi *et al.,* 2012). Therefore, it is very important each types of organic fertilizer has to be tested to find the best amounts of organic materials that should be applied as an organic amendment to improve sustainable crop production, minimize environmental pollution and maximizing economic yield.

Nowadays, pepper is widely cultivated in Kurdistan region to meet local food demands but its production is still limited almost entirely to the local area. In addition, there are many types of organic fertilizers (Potting Mixes or Substrates) becoming available in the area but the farmers are not fully aware about the quality of these types of organic fertilizer and their potential capacity on soil and plants improvement. This necessitated an intensive study on the effects of various fertilizers on soil and plant growth to be conducted in the area. Therefore, this study was conducted to study the effect of different types of organic amendments on germination and vegetative growth of sweet pepper plants.

2. Materials and Methods

This study was carried out in pots (Ø 25cm) under greenhouse condition at the College of Agriculture, Duhok University, Kurdistan region, Iraq during March15th, 2015, to June 25th, 2015. Three types of organic fertilizers as potting mixes (municipal waste compost, peat moss and sheep manure) at rate 50% V/V with soil in addition to control (containing 100% soil) were used for current study to evaluate their effects on germination and growth of sweet pepper plants under greenhouse condition. So, the pots were divided into 4 groups with 5 plants in each group. They were labeled as **T1** (control), **T2** (Municipal Solid Waste compost taken from Kashe factory), **T3** (sheep manure) and **T4** (Peat moss).

Table (1): Characteristics of organic fertilizers used as potting substrates.

Parameters	MSWC	Sheep manure	Peatmoss	Soil	Units
$EC_{1:1}$	11.5	4.6	0.48	0.46	dS/m
pH	7.89	7.78	7.1	7.7	
Total Na	3123	556	295	510	mg/Kg
Total K	60125	26557	15461	18550	mg/Kg
Total Ca	21155	23100	22546	20155	mg/Kg
Mg	8232	5556	6789	16650	mg/Kg
C/N ratio	13.8	15.5	30.6	5.9	
Total P	3985	6200	2350	385	mg/Kg
Total N	1.75	1.95	1.2	0.11	%
OC	22.4	30.2	36.5	0.65	%
OM	38.62	52.1	62.9	1.12	%

The control was soil without compost addition. Each potting-medium was repeated three times (3 replications) and the pots were located randomly throughout the greenhouse table. Some chemical properties of the soil and organic fertilizer used in current study were presented in (Table 1). California Wonder pepper, a high yielding variety of capsicum with bell-shaped (*Capsicum annum* L.), was used in this study. Five pepper seeds were sown in each pot at the depth of 5cm and placed in greenhouse. The plants were watered when it needs and the same amount of water was applied to each using graduated cylinder. By the end of the experimental period (Approximately after about 35 days), samples of three plants per pot were taken and the following parameters were measured: plant height (cm), leaf area (cm^2), number of leaves per plant and dry and fresh weight of plant ($g\ pot^{-1}$).

2.1. Parameters Measured

2.1.1. Germination Percentage

Seed germination was recorded regularly until completion of the process (10 days after sowing) (ISTA, 1996). At the end of germination study, germinating percentage was calculated by following formula:

Germination Percentage = (no. seeds germinated/total no. of seeds sown) ×100.

2.1.2. Plant height

The height of the plants was measured in cm from the ground level to the tip of the main shoot. A ruler was used to measure the height.

2.1.3. Number of Leaves per Plant

At the end of the experiment, three pepper plants per pot were randomly selected and their leaves counted, then the total number of leaves per plant was considered.

2.1.4. Leaf Area

Ten leaves per replicate were collected at the end of experiment, and their area in cm^2 was measured by ruler after taking the length and width of the leaves and multiplying by 0.85, then average leaf was calculated. (Watson and Watson, 1953).

2.1.5. Plant fresh and Dry Weight

The average weight (fresh and dry) of plant was considered for the three harvested plants per replicate. The fresh weight of plant was determined from three harvested plant per pot and then dried in an oven at 60°C for two days to a constant weight for dry weight determination.

2.2 Statistical analysis

For statistical analysis, analysis of variance (ANOVA) was used to test the significant effects of organic fertilizer on plant traits following the general linear model (GLM) procedure at ($P < 0.05$). All statistical analyses have been performed using the Minitab software package 16. Significant differences between treatment means were tested using Tukey's test.

