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EFFECT OF PLANTING DISTANCE OF CERTAIN CULTIVARS ON INCIDENCE OF ROOT AND CROWN ROT DISEASES IN STRAWBERRY NURSERIES

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ABSTRACT: The effect of planting distances on the development of root and crown rot diseases of strawberry in the transplanting nursery was studied in two successive seasons of 2015 and 2016. Three Super Elite mother plants of Festival, Florida and Sweet Charlie were tested. Seven Planting distances (0.6, 0.9, 1.2, 1.5, 1.8, 2.1, 2.4 m) were used between mother plants. The first three planting distances (0.6, 0.9, 1.2 m) were the standard distances used by strawberry growers in the commercial nurseries. The rest of planting distances (1.5, 1.8, 2.1, 2.4 m) represented the suggested modified distances. The obtained results showed a considerable amount of reduction (%) on root and crown rot diseases on the produced transplants of the modified planting distances. The modification of planting distances in strawberry nurseries could be used as one of banned methyl bromide alternatives.

Key words: Plant distance, strawberry cultivars, root and crown rot, nurseries.

INTRODUCTION

Certified strawberry nursery is very important element in the strawberry production, since it produces pathogen-free propagation materials (runners or transplants). Runners traditionally have been the principal means of strawberry propagation (**Mass, 1984**). Runners are frequently infected with root and crown rot pathogens which considered great obstacles facing the strawberry growers. Such diseases can be caused by single, or combinations of fungal/or oomycete pathogens, including one or more species of *Fusarium* (**Golzar *et al.,* 2007**), *Rhizoctonia* (**Martin, 1999**), *Macrophomina* (**Mertely *et al.,* 2005**), *Pythium* (**Martin, 1999**) and *Phytophthora* (**Duncan, 2002**). Strawberry growers depend mainly on methyl bromide in soil fumigations for controlling soil borne diseases. However, soil fumigation using methyl bromide or other fumigants is considered prohibitively expensive or sometimes impractical. In addition, the "Montreal Protocol" declaration came out with the fact of developed countries should phased-out such uses of methyl bromide in 2005, while developing countries have to phase-out controlled uses of methyl bromide by January 1st, 2015 (**UNEP, 2014**). Also, controlling both diseases using a fungicides program is considered a great challenge, since the causal pathogens are belonged to different fungal taxa and each one required a specific group of fungicides accordingly. Likewise, performing such fungicides program will reduce a considerable amount of profit from the production output income. Therefore, much reliance has been placed on the use of integrated pest management program (IPM) as a soil fumigation alternative to tackle such pests and diseases impairing the strawberry production and minimize the cost expenses. Reducing plant density (**Strand, 1994**) by establishing wider within-row plant distances or using cultural practices that prevent competition for enough nutrients and promote plant vigor have been recommended as methods to reduce soil borne diseases that require high plant density and root condensation.

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The current work aimed to study the role of agricultural practice as one of the IPM elements in controlling or reducing both root and crown rot diseases in strawberry nurseries through modifying the planting distances between mother plants by establishing wider within-row planting distances.

MATERIALS AND METHODS

A field experiment was carried out in growing season of 2015 then repeated once in the following season of 2016 at Kafr El-Sohby, Qalyubia Governorate to study the effect of planting distances between mother plants in strawberry nurseries on the development of root and crown rot diseases. Three Super Elite Class (certified) mother plants of Festival, Florida and Sweet Charlie represented the main commercial and favorable cultivars for the strawberry growers in Egypt were chosen in this study. Ten mother plants were placed in one offset row per raised bed (2.0 m width, 15.0 m length and 0.20 m height). Drip irrigation system was applied with 30 cm apart between drippers. Seven planting distances (0.6, 0.9, 1.2, 1.5, 1.8, 2.1, 2.4 m) were used between mother plants. The first three planting distances (0.6, 0.9, 1.2 m) were the standard distances used by strawberry growers in the commercial nurseries. The rest of planting distances (1.5, 1.8, 2.1, 2.4 m) represented a suggested reasonable range that could be used commercially to avoid high numbers of runners densities in the field that favor the development of root and crown rot diseases. Roots of the tested mother plants were disinfested before planting by immersing in an aqueous solution containing Rizolex T50 (3.0 g/l), Topsin M70 (1.0 g/l) and Tachigaren 30% SL (1.5 ml/l). The experimental design was randomized complete block with four replicates for each treatment (**Steel and Torrie, 1980**).

When the runners reached the mature stage, percentage of root and crown rot diseases was estimated. In addition, numbers of healthy, diseased and percentages of plant losses per faddan were also calculated.

Analysis of variance (ANOVA) was carried out using the computerized program (SPSS Inc., Vesion 13.0, Chicago, IL., USA).

