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Effect of Mulching Materials and Foliar Spray with Compost Tea on Growth ,Yield and Bulb Quality of Garlic Plants under Sandy Soil Conditions

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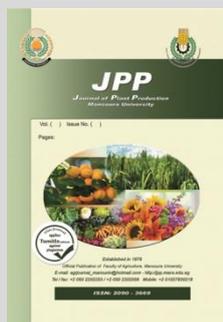
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ABSTRACT

Garlic (*Allium sativum*, L.) is an important vegetable crop in Egypt. A current study was aimed to study the effect of hoeing (H), black plastic mulching (PM), rice straw mulching (SM), H + 10 % compost tea, PM + 10 % compost tea and SM + 10 % compost tea on growth, yield components as well as some chemical constituents of garlic plants under sandy soil conditions. Two field experiments were carried out during the two consecutive seasons of 2013/2014 and 2014/2015 at Experimental Farm of Horticulture at El-Kassasein Distract, Ismailia Governorate, Egypt . Plastic, straw and hoeing plus 10 % compost tea resulting in the highest plant height, leaf number per plant, bulb diameter and bulbing ratio .Fresh and dry weights of bulb as well as whole-plant increased by using plastic or straw mulches in combined with compost treatments with no significant difference between them. The highest average bulb weight significantly recorded with straw mulch and foliar spray with 10 % compost tea. Straw or plastic mulches plus compost significantly increased average clove weight and total bulb fresh yield per feddan and relative yield percentage. In most cases, total soluble solids as well as nitrogen, phosphorus and potassium percentages in garlic bulb significantly increased by using straw or plastic mulches + foliar spray with 10 % compost tea

Keywords: Garlic, mulching, plastic, straw, hoeing, growth



INTRODUCTION

Garlic (*Allium sativum* L.) is a valuable vegetable plant with a high consumption in the Mediterranean region, including Egypt. Garlic is one of the oldest vegetable plants under farming in the world. It is turn up in the second most substantial crops cultivated and utilized through alliums after onion. Garlic cloves commonly utilized as a condiments or spice as well as many medicinal objectives (Ahmed *et al.*, 2010). Rising garlic production has turn into major necessary to gathering the always increased demand of local consumption and exportation (El-Hifny, 2010).

Hoeing and hand attracting of weeds are expensive, function demanding and strenuous and liable to cause damage to the brittle roots and bulbs as garlic plant (Ghaffoor, 2004). In management relationships of the soil, mulching has been suggested to impact activity of microorganisms, organic matter content, soil nutrients availability, erosion control and compaction of the soil (Stowell, 2000). Most mulches in common application are some kinds of organic matter. They participate to the humus content of soil where they tolerate decay (Hassan, 1999). Plastic mulch has been notified to raise output and farm income (Mugalla *et al.*, 1996). Straw mulch is recommended for the vegetable crops production based on better total performance than the other mulching and also for being inexpensive and organic type (Jamil *et al.*, 2005).

Compost tea is a liquid extract of compost consisting with primary plant nutrients and helpful

microorganisms which recycles organic matter. It also increases the plant and soil improving activity of soil lifetime. Compost tea has been utilized as a fertilizer, pesticide and fungicide (Litterick *et al.*, 2004). Compost tea has been cited as an choice for traditional and organic farmers thought to promote crop productivity by put in microorganisms that might relief in soil nutrient retention and extraction, and by raising soluble nutrients, moreover adding to their possibility amount as a part of an incorporate crop management project (Merrill and McKeon, 2001, Ingham, 2005 and Kannangara *et al.*, 2006).

The present study was executed to check the effect of different mulches (plastic and rice straw), hoeing practice and compost tea in promote garlic growth, yield components and chemical constituents under sandy soil conditions.

