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The Effects Of Different Water Stress And Perlite Media On Growing Of Pepper Plant (*Capsicum annuum grossum var. cv.Demre*)

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ABSTRACT : This study was conducted to determine whether incorporation of different perlite fractions onto the growth media could be used for manipulation of yield of pepper plant at different water stress levels. Fine, moderate and coarse perlite was added to the soil at 8% and stress was applied at levels of 75, 50, 25 and 12.5 %of available water. Transpiration rate, root dry weight, root length, root area, and fresh plant weight of plants were measured. All parameters were affected by decreasing size of perlite material mixing to soil. The finest perlite was the most effective media on plant growth. Different water stresses were applied from blooming to the end of harvest. At that time interval, the most effect on transpiration, root dry weight, root length, root area and fresh plant weight was obtained from applying 50% of available water level. On the other hand, the root length was the same affected by the lowest stress level (12.5% of available water level), too. There was no significant effect at different water stress levels and in different growth media on the root area. Under limited watering conditions, it may be suggested that using the finest perlite particle size and maintenance of 50% available water level could be suitable conditions for adequate root growth.

Key Words: Pepper (*capsicum annuum*), perlite, water stress, root, transpiration

Farklı Su Stresi ve Perlit Ortamlarının Biber Bitkisinin Gelişimi Üzerine Etkileri

ÖZET: Bu çalışma, farklı perlit fraksiyonlarının yetiştirme ortamlarıyla birlikte farklı su stres seviyelerinde biber bitkisinin verimine etkisinin olup olmadığını belirlemek için yürütülmüştür. Toprağa hacimsel olarak %8 oranında ince, orta ve kaba perlit ilave edilmiş ve yarayışlı suyun %75, %50, %25 ve %12.5'u seviyesinde su stresi uygulanmıştır. Bitkilerin terleme, kök kuru ağırlığı, kök uzunluğu, kök alanı ve yaş bitki ağırlıkları ölçülmüştür. Toprağa ilave edilen perlit materyalinin tane çapı küçüldükçe tüm parametreler etkilenmiştir. İnce perlit bitki gelişimi üzerine en etkili ortam olmuştur. Çiçeklenme döneminden hasat sonuna kadar farklı su stresleri uygulanmıştır. Terleme, kök kuru ağırlığı, kök uzunluğu ve yaş bitki ağırlığı üzerine en iyi etki yarayışlı su düzeyinin %50'si uygulanmasıyla elde edilmiştir. Bununla birlikte, kök uzunluğuna en düşük stres düzeyi (yarayışlı suyun %12.5düzeyi) de aynı etkiyi göstermiştir. Kök alanı üzerine farklı perlit ortamlarının ve farklı su stres düzeylerinin bir etkisi bulunamamıştır. Suyun yetersiz olduğu durumlarda, yeterli kök gelişimi için ince perlit materyalinin kullanılması ve yarayışlı suyun %50 düzeyinde tutulması önerilir.

Anahtar Kelimeler: Biber *(Capsicum annuum*), perlit, su stresi, kök, terleme

INTRODUCTION

Firstly, being provided a good production in soil is related to soil physical properties. Some materials which are known "soil amendment" are used to improve of soil physical properties. These materials are necessary to include suitable aeration, sufficient amount and balance available water and plant nutrient matter for successful production. Perlite which especially affects soil physical properties and inorganic soil amendment has got large perlite deposits in Turkey (Munsuz et al., 1974, Munsuz et al., 1982). Properties of perlite especially affects water holding capacity, bulk density and macro-micro porosity of soil.

Plants are exposed to various stresses during growth. Water is the most important life deposit and even if there is suitable temperature its deficiency is the most limiting factors for plant growing. If the water lost by transpiration is more than this absorbing with roots, water stress occur, which causes decrease of germination, limits of root growth, decrease in nutrient absorbent with roots and decrease production and quality of plant.