RESULTS AND DISCUSSION

The effect of agricultural practices which represented in the current study by the planting distances on controlling of root and crown rot diseases in strawberry nursery was experimented in two successive seasons (2015 and 2016). The obtained results were shown in Tables 1, 2, 3, 4. Statistical analysis showed that results of both seasons were completely coincident. The percentage of both root and crown rot diseases were reduced by increasing the distances between mother plants. The more the distance the less the development of such diseases. Also, the results of both seasons showed that Sweet Charlie cultivar was more tolerant to both diseases than the other two cultivars (Florida; Festival). In addition, statistical analysis showed that there was no significant interaction between the tested cultivars and the suggested planting distances, which gave an impression that the planting distance has direct effect on reducing the development of root and crown rot diseases in the strawberry nursery. However, the planting distance of mother plants has no effect of the cultivar's disease tolerance. The tolerance level of the tested cultivars to both diseases could be contributed to their genetic makeup. Sweet Charlie has higher level of disease tolerance than the other cultivars, Florida and Festival.

The suggested planting distances reduced the losses of the resulting transplants produced by the tested cultivars in both growing seasons (Tables 5 and 6). The more the planting distance the less the losses. The development of such diseases resulting in a number of dead or may be fewer number of runners than the healthy ones. Reduced the number of transplants in the strawberry nurseries or even in the production fields is mainly due to the soil borne pathogens which cause the development of root and crown rot diseases or other soil borne pathogens (**Perez-Jimenez *et al.*, 2012; Chamorro *et al.*, 2015**). The losses are reportedly the result of soil borne pathogens such as *Macrophomina phaseolina*, the causal agent of charcoal rot (**Avilés *et al.*, 2008**); *Phytophthora cactorum*, causing strawberry crown rot (**De los Santos *et al.*, 2002**); *Fusarium solani*, causing crown and root rot (**Pastrana *et al.*, 2014**). The dramatic increase of these diseases in strawberry nurseries

Table 1. Effect of planting distance and strawberry cultivars on the percentage development of root rot disease in the nursery (season 2015)

Cultivar	Planting distance (m)							Mean
	0.6	0.9	1.2	1.5	1.8	2.1	2.4	
Festival	28.00	25.00	22.00	20.00	18.00	16.00	14.00	20.43[a]
Florida	23.00	21.00	20.00	18.00	15.00	13.00	11.00	17.25[b]
Sweet Charlie	20.00	17.00	15.00	12.00	10.00	8.00	7.00	12.71[c]
Mean	23.67[a]	21.00[ab]	19.00[bc]	16.67[cd]	14.00[de]	12.33[ef]	10.67[f]	

Means followed by common letters within rows or columns are not significantly different at 0.05 level of probability.

Table 2. Effect of planting distance and strawberry cultivars on the percentage development of crown rot disease in the nursery (season 2015)

Cultivar	Planting distance (m)							Mean
	0.6	0.9	1.2	1.5	1.8	2.1	2.4	
Festival	27.00	25.00	24.00	21.00	17.00	15.00	13.00	20.29[a]
Florida	24.00	21.00	20.00	18.00	16.00	12.00	11.00	17.43[b]
Sweet Charlie	21.00	19.00	16.00	15.00	11.00	8.00	7.00	13.86[c]
Mean	24.00[a]	21.67[ab]	20.00[bc]	18.00[c]	14.62[d]	11.67[e]	10.33[e]	

Means followed by common letters within rows or columns are not significantly different at 0.05 level of probability.

Table 3. Effect of planting distance and strawberry cultivars on the percentage development of root rot disease in the nursery (season 2016)

Cultivar	Planting distance (m)							Mean
	0.6	0.9	1.2	1.5	1.8	2.1	2.4	
Festival	24.00	21.00	19.00	16.00	13.00	11.00	10.00	16.32[a]
Florida	20.00	17.00	16.00	14.00	12.00	10.00	9.00	14.00[b]
Sweet Charlie	18.00	15.00	13.00	10.00	9.00	6.00	6.00	11.04[c]
Mean	20.67[a]	17.75[b]	16.00[b]	13.33[c]	11.33[cd]	9.08[de]	8.33[e]	

Means followed by common letters within rows or columns are not significantly different at 0.05 level of probability.

Table 4. Effect of planting distance and strawberry cultivars on the percentage development of crown rot disease in the nursery (season 2016)

Cultivar	Planting distance (m)							Mean
	0.6	0.9	1.2	1.5	1.8	2.1	2.4	
Festival	26.00	24.00	22.00	20.00	15.00	13.00	12.00	18.86[a]
Florida	22.00	20.00	19.00	16.00	14.00	11.00	10.00	16.00[b]
Sweet Charlie	16.00	16.00	14.00	13.00	9.00	7.00	6.00	11.64[c]
Mean	21.50[a]	20.00[ab]	18.33[bc]	16.33[c]	12.67[d]	10.33[de]	9.33[e]	

Means followed by common letters within rows or columns are not significantly different at 0.05 level of probability.