MATERIALS AND METHODS

Two field experiments were carried out during the two consecutive winter seasons of 2013/2014 and 2014/2015 at Experimental Farm of Horticulture Research station at El-Kassasein Distract, Ismailia Governorate, Egypt, to study the effect of two mulching materials (black plastic 0.08 mm thick and rice straw at 5 ton / feddan) beside hoeing practice three times at 25, 50 and 75 days after planting with and without addition of compost tea at 10 % as foliar spray at 70, 80 and 90 days after planting. This experiment included 6 treatment as follows : hoeing (H), black plastic mulching (PM), rice straw mulching (SM), H + 10 % compost tea, PM + 10 % compost tea and

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SM + 10 % compost tea on the plant growth, yield components and bulb chemical constituents of garlic plants Cv. Chinese grown in sandy soil conditions under drip irrigation system . These treatments were arranged in randomized complete blocks design with three replicates. The soil utilized was sandy in texture. It was sampled before treatments application to a depth of 30 cm and analyzed for some physical and chemical properties as shown in Table (1) according to Chapman and Pratt (1978).

Table 1. The physical and chemical properties of soil during 2013/2014 and 2014/2015 seasons

	Physical properties			Soil texture					
	Sand (%)	Silt (%)	Clay (%)						
2013/2014	93.42	1.78	4.80	Sandy					
2014/2015	92.80	2.10	5.10						
Chemical properties									
Characters	Organic matter		Available nutrients (ppm)						
	pH	Calcium carbonate (%)	N	P	K	Fe	Zn	Mn	
2013/2014	8.12	0.05	0.23	8.1	6.8	56	4.87	3.42	2.06
2014/2015	8.09	0.07	0.26	7.8	5.7	58	5.14	3.37	2.14

The chemical contents of the compost were presented in Table (2). The stock solution of compost tea was prepared by soaking 10 Kg compost in 30 l of water for three days and was filtrated by plastic net, the clear stock solution was utilized to prepare the diluted compost tea for reaching the electrical conductivity (EC) of the compost tea to 2 ml.mhos/cm as described by Abou-El-Hassan (2010).

Table 2. Chemical analysis of the compost

Characters	pH	Organic matter (%)	Macronutrients (%)				Micronutrients (ppm)				
			N	P	K	Ca	Mg	Fe	Zn	Mn	Cu
Values	7.35	35	1	0.5	1.1	6.46	1.56	27	82	25	16

The area of the experimental unit was 12.60 m². It contained three dripper lines each of 6 m length and 0.70 m width. One line was used for sample to measure garlic growth parameters and the other two lines were used for yield determination. In addition, one row was left between each two experimental unit as a guard row to avoid the overlapping of spraying solutions. All experimental units received equal amounts of botanical compost at 12 ton/feddan during soil preparation.

The cloves of garlic cv. Chinese were sown in 29 September in the two seasons. The black plastic was spread, then irrigation and the perforation was done at 10 cm on both sides of the irrigation line. Rice straw was spread after 2 days from planting. Garlic cloves were selected from uniformity in shape and size. The other normal agricultural treatments for growing garlic plants were practiced.

Recorded Data

Plant growth:

After 120 days from planting of garlic cloves, a sample of three plants were randomly taken from each experimental unit and plant growth parameters were recorded: plant height (cm), number of leaves/plant, neck diameter (cm), bulb diameter (cm), bulbing ratio (neck diameter/ bulb diameter) as reported by Mann(1952), bulb

fresh and dry weights (g), leaf fresh and dry weight ,and total fresh and dry weights (bulb+ leaves).

Yield and its components:

At proper maturity stage of bulbs (about 180 days after planting), bulbs in every plot were harvested, then moved to a shady place in the same day for curing .After 15 day, average bulb weight (g), average number of cloves/bulb, average cloves weight (g) and total yield (ton/feddan) as well as relative yield (%) were recorded.

Chemical constituents:

After 120 days from planting date, chlorophyll a, b, total chlorophyll a+ b and carotenoids contents (mg/100 g fresh weight) in garlic leaves were analyses according to AOAC (1990). Also, nitrogen , phosphorus as well as potassium percentages in garlic bulb was determined according to Chapman and Pratt (1978) at the end of experiment. Nitrate content (mg NO₃ kg⁻¹) was determined in green plants by direct potentiometer using the ion-selective electrode. In addition, total soluble solids (TSS) of garlic bulb (Brix°) was determined by using a hand refractometer.