Some problems occur in soils which is frequently treated especially in greenhouse. Therefore, suitable ratios of growing materials are needed to be mixed with soils in order to amendment. Pepper plant is important greenhouse plant for Turkey. It wants suitable level of soil moisture for optimum growing, because it is fairly sensitive to drought (Günay, 1992). In vegetable growing, irrigation is absolutely necessary when precipitation is unsufficient. This dezadvantage is merely balanced with controlled irrigation and applying of growing materials high in organic matter and water holding capacity (Özbek et. al, 1993).

The aim of this research was to evaluate the growing of pepper in different water stress levels and different perlite media.

MATERIALS AND METHODS

The experiment was carried out in greenhouse of Ankara University, Agriculture Faculty between May 30 and September 30, 1998. Average temperature and average proportional moisture in experiment periods were 22°C and 55%, respectively (Anonymous, 1998). Soil used in trial was taken from trial field of Agriculture Faculty. Soil has been screened through a 4mm sieve and perlite material which course perlite (CP) (0.5-4mm), moderate perlite (MP) (0.8-2mm) and fine perlite (FP) (0.1-0.5mm) was used in three different fractions. Some

analysis results of soil and perlite used in research are given Table 1.

Texture was obtained by hydrometer method (Bouyoucos, 1951), bulk density of soil was determined according to paraffin method (Black, 1965) and bulk density of perlite was determined according to De Boodt et al. (1973), organic matter was determined by Jackson (1958), pH and electrical conductivity (EC) in 1:2,5 soil-water suspension and FC and WP values by U. S. Salinity Lab. Staff (1954), AW value was obtained by WP value was subtracted from FC value.

In according to goal of trial was used in 2,5liter pots. Trial was arranged separately in randomized plot design with three perlite fractions, three water levels, control and three replications under greenhouse condition. Perlite was mixed with soil as follows and these mixtures were filled in:

%100 soil (S) (control)
%8 fine perlite (FP) + %92 S
%8 moderate perlite (MP) + %92 S
%8 course perlite (CP) + % 92 S

Some analysis results of preparing mixtures are given Table 2. pF values of mixtures were determined according to De Boodt et al. (1973). Pepper seeds (*capsicum annuum grossum var. cv. Demre*) used in trial were germinated into medium which contains peat, perlite and sand.

Before trial, polyethylene plastic and two hole plastic pipes were placed into pots, then, and mixtures were filled in equal amount. A unit seedling was planted in each pot. Surface of pots was covered by plastic for preventing evaporation after planting and applying water level of 75% of available water. Pots were weighted every day and deficient water was added from pipes. After irrigation, hole of pipes was plugged by stopper.

While pots with applying water stress were irrigated by water level of 50%, 25% and 12.5% of available water, pots with non-applying water stress (control) were irrigated by water level of 75% of available water. Water stress applications were carried from blooming to end of the harvesting period. A group was formed for each mixture media and 75%, 50%, 25% and 12.5% of stress applications were done separately in each group.

Transpiration, root dry weight, root length, root area and fresh plant weight were determined in the research. Transpiration was obtained by weighting daily water deficient. Root dry weight was determined according to Kacar (1984). Plants were cut the end of harvesting, roots in soil were washed and dried by blotting paper. After roots had been placed in paper bag they were dried 60˚ C for 24-48 hours. Root length and root area were determined according to Böhm (1979), fresh plant weight was determined by weight.

Statistical analysis of results were done Minitab and Mstat computer programs.

RESULTS AND DISCUSSION

It was determined that some physical properties of soil were affected by applying of perlite fraction (Table 2). Perlite had positive effects on increasing water holding capacity of soil. This increase had supported plant growth under stress conditions. Bender et al. (1998) reported that, different organic material mixed with soil have positive effects on soil physical properties.

Transpiration ratio, root dry weight, root length, root area and fresh plant weight of growing pepper plants under different perlite fractions and different water stress were shown during from blooming to end of the harvesting period (Table 3).