Table 5. Effect of planting distance on the amount of healthy and percentage of lost transplants in strawberry nursery during season of 2015

Cultivar	Distance (m)	Total and healthy produced transplant (thousand)/faddan			
		Total transplants/ faddan	Healthy transplant/ faddan	No. of lost transplants	Losses (%)
Festival	0.6	540	365	175	32.4
	0.9	527	370	157	29.8
	1.2	513	381	132	25.7
	1.5	499	402	97	19.4
	1.8	505	456	49	9.7
	2.1	428	399	29	6.8
	2.4	362	350	12	3.3
Florida	0.6	450	330	120	26.7
	0.9	425	340	85	20.0
	1.2	420	350	70	16.7
	1.5	390	360	30	7.7
	1.8	375	335	40	10.7
	2.1	350	335	15	4.3
	2.4	300	292	8	2.7
Sweet charlie	0.6	420	320	100	23.8
	0.9	405	325	80	19.8
	1.2	380	330	50	13.2
	1.5	370	345	25	6.7
	1.8	350	330	20	5.7
	2.1	320	308	12	3.8
	2.4	240	234	6	2.5

Table 6. Effect of planting distance on the amount of healthy and percentage of lost transplants in strawberry nursery during season of 2016

Cultivar	Distance (m)	Total and healthy produced transplant (thousand)/faddan			
		Total transplants/ faddan	Healthy transplant/ faddan	No. of lost transplants	Losses (%)
Festival	0.6	542	372	170	30.4
	0.9	530	377	153	28.9
	1.2	517	388	129	23.0
	1.5	504	429	75	14.7
	1.8	506	468	38	7.5
	2.1	430	403	27	6.3
	2.4	365	356	9	2.5
Florida	0.6	452	337	115	24.3
	0.9	443	363	80	18.1
	1.2	424	366	58	11.3
	1.5	395	370	25	6.4
	1.8	376	359	17	4.5
	2.1	352	339	13	3.7
	2.4	295	290	5	1.7
Sweet Charlie	0.6	422	332	90	21.3
	0.9	408	335	73	17.9
	1.2	384	338	46	11.9
	1.5	375	353	22	5.9
	1.8	360	343	17	4.7
	2.1	335	325	10	3.0
	2.4	225	221	4	1.8

are related largely to the phasing out of soil fumigants, including methyl bromide, in accordance with the Montreal Protocol (**Martin, 2003**) in addition to the high prices of other fumigants. Such extra costs may reduce the growers input incomes. Therefore, for managing and tackling these challenges, the strawberry growers should find out other reasonable management to keep their high profits. Following IPM system is considered a reasonable method to compensate the growers' losses due to such diseases. Modification of agricultural practice is considered an element of the IPM approach. Some experimental evidence supports the widespread belief that growing plants in dense stands promotes epidemic (**Bordon and Chilbers, 1982**). Some cultivars of common bean have a higher incidence of white rot disease (*Sclerotinia sclerotiorum*), possibly because reduced air movement within foliage favored disease development (**Saindon *et al.*, 1995; Tu, 1989**). In strawberry, planting distance also is affected by the need to enter the field to regularly apply pesticides, weeding and easy perform other agricultural practices (**Legard *et al.*, 2000**).

In conclusion, modifying planting distance of strawberry mother plants in the nurseries or of transplants in the production fields could reduce the development of soilborne diseases. However, the strawberry's growers should justify the required planting distances according to their field status to optimize high numbers of healthy runners, amount of yield and maximize profit.

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تأثير مسافات الزراعة على حدوث أمراض أعفان الجذور والتيجان على بعض أصناف الفراولة تحت ظروف المشتل

إيمـــان يحيـــى خفـاجـــي

معهد بحوث أمراض النباتات – مركز البحوث الزراعية – الجيزة - مصر

تم دراسة تأثير تعديل مسافات الزراعة في مشاتل الفراولة على تطور حدوث أمراض أعفان الجذور والتيجان خلال الموسمين المتتاليين من ٢٠١٥ و ٢٠١٦، تم اختبار هذه المسافات على ثلاث أصناف (سوبر ايليت) هم فستيفال وفلوريدا وسويت تشارلي، حيث تم استخدام سبع مسافات زراعة (٠,٦، ٠,٩، ١,٢، ١,٥، ١,٨، ٢,١ و٢,٤م) بين النباتات الأم، وكانت المسافات الثلاث الأولى للزراعة (٠,٦، ٠,٩، ١,٢م) هي المسافات القياسية المستخدمة من قبل مزارعي الفراولة في المشاتل التجارية، أما بقية مسافات الزراعة (١,٥، ١,٨، ٢,١ و٢,٤م) فكانت تمثل المسافات المعدلة المقترحة، وأظهرت النتائج التي تم الحصول عليها قدرا كبيرا من الانخفاض في نسبة الإصابة (%) بأمراض تعفن الجذور والتيجان وذلك بالنسبة للشتلات المنزرعة علي المسافات المعدلة والمقترحة، وهذا يمكننا من استخدام تعديل مسافات الزراعة في مشاتل الفراولة كأحد بدائل بروميد الميثيل المحظورة.

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