Statistical Analysis:

Data were statistically analyzed using the analysis of variance according to Snedecor and Cochran (1980). Least significance difference (L.S.D.) was used to differentiate means at the at 5 % level of probability. The means were compared using computer program of Statistix version 9 (Analytical software, 2008).

RESULTS AND DISCUSSION

Vegetative growth characters:

Plant height, number of leaves/plant, neck and bulb diameter were increased by using all mulching treatments plus compost tea application as foliar spray compared to hoeing alone during both seasons, in most cases (Table 3). Generally, the highest values in this concern were observed by black plastic mulch, rice straw mulch and hoeing when combined with 10 % compost tea application compared to each practice Individually. Furthermore, the best treatments in increase bulb diameter, bulb fresh weight and bulb dry weight were that plastic mulch and rice straw mulch + compost tea at 10 % spread three times/season with no significant difference between them in both seasons (Table 4). Moreover, the heaviest fresh weight of leaves and total fresh and dry weights (bulb +leaves) weights of garlic were observed with black plastic and rice straw mulches plus compost tea compared to the other treatments under study during the two consecutive seasons (Table 4). Plastic mulch+ 10 % compost tea increased garlic bulbing ratio compared to the other ones under study. Rice straw mulch without compost tea treatment recorded the lowest values regard total dry weight.

Anisuzzaman *et al.* (2009) found that the tallest plants and the more leaves number per onion plant were noticed in the plots covered with black polythene mulch compared to the other mulches under study. The superiority of black polyethylene mulching on the rice straw and comparison in awarding the elevated temperature in the soil, which enhances the vigor and growth of roots length, water absorption and the needful elements dissolved and especially NPK development vegetative growth and its move to the leaves which leads to

increase the number of leaves/plant, may be due to the reason that garlic bulb analysis that holds some nutrients that have increased garlic growth (Homez and Arouiee, 2016). Maximum plant height and leaf number/plant were recorded in the plants mulched by black polyethylene mulch followed by grass mulch treatment (Seifu *et al.*, 2017). Also, compost tea is suitable than compost in order

that it contain on dissolvable nutrients so it can be used to soil through irrigation systems or to plant foliage. Also, compost tea is highly rich in phytohormones and growth regulators which reflected on plant growth. (Abou-El-Hassan and Desoky, (2013), and Diab *et al.* (2012) on cucumber, and Shaheen *et al.* (2018) on common bean also have reported similar results.

Table 3. Effect of mulching materials and compost tea application on vegetative growth parameters of garlic at 120 days after planting during 2013/2014 and 2014/2015 seasons.

Treatments	Plant height	Number of leaves/plant	Neck diameter (cm)	Bulb diameter (cm)	Bulbing ratio
	2013/2014 season				
Hoeing (H)	72.00	10.67	1.14	4.31	0.264
Plastic mulching (PM)	73.33	10.33	1.11	4.39	0.253
Straw mulching (SM)	73.00	11.00	1.12	4.37	0.256
H + 10% compost tea	78.00	10.33	1.13	4.39	0.258
PM + 10% compost tea	81.00	11.00	1.39	4.74	0.294
SM + 10% compost tea	79.00	11.00	1.35	4.75	0.283
L.S.D. at 5 %	5.98	N.S.	0.20	0.20	0.041
2014/2015 season					
Hoeing (H)	72.00	10.33	1.08	5.03	0.216
Plastic mulching (PM)	68.67	11.00	1.26	5.23	0.241
Straw mulching (SM)	72.00	10.67	1.11	5.01	0.222
H + 10% compost tea	77.33	11.67	1.23	5.43	0.227
PM + 10% compost tea	80.00	11.33	1.45	5.69	0.255
SM + 10% compost tea	77.00	11.67	1.35	5.70	0.238
L.S.D. at 5 %	6.68	0.92	0.16	0.57	0.027

Table 4. Effect of mulching materials and compost tea application on yield and its components of garlic at 120 days after planting during 2013/2014 and 2014/2015 seasons.