Table 1. Some physical and chemical properties of soil and perlite

	Soil	FP	MP	CP
Sand, (%)	37	-	-	-
Loam, (%)	36	-	-	-
Clay, (%)	27	-	-	-
Texture class	CL	-	-	-
Field capacity, (FC) (%)	32.17	-	-	-
Wilting point (WP), (%)	17.24	-	-	-
Available water (AW), (%)	14.93	-	-	-
Bulk density,(g/cm^3)	1.21	0.070	0.126	0.174
PH	7.52	7.3	7.7	7.5
EC, dS m^{-1}	0.595	0.057	0.18	0.099
Organic matter, (%)	0.56	-	-	-
Water buffering capacity, (%)	-	5.7	4.5	1.3
Easily available water, (%)	-	40.4	11.5	4.7

Table 2. Some physical properties of perlite mixed with soil samples.

Materials	Water holding capacity (%)				Available water
	pF 0	pF 1.7	pF 2.54	pF 4.2	(%)
%100 S	60.05	45.29	32.17	17.24	14.93
%8FP+%92S	74.54	52.32	38.87	16.65	22.22
%8MP+%92S	71.08	48.41	35.03	18.30	16.73
%8CP+%92S	65.76	42.23	29.43	14.41	15.02

Table 3. Transpiration, root dry weight, root length, root area and fresh plant weight of growing pepper plants under different perlite fractions and different water stress levels

Application		Transpiration	Root dry weight	Root length	Root area	Fresh plant weight
Media	Stress	(g)	(g)	(cm)	(cm^2)	(g)
75	%100S	2223	0.86	4892.12	764.15	21,13
50		2135	1.04	9442.60	932.01	21,67
25		1750	1.03	6500.99	526.05	20,25
12.5		1520	0.95	8269.62	734.44	14,66
75	%8FP + %92S	2840	1.16	8550.80	730.63	18,21
50		2893	1.23	11421.84	801.22	20,42
25		2083	1.14	6666.89	528.77	25,16
12.5		2386	0.90	10862.82	855.56	21,88
75	%8MP + %92S	2252	0.83	6647.97	1033.64	14,81
50		2513	1.20	8132.45	686.67	22,63
25		2787	1.08	9850.05	1033.64	22,43
12.5		1737	0.78	10303.72	1025.18	20,51
75	%8CP + %92S	1253	0.46	3732.92	991.39	12,63
50		1962	0.67	5900.31	955.45	14,51
25		1573	0.60	4255.04	688.58	15,33
12.5		1138	0.39	4029.51	705.10	8,61

Transpiration

Transpiration means losing water by evaporation from plant. It is not simple event, because this has effect on physiology and life of plant. Transpiration increases as soil water is available and sufficient. Therefore, if the water is insufficient, it is necessary to be mixed organic and inorganic material with soil.

The effects of different water stress and different perlite fraction on transpiration were shown Table 4. Both stress levels and perlite fractions had significant differences in compared to control ($P<0.01$). Mixing 8% of fine perlite to the soil has increased for water holding capacity of soil more than the others, therefore, transpiration increased, too. It was followed by moderate perlite media, soil (control) and course perlite media, respectively. Also, these differences among the media were shown by Figure 1. While diameter of perlite increased, transpiration values decreased, because water holding capacity of course perlite was lower than the others. Eavis and Taylor (1979) have explained to be linear balance between decreasing of total water content in soil and decreasing transpiration ratio.

Table 4. Mean transpiration values of growing pepper plants in different perlite and water stress levels

Stress levels	Transpiration (g)	Media	Transpiration (g)
%75	2143	%100S	1909
%50	2376	%8FP+%92S	2551
%25	2050	%8MP+%92S	2322
%12.5	1695	%8CP+%92S	1482
LSD : 495.3 P < 0.01			

As seen in Table 4, 50% of available water level increased transpiration of plants, following 75% and 25% available water levels, respectively. The most limited transpiration was obtained by 12.5% of available water level. El-Sayed (1992) reported that when *C. annuum* has exposed to slight, medium, severe and very severe water stresses, leaf area and relative moisture content have decreased in all of stress levels, but this decreasing has been clear in very severe stress. Also, Rao and Bhatt (1988), Cucci (1993) obtained same results. Also, these differences among the media were shown by Figure 2.