3. Results

3.1. Seed Germination

The average germination percentage with different organic treatments was compared with control of plant pepper and is illustrated (Table 2). The analyzed results showed that different treatments significantly affected ($F_{3,8}= 22.56; P < 0.0001$) the germination percentage of pepper plant. It was observed that application of peatmoss and sheep manure increased the germination percentage when compared to control and compost. The germination percentage values were 86.7, 81.7, 58.3 and 32.5% for each of peatmoss, sheep manure, control, and compost respectively.

3.2. Plant Height

In general it can be observed from Table (1) that all parameters of vegetative growth were affected by the application of fertilizers, in spite of existence of non - significant difference in some cases. However, it has been found that the application of organic fertilizers significantly affect ($F_{3,8}= 92.99; P< 0.0001$) the height of plant (Table 2). The plant height was significantly greater in pots amended by peatmoss (31.77 cm) and animal manure (30.55cm) than pots amended by compost and soil (control) with means value of (7.25 cm) and (9.7cm) for both compost and control respectively (Table 2). No, significant difference were found between peatmoss and animal manure and between control and compost ($P> 0.05$).

3.3. Number of Leaves per Plant

Number of leaves per plant were also significantly affected ($F_{3,8}= 8.99; P= 0.006$) by the types of studied fertilizers (Table 2). Significantly highest number of leaves per plant was recorded in pots which have been treated by peatmoss with mean value of (13.7) than the pots which contained compost and control with means value of (7.0) and (7.67) for both compost and control respectively (Table 2). The number of leaves per plants was also higher in pots

treated with peatmoss than pots which were treated with animal manure but these trends were not significantly different *(P> 0.05)* (Table 2).

3.4. Leaf Area

Regarding the effect of studied fertilizers on leaf area, there was a significant difference *($F_{3,8}$= 14.17; P= 0.001)* in the leaf area among the studied treatments (Table 2). The results revealed that the average leaf area was significantly higher in pots treated by peatmoss (39.78 cm^2) and animal manure (35.59 cm^2) compared to pots treated by compost and soil only with mean value of (6.93 cm^2) and (7.15cm^2) for both compost and soil respectively (Table 2). No significant differences were found in leaf area among the rest of the treatments *(P > 0.05)*.

3.5. Plant fresh weight

There was a significant differences (*$F_{3,8}$= 1134.43; P < 0.0001*) in plant fresh weight amongst the studied treatment (Table 2). It was observed that the pots that have been amended by peatmoss and sheep manure had significantly greater fresh weight (17.1 and 16.1g pot^{-1}) than those that have been amended with municipal waste compost and control with mean value of 0.67 and 1.031 (g pot^{-1}) for both compost and control respectively (Table 2 and Figure 1).

3.6. Plant Dry Weight

There also was a significant effect *($F_{3,8}$= 7.24; P= 0.011)* of fertilizer types on plant dry weight (Table 2). Application of peatmoss and animal manure was also significantly increased the plant dry with mean value of (4.42g pot^{-1}) for peatmoss and (4.33g pot^{-1}) for animal manure, while the mean values of compost and control was (0.15g pot^{-1}) (Table 2). Not significant differences in plant dry weight were recorded among the other treatment *(P> 0.05)*.

Table (2): Effect of different types of organic fertilizer with control on Bell pepper germination and some growth characteristics.

Treatment	Germination Percentage (%)	No. of leaves per plant	Leaf area (cm^2)	Plant height (cm)	Plant fresh weight (g pot^{-1})	Plant dry weight (g pot^{-1})
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Peat moss (50%)	86.7 ± 11.55a	13.37 ± 2.32a	39.78 ± 13.83a	31.77 ± 2.32a	17.1 ±0.53a	4.42 ± 1.47a
Sheep Manure (50%)	81.7 ± 2.89a	11.53 ± 1.33a	35.59 ± 8.41a	30.55 ± 3.38a	16.1 ±0.76a	4.33 ± 1.3a
Control (100% soil)	58.3 ± 2.89b	7.67 ± 2.08b	7.15 ±1.06b	9.7 ± 2.33b	1.03 ±0.15b	0.3 ± 0.03b
Compost (50%)	32.5 ± 10.6c	7.00 ± 1.00b	6.93 ± 2.15b	7.25 ± 0.25b	0.67 ±0.06b	0.15 ± 0.05b
				ANOVA summary P-values		
Effect of organic fertilizers	< 0.0001		0.006	0.001	< 0.0001	< 0.0001 0.01

Means within each column having different letters are significantly different according to Tukey's test at 5 % level.
± denotes standard deviation