Treatments	Bulb fresh weight (g)	Leaves fresh weight/ plant (g)	Total fresh weight (g)	Bulb dry weight (g)	Leaves dry weight/ plant (g)	Total dry weight (g)
	2013/2014 season					
Hoeing (H)	38.04	59.81	97.85	15.70	10.30	26.00
Plastic mulching (PM)	40.33	71.29	111.62	16.77	10.55	27.35
Straw mulching (SM)	36.35	71.84	108.19	15.80	10.15	25.95
H + 10% compost tea	45.64	75.55	121.19	18.00	11.21	29.21
PM + 10% compost tea	46.36	84.65	131.01	20.00	11.47	31.47
SM + 10% compost tea	52.33	93.95	146.28	19.61	11.88	31.49
L.S.D. at 5 %	6.67	2.56	8.36	1.13	1.30	1.89
2014/2015 season						
Hoeing (H)	36.76	74.36	111.12	14.98	9.85	24.83
Plastic mulching (PM)	38.50	85.92	124.42	14.66	10.10	24.76
Straw mulching (SM)	35.00	75.95	110.95	14.32	9.06	23.38
H + 10% compost tea	43.59	96.47	140.06	15.79	10.87	26.66
PM + 10% compost tea	35.65	99.33	134.98	19.13	11.07	30.20
SM + 10% compost tea	50.41	100.39	150.80	16.89	11.42	28.31
L.S.D. at 5 %	7.33	1.33	7.92	4.69	2.23	5.22

Yield and its components:

It is evident from the obtained data in Table 5 that, the highest average bulb weight, total yield per feddan and relative yield (%) recorded significantly with rice straw mulch and foliar spray with 10 % compost tea compared to the other ones under study.

All treatments of hoeing and different materials mulches with or without compost tea non significantly affected average number of cloves per bulb during both seasons. Straw or plastic mulches and foliar application with compost tea application significantly increased average clove weight and total bulb fresh yield per feddan compared to hoeing lonely and the other treatments under study.

In this connection, Kwon *et al.* (2011) investigated the influences of mulching by polyethylene on the growth and yield of garlic. They found that polyethylene mulch promoted the number of cloves/bulb. Homez and Arouiee (2016) reported that black polyethylene recorded a

significant impact as compared to other mulch treatments on the cucumber yield and its component parameters (number of fruits and yield). Prasad *et al.* (2017) found that the best quality of onion bulb in regard of maximum neck thickness, basal diameter, diameter of bulb and number of scales per plant were obtained when mulching was done with wheat straw and rice husk. Barakat *et al.* (2019) indicated that the rice straw mulch enhanced total bulbs yield of garlic and its components compared without mulching soil.

However, Abou-El-Hassan and Desoky (2013) demonstrated that organic production of head lettuce in sandy soil can be complete successfully employing compost tea to get high yield and quality. Kim *et al.* (2015) showed that application of compost tea increased yield of red leaf lettuce, sweet corn, and soybean. Thus, compost tea could be utilized as a factor for raising plant growth and yield in organic cultivation of different crops.

Table 5. Effect of mulching materials and compost tea application on yield and its components of garlic plants during 2013/2014 and 2014/2015 seasons

Treatments	Average bulb weight (g)	Average number of cloves /bulb	Average clove weight (g)	Total yield /feddan (ton)	Relative yield (%)
2013/2014 season					
Hoeing (H)	42.04	15.00	2.80	4.691	100.00
Plastic mulching (PM)	44.33	13.00	3.28	4.928	105.09
Straw mulching (SM)	40.35	14.00	2.86	4.454	95.31
H + 10% compost tea	49.64	14.33	3.42	5.473	117.01
PM + 10% compost tea	51.36	14.00	3.64	5.694	121.52
SM + 10% compost tea	56.33	14.33	3.91	6.253	133.22
L.S.D. at 5 %	1.06	N.S.	0.28	0.593	---
2014/2015 season					
Hoeing (H)	40.76	14.00	2.89	4.542	100.00
Plastic mulching (PM)	42.50	14.00	3.00	4.705	103.59
Straw mulching (SM)	39.00	13.33	2.92	4.305	94.85
H + 10% compost tea	47.59	14.00	3.38	5.207	114.65
PM + 10% compost tea	49.65	13.33	3.72	5.453	120.19
SM + 10% compost tea	54.41	14.00	3.86	5.997	132.16
L.S.D. at 5 %	0.66	N.S.	0.30	0.617	--