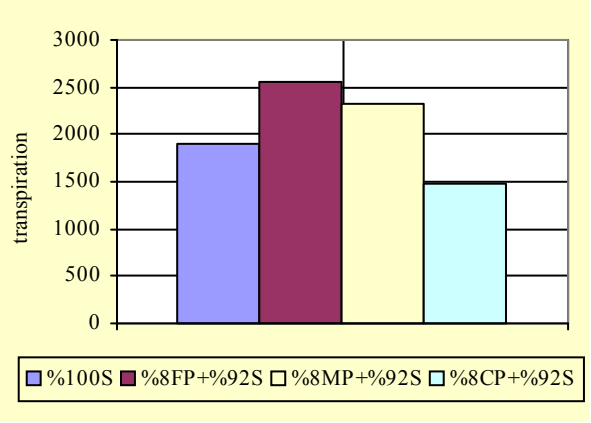

Figure 1. Mean transpiration values of different perlite fractions

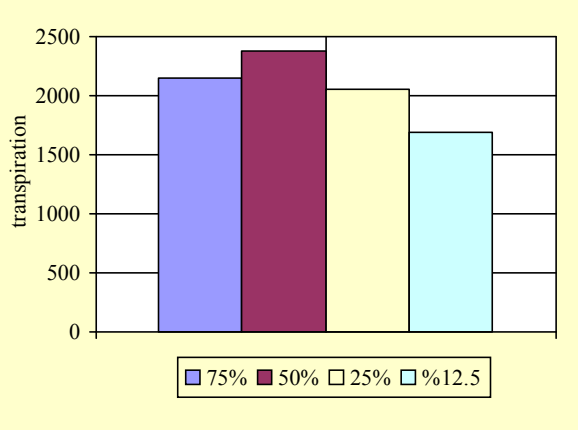

Figure 2. Mean transpiration values of different water stress

Root Dry Weight

Changes in root dry weight of pepper plant was determined to be depend on diameter of perlite (Table5).

Table 5. Mean root dry weight of growing pepper plants in different perlite and water stress levels

Media	Root dry weight (g)
%100S	0.97
%8FP+%92S	1.11
%8MP+%92S	0.99
%8CP+%92S	0.53
LSD : 0.3497 P < 0.01	

As seen in Table 5, changes in root dry weight of perlite mixed with soil were found to be significant (P<0.01). It has been the lowest in media with 8% of course perlite. On the contrary, the highest root dry weight was obtained by fine perlite mixture and moderate perlite and soil media, respectively. Furthermore, as shown Figure 3, effects of fine and moderate perlite media on root growth were fairly clear compared to the other medias. It was clarified that different growing media were used for green pepper and the highest production was obtained by perlite plus soil media.

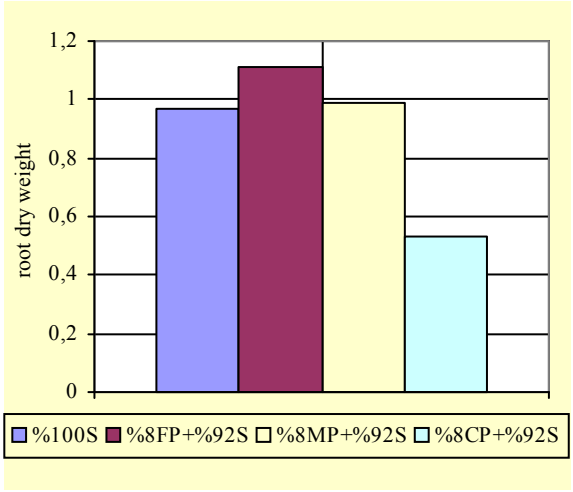

Figure 3. Mean root dry weight of different perlite fractions

However, the most suitable growing media was obtained by growing material mixed with soil (Oktay et al., 1995).

