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EFFECT OF DIFFERENT IRRIGATION LEVELS AND POLYETHYLENE MULCH COLORS ON THE GROWTH AND YIELD OF GREENHOUSE CUCUMBER.

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ABSTRACT

During two successive seasons of 1997 and 1998, water requirements of cucumber (*Cucumis sativus* L.) grown in clay soil under unheated plastic house were determined based on Class A pan method with or without polyethylene mulch.
Water application of three levels were (75%, 100% and 125% of Class "A" pan) and three polyethylene mulch colors were used (Black, Silver, transparent and bare soil). The vegetative growth, i.e., plant height, leaf number, and leaf area together with yield were determined. Soil temperature was also recorded. The results showed that high level of water gave the highest vegetative growth, K content and total yield in comparison with other treatments. On the other hand high water treatment (125% of pan) resulted in a significant decrease in Na content of cucumber leaves. Concerning polyethylene mulch, results showed that silver plastic mulch gave the highest vegetative growth in comparison with clear and black polyethylene mulch but highest yield was recorded with black polyethylene mulch.

INTRODUCTION

The use of Class A pan evaporation as a reference for the management of irrigation of vegetables grown under protected cultivation has been demonstrated in several investigations. Guttormsen (1974) on tomato and Metochis (1977) reported that daily evaporation pan measurements were an adequate expression for the water consumptive use, calculated on a 24 hour basis and it gave better estimates of potential evapotranspiration. Chiarada and Zebi (1981 &1986) found linear relationship between both marketable, total yield and seasonal evapotranspiration in tomato under protected cultivation when irrigated on basis of evaporation from a Class A pan in the greenhouse.

Detailed research in Egypt on Class A pan as successful method to calculate the water requirement under protected cultivation were reported by Abou-Hadid and El-Beltagy (1988) and (1989) who reported that class "A" pan method is more suitable to identify water requirement of vegetables grown in plastic house under Egyptian condition rather than radiation method. They stated that evaporation from class "A" pan in plastic house was found to be statistically correlated to maximum and minimum temperature, mean relative humidity, and global radiation.

Recently, the use of polyethylene much by Egyptian growers especially under unheated plastic house became obvious. The influence of polyethylene mulch on soil temperature and crop response was dependent

upon film color (Lippert *et al.*1964). Black polyethylene film dissipated the heat by conduction, half going into the soil and half into the air space, so the soil heats up quite slowly. While transparent film transmits practically the whole of the solar radiation, which becomes absorbed by the soil and heats up more quickly and the film itself does not get hot (Manutention 1984). The effects of plastic mulch on weed growth control were reported by Manutantion (1984), Emmert on tomato (1956), Richard on beans and tomato (1976), Gorske on cucumber, eggplant and muskmelons (1979) and vicaria on tomato, cucumber and melon (1986). They reported that the absence of light with black plastic mulch didn't allow photosynthesis under the film and therefore weed growth was depressed. On the contrary with transparent film, the presence of light with the improved condition for growth (heat, moisture, good soil structure, etc.) encouraged weed growth.

This experiment aimed to study the effect of different irrigation levels (75%, 100% and 125% of Class A pan) and plastic mulch (Black, Silver, transparent and bare soil) on growth and yield of Cucumber grown under unheated plastic house**.**

MATERIALS AND METHODS

The experiment was performed during the two successive seasons of 1997 and 1998 at Kaha Experimental Station, Agricultural Research Center, Cairo, Egypt. Cucumber seedlings (*Cucumis sativus* L.) were transplanted on the Last week of September in unheated plastic house of 60 meters long, 9 meters wide, and three meters high, the greenhouse has five raised beds for cultivation, each of 100cm wide, 20cm high and 50cm apart, double rows have been planted on each bed at a distance of 50cm between rows and 50cm between plants. Plants were trained to one stem and cultural operations other than the experimental treatments were carried out normally according to the recommendations of Ministry of Agriculture.

The plastic house was equipped with a drip irrigation system can deliver certain amounts of water (or water + fertilizer) to each plant daily, two lateral drip lines were used for each raised bed with double row. Each treatment had a separate submain line with a control valve so that it could be irrigated separately.

The effects of water levels and plastic mulch were studied in a split plot experimental design with 4 replicates. The three water levels were arranged in the main plots and the four plastic mulch types were assigned at random in the sub-plots as follows:

Main plots.

1- 75% of Class A pan (The amount of water calculated according to Class A pan - 25% of it).
2- 100% of class A pan (The amount of water calculated according to Class A pan).
3- 125% of Class A pan (The amount of water calculated according to Class A pan + 25%).

Treatment	Amount of irrigation water m^3/day							
	Sept.	Oct.	Nov.	Des.	Jan.	Feb.	Mar.	Apr.
75 % of pan	0.21	0.34	0.50	0.65	0.92	1.22	1.42	0.99
100% of pan	0.27	0.46	0.67	0.87	1.23	1.63	1.09	1.32
125% of pan	0.34	0.54	0.83	1.08	1.54	2.02	2.37	1.65

Sub-plots

1- Bare soil
2