Leaf and Bulbs chemical constituents:

The obtained data in Tables 6 and 7 reveal that, chlorophyll a, carotenoids and nitrate contents of garlic were not significantly affected by mulching treatments without or with compost tea application. In most cases,

chlorophyll b and total chlorophyll(a + b) contents in garlic leaves as well as total soluble solids in garlic bulb were increased with soil mulching plus 10 % compost tea compared to hoeing treatment individually during both seasons.

Table 6. Effect of mulching materials and compost tea application on leaf pigments of leaves (mg/100g as fresh weight) of garlic plants during 2013/2014 and 2014/2015 seasons

Treatments	Chlorophyll a	Chlorophyll b	Total chlorophyll(a+b)	Carotenoids
2013/2014 season				
Hoeing (H)	3.78	2.71	6.49	3.98
Plastic mulching (PM)	3.82	2.75	6.57	3.91
Straw mulching (SM)	3.71	2.56	6.26	3.98
H + 10% compost tea	3.92	2.97	6.89	3.87
PM + 10% compost tea	3.73	3.05	6.79	3.83
SM + 10% compost tea	4.18	2.44	6.62	3.85
L.S.D. at 5 %	N.S.	0.54	0.61	N.S.
2014/2015 season				
Hoeing (H)	3.76	2.89	6.65	4.00
Plastic mulching (PM)	3.77	2.68	6.45	3.93
Straw mulching (SM)	3.69	2.66	6.35	3.97
H + 10% compost tea	3.81	2.96	6.77	3.90
PM + 10% compost tea	3.93	2.89	6.82	3.85
SM + 10% compost tea	3.91	2.87	6.78	3.87
L.S.D. at 5 %	N.S.	0.30	0.44	N.S.

Table 7. Effect of mulching materials and compost tea application on bulb quality of garlic plants during 2013/2014 and 2014/2015 seasons

Treatments	Nitrogen (%)	phosphorus (%)	Potassium (%)	Nitrate content (mg/kg as fresh weight)	Total soluble solids (Brix°)
2013/2014 season					
Hoeing (H)	1.380	0.298	1.703	666.20	35.27
Plastic mulching (PM)	1.473	0.307	1.783	667.00	35.68
Straw mulching (SM)	1.420	0.305	1.730	664.10	35.46
H + 10% compost tea	1.500	0.315	1.810	664.43	36.54
PM + 10% compost tea	1.590	0.321	1.890	664.30	37.03
SM + 10% compost tea	1.553	0.318	1.840	665.00	37.00
L.S.D. at 5 %	0.047	0.009	0.059	N.S.	0.31
2014/2015 season					
Hoeing (H)	1.403	0.301	1.680	664.43	35.77
Plastic mulching (PM)	1.490	0.308	1.753	663.70	36.12
Straw mulching (SM)	1.457	0.304	1.713	663.50	35.53
H + 10% compost tea	1.523	0.314	1.787	664.43	36.70
PM + 10% compost tea	1.603	0.317	1.920	664.30	36.95
SM + 10% compost tea	1.557	0.319	1.850	665.00	37.42
L.S.D. at 5 %	0.038	0.007	0.063	N.S.	0.30

Using hoeing + compost tea resulted in an increase regard chlorophyll b content in the second season and total

chlorophyll content in the first season compared to the other treatments under study (Table 6). Nitrogen,

phosphorus and potassium percentages in garlic bulb significantly increased by using straw or plastic mulches + foliar spray with 10 % compost tea compared to the other treatments under study, in most cases (Table 7). Hoeing treatment without compost tea addition recorded the lowest values in this concern in both seasons. In the same time, the lowest values of nitrate content were recorded with rice straw mulch without compost tea application compared to the other treatments under study in the first and second seasons.

Plants treated with organic mulches significantly increased chlorophyll "a" and chlorophyll "b" contents of garlic (Baten *et al.*, 1995). Also, Najafabadi *et al.* (2012) suggested that TSS and vitamin C content were influenced by mulching. Although mulching could enhanced some quality parameters in garlic. Due to two years experiment and interaction between year and mulches the usage of rice straw and plastic mulch recommended improving garlic quality. Abou-El-Hassan and Desoky (2013) showed that 100% and 125% compost with added compost tea treatments recorded the highest TSS% and chlorophyll content of lettuce heads compared to other treatments. The statically analysis of the chemical constituents effect of the compost tea on tomato plants clearly indicated that compost tea when applied weekly, produce a positive effect on chlorophyll content compared to untreated plants (Morales-Corts *et al.*, 2016). The best onion TSS. (Brix°) was also achieved when mulching was done by wheat straw and rice husk (Prasad *et al.*, 2017). In the same time, Gouda and Gahwash (2015) revealed that soaking garlic cloves in compost tea before planting significantly increased the concentration of chlorophyll at leaves in both seasons of study.

However, Gouda and Gahwash (2015) pointed out that foliar spraying by compost tea on garlic plants significantly increased the chemical constituents i.e., N, P and K percentages and significantly decreased the nitrate contents in garlic bulbs in the two seasons. Furthermore, El-Metwally and Adel El-Wakeel (2019) indicated that the use of black plastic mulch and banana leaf mulch drive to the highest significant raise in growth traits and potato tubers yield. This in turn correlated with a significant increase in tuber contents of phosphorus and potassium percentages than weeded control treatment.

CONCLUSION

From previous results of this study, it could be concluded that spraying garlic plants with compost tea at 10 % three times under rice straw mulch increased plant growth and total yield of garlic as well as leaf pigments and mineral content, also, decreased nitrate content under organic cultivation conditions.

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تأثير مواد التغطية والرش الورقي بشاي الكمبوست على النمو والمحصول والجودة في نباتات الثوم تحت ظروف الاراضي الرملية

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يعد الثوم من محاصيل الخضرة الهامة في مصر. الهدف من هذه الدراسة دراسة تأثير العزيق، التغطية بالبلاستيك الأسود، التغطية بقش الأرز، العزيق + 10% شاي كمبوست، التغطية بالبلاستيك + 10% شاي الكمبوست والتغطية بقش الأرز + 10% شاي كمبوست على النمو، مكونات المحصول وكذلك بعض المكونات الكيميائية لنباتات الثوم تحت ظروف الاراضي الرملية. أجريت تجربتين حقليتين خلال الموسمين المتتاليين 2014/2013 و 2015/2014 في المزرعة التجريبية لبحوث البساتين بمنطقة القصاصين بمحافظة الإسماعيلية، مصر. ، أدى استخدام التغطية بالبلاستيك والقش والعزيق بالإضافة إلى 10% من شاي الكمبوست إلى الحصول على أعلى القيم لارتفاع النبات وعدد الأوراق لكل نبات وقطر البصلة ومعدل التوصيل. زادت الأوزان الطازجة والجافة للأبصال وكذلك وزن النبات كاملاً باستخدام التغطية بالبلاستيك أو قش الأرز مع المعاملة بشاي الكمبوست بدون وجود فرق معنوي بينهما. تم تسجيل أعلى متوسط لوزن البصلة معنويًا مع قش الأرز والرش الورقي بمعدل 10% شاي كمبوست. أدت التغطية بقش الأرز أو البلاستيك بالإضافة إلى شاي الكمبوست إلى زيادة معنوية في كل من متوسط وزن البصلة والمحصول الطازج الكلي للفدان والنسبة المئوية للمحصول النسبي، زاد إجمالي المواد الصلبة الذائبة الكلية بالإضافة إلى النسب المئوية للنتروجين الكلي والفسفور الكلي والبوتاسيوم في أبصال الثوم معنويًا بالتغطية بقش الأرز أو البلاستيك + الرش الورقي بمعدل 10% من شاي الكمبوست .