Different water stress levels on root dry weight were haven't any effect. This result was supported by similar result obtained by Sharp and Davies (1989). Furthermore, growing materials mixed with soil were found to be effect on root dry weight but, not found to be any effect of water stress (Bender, 1999).

Root Length and Root Area

As seen in Table 6, both stress levels and perlite fractions had significantly difference (P<0.01) and root length was increased. The most increased was obtained from fine perlite mixture and following moderate perlite, soil and course perlite respectively. These results were expected that because a similar results were obtained by transpiration and root dry weight. Opena and Porter (1999) reported that soil amendments have significantly increased root length density of potato during growing season but, not shown effect of irrigation on root growth.

Table 6. Mean root length of growing pepper plants in different perlite and water stress levels

Water levels	Root length (cm)	Media	Root length (cm)
%75	5205.91	%100S	6776.29
%50	8989.29	%8FP+%92S	9375.59
%25	7068.25	%8MP+%92S	8733.55
%12.5	8101.43	%8CP+%92S	4479.44
LSD : 2434. P < 0.01			

However, applying of 50% available water level has mostly increased root length. Also, this increase was supplied by 25% of available water level. The lowest root length was obtained from 75% of available water level, which is control group. For this reason, plants have sufficient water in this group. Rhizopoulou and Davies (1993) reported that, root length of Eucalyptus seedlings have been increased by decrease soil water. Hoogenboom et al. (1987) clarified that, root growth was increased by drought stress after vegetative growth. Differences occurred by different stress levels and perlite fractions were shown Figure 4 and Figure 5.

Different perlite medias and water stresses applied on root area of pepper plants were not found any effect. In water stress situation, plants have benefited from this water releasing from perlite in soil. For this reason, we can consider that this result can be obtained for root area.