4. Discussion

The current study was conducted to investigate the effect of different types of organic fertilizers on germination and vegetative growth of sweet pepper plant. According to the results that have been collected, in general, there was a significant effect of organic fertilizer on vegetative growth of pepper plant, in spite of existence of non-significant effects in some parameters. The results showed that the addition of sheep manure and peatmoss was significantly increased all studied vegetative growth parameters of pepper plant (leaves number per plant, plant height, leaf area, plant fresh and dry weight) compared to compost and control. Germination percentage was also increased with the application of organic fertilizer except MSWC which clearly decreased the germination percentage. These results are consistent with the results of other authors (Ling *et al.*, 2005; Abul-Soud *et al.*, 2014; Abu Rayyan and Abu Irmaileh, 2015). This could be explained that the organic fertilizer and its organic matter content are the key factors for enhanced vegetative growth. Another possible reason is that the animal manure and peatmoss contain nutrient content to such an extent that enhance the growth pepper plants at a faster rate in comparison to control. According to Ling et al., (2005) the positive impact of peat moss on both germination percentage and vegetative growth may be attributed to an increase in soil porosity and water holding capacity when peatmoss added to the soil. On other hand, it has been claimed that the higher EC for MSWC could be the main reason responsible in reducing the rate of germination under this treatment. Regarding findings of vegetative growth in compost treated pots, it was observed that the pots that have been amended by municipal waste compost shown very weak germination and production compared to other studied organic amendments. In addition, compost treated pots failed to grow until the fruit maturity stage (Fruit set), as a result it was difficult to take or measure the yield parameters of the plant. Maas (1986) classified pepper as a moderately sensitive crop and maximum permissible concentration in soil water without yield reduction was given as 1.0 - 2.0 dSm^{-1} EC. Thus, this weak germination and vegetative growth of pepper plant in compost treated pots could be explained that the higher EC value of compost, which was about (11.5dS m^{-1}), might be one of the main factors caused the germination and growth to be lower in these growing media, therefore future research should use less amount of this type of organic fertilizer when studying the quality of organic a amendments.

5. Conclusion

Depending on the obtained results it was found out that organic fertilizer increased pepper plant growth, since greater number of leaves/plant, leaf area, height of plant and plant dry and fresh weight were obtained by the addition of organic amendment particularly animal manure and peatmoss, while municipal waste compost decreased all the studied growth parameters of plant. The application of organic fertilizer was also increased the germination percentage of pepper plant except MSWC which decreased the germination percentage.

Thus, the results of present study revealing that the effect potting mixtures on plant growth depending on the types of substrate used as potting mixture. However, according to the results of this project it can be recommended that the animal manure and peatmoss could be used as substrate or potting mixture for pepper plant production. In the case of using municipal waste compost it is suggested that further research should done on this kind of compost with using different ratio.

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6. References

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كارتێكرنا ژينگەهيێت ئەندامى يێت جياواز لسەر شينبوون و گەشكرنا كەسكاتيێ د فلفلا شرين (Capsicum annum L) دا ل بن كاودانێت خانيێت شيشەيدا

كورتيا لێكولينێ:

فلفلا شرين ژ وان رووە كێن زەرزەواتى يە ئەۆێن توخمێت خارنێ ب رێژێن بلند دخازيت. ژبەر هندێ بكارئينانا پەينا و رێڤەبرنا وان گەلەك يا فەرە بو بەردەوامى يا گەشەكرنێ و بەرهەمێ بلند. و دگەل ڤێ چەندێ ژى ئەڤ ڤەكولينە هاتى يە ئەنجامدان بۆ هەلسەنگاندنا كارتێكرنا بكارئينانا جۆرێت جياواز ژ پەينێ ئەندامى ل سەر گەشەكرنا كەسكاتيێ د رووەكێ فلفلێ دا، كو ئەوژى وەكى زەنگلێ يە د شێوەى دا (Capsicum annum L)، رووەكێ فلفلێ هاتە چاندن دناڤ قافكادا ل بن بارودوخێ خانيێ شويشەى ڤە، ئەڤ ڤەكولينە هاتە ئەنجامدان ل كوليژا چاندنێ، پارێزگەها دهوكێ، هەرێما كوردستانێ، عراقێ، ل سالا 2015، ل 15 ئاذارێ هەتا 25 حوزەيرانێ. ئەو مامەلە يێن بەراوردى دناڤ بەرا وان دا هاتى يە كرن ژى ئەڤەنە؛ T1 (مامەلا بەراورديێ 100% ئاخ)، T2 كومبوست بەرمايكێت باژێرى يێن رەق ئەوێ هاتى يە وەرگرتن ژ كارگەها كاشێ (V/V 1:1)، T3 بەرمايكێن تەرش و كەوالى (V/V 1:1) و T4 بيتموس (V/V 1:1). ديزاينا هەرەمەكى يا تمام بو ڤێ ڤەكولينێ هاتە ب كارئينان دگەل سێ دووبارەكرنا. سالوخەتێن هاتينە هەلسەنگاندن ژى ئەڤەبوون، بلندى يا رووەكى، هژمارا بەلگا د هەر رووەكەكى دا، رووبەرێ بەلگى و هەروەسا كێشا تەر و هشك يا رووەكى، ريژا شينبونێ. دبەهرا پتر يا بارودوخا دا هەمى سالوخەتێن رووەكى يێن هاتينە خاندن بلندى يەكا بەرچاڤ هەبوو د وان قافكێن هاتينە مامەلە كرن ب پيتموسى و بەرمايكێن تەرش و كەوالى بەراوردى دگەل مامەلا بەراوردكرنێ و مامەلا كومبوست بەرمايكێن باژێرى يێن رەق. رێژا شينبوونێ هاتە هاندان ب شێوەيەكێ بەرچاڤ دەمێ قافك هاتيە مامەلە كرن ب پيتموسى و بەرمايكێن تەرش و كەوالى. كومبوست بەرمايكێن باژێرى يێن رەق هەمى سالوخەتێن هاتينە خاندن ب شێوەيەكێ ديار كێمكرن زێدەبارى رێژا شينبوونێ. و ل دوماهيێ ل دويف ئەڤان ئەنجاما ئەم دشێين پێشنيار بكەين كو پەينێ ئەندامى و ب تايبەت پيتموس و بەرمايكێن تەرش و كەوالى دشيان دايە بهێنە ب كائينان بو هاندانا گەشەكرنێ و بەرهەمێ رووەكێ فلفلێ. و هەروەسا رێژا كومبوست بەرمايكێن باژێرى يێن رەق ئەوێن هاتينە ب كارئينان د ڤێ ڤەكولينێ دا رێژێن وان گەلەك د بلند بوون و ژبەر ڤێ چەندێ ژى دڤێت هێشتا خاندن ل سەر بهێنە كرن دگەل رێژە و جورێن جياوازێن ڤى جورێ پەينێ ئەندامى.

تأثير الاوساط العضوية المختلفة على الانبات و النمو الخضري لنبات الفلفل الحلو (*Capsicum Annum* L.) تحت ظروف البيوت البالستيكية

الخلاصة:

يعد الفلفل الاخضر (الحلو) من المحاصيل الخضرية متطلبة للعناصر الغذائية بكميات عالية. لذلك فان استخدام الاسمدة و إدارتها يعتبر مهماً جدا لإدامة النمو و الإنتاجية العالية. ومع ذلك،فقد إجري هذا البحث لتقييم تأثير استخدام انواع مختلفة من الاسمدة العضوية على النمو الخضري لنبات الفلفل (Capsicum annum L). اجريت هذه الدراسة تحت ظروف البيت الزجاجي التابعة لكلية الزراعة، جامعة دهوك، اقليم كردستان العراق للفترة من 15 اذار و لغاية 25 حزيران 2015 في اصيص بلاستيكية باستخدام اربع معاملات و كما يلي: T1 (معاملة المقارنة 100% تربة)، T2 كومبوست النفايات البلدية الصلبة التى اخذت من معمل كاشي (V/V 1:1)، T3 مخلفات الاغنام (V/V 1:1) و T4 بيتموس (V/V 1:1). تم استخدام التصميم العشوائي الكامل و ثلاثة مكررات لكل معاملة و شملت الدراسة قياس الصفات التالية: ارتفاع النبات، عدد الاوراق لكل نبات، مساحة الورقية، اوزان الرطب و الجاف للنبات بالا ضافة الى نسبة الانبات. اظهرت النتائج ان جميع صفات النبات المدروسة اختلفت معنويا في الاصيص التي تم معاملتها بالبيتموس و مخلفات الاغنام مقارنة بمعاملة المقارنة و النفايات البلدية الصلبة. نسبة الانبات حفزت معنويا في المعاملتي البيتموس و مخلفات الاغنام. النفايات البلدية الصلبة قللت معنويا جميع الصفات نمو النبات المدروسة بالاضافة الى نسبة الانبات. اخيراً، اعتمادا على هذه النتائج يمكن الاقتراح بان الاسمدة العضوية وبالاخص البيتموس و مخلفات الاغنام يمكن استخدامها لتشجيع نمو و انتاجية نبات الفلفل. وان كمية النفايات البلدية الصلبة التي تم استخدامها في هذه التجربة كانت عالية جداً لذلك يصح عند اجراء دراسات اخرى مع نسب و نوعية مختلفة من هذا النوع من السماد العضوي.