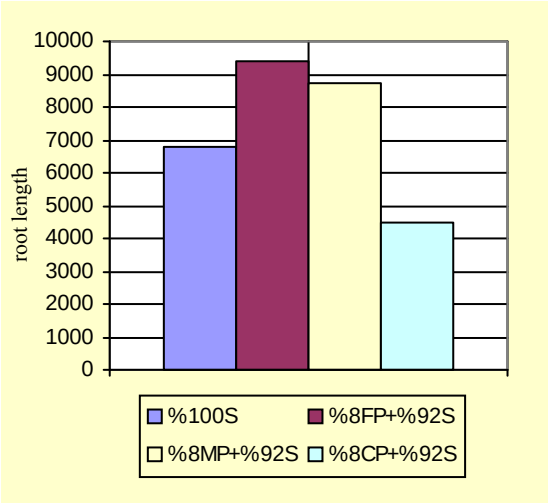

Figure 4. Mean root length values of different perlite fractions

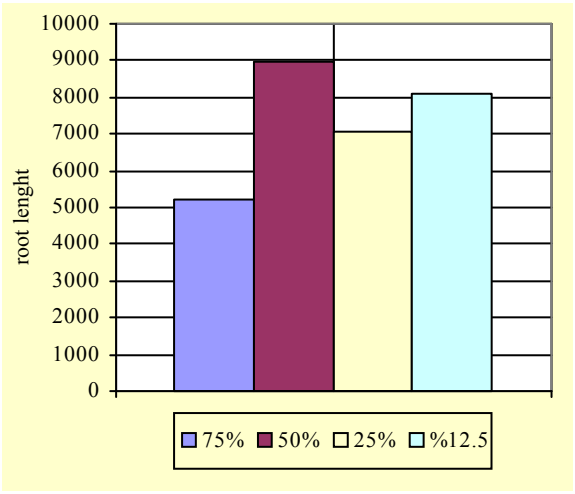

Figure 5. Mean root length values of different water stresses

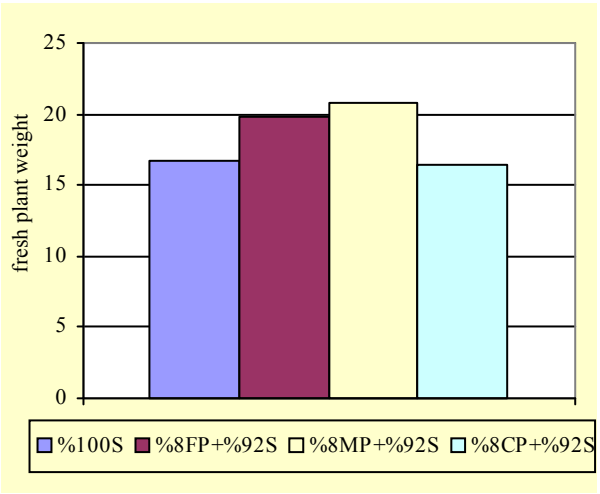

Figure 6. Mean fresh plant weight of different perlite fractions

Fresh Plant Weight

The effects of different water stress and perlite fraction on fresh plant weight were shown Table 7. There were significantly affected by stress levels and perlite fractions in comparison with control, respectively ($P<0.01$ and $P<0.05$).

Table 7. Mean fresh plant weight of growing pepper plants in different perlite and water stress levels

Water levels	Fresh plant weight (g)	Media	Fresh plant weight (g)
%75	19.428	%100S	16.70
%50	21.408	%8FP+%92S	19.81
%25	20.097	%8MP+%92S	20.79
%12.5	12.769	%8CP+%92S	16.42
LSD : 4.517 P < 0.01		LSD : 3.360 P < 0.05	

As seen in Table 7, mixing 8% of moderate perlite to the soil has increased more than the others. Generally, moderate perlite media was found to effect such as fine perlite on all parameters (Table 7). It was followed fine perlite media, control and course perlite media, respectively. The lowest weight was obtained from course perlite media such as the others properties.

Fresh plant weight was mostly decreased by applying 12.5% of available water level. The others stress levels had a significant effects, but among these statistical differences were not found. It was reported that, yield and average fruit weight was decreased by very severe water stress (Rubino et al., 1993). Saab and Sharp (1990) have explained decreasing of leaf growth with decreasing of soil water. Also, changes occurred in fresh plant weight were shown by Figure 6 and Figure 7.

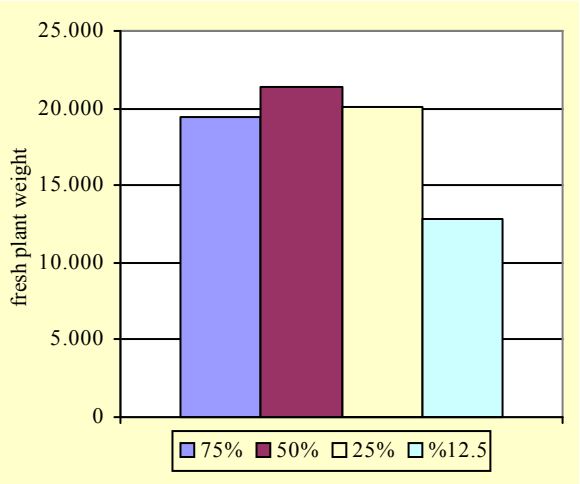

Figure 7. Mean fresh plant weight of different water stresses

CONCLUSION

It was determined that transpiration, root dry weight and root length were more increased by adding 8% of fine perlite to the soil and applying 50% of available water level during from blooming period to harvest. But, root length has been increased by applying 25% of available water level. However, both different water levels and different perlite media on root area haven't any effect. As stress applications have been started after blooming period, plants may have been less affected from stresses, because plants have supplied adaptation for growing media and it has completed a part of development. For this reason, it can be thought of new researches such as how will have been plants affected another growing periods by applying water stress in the same growing media and what kind of effects will be on product of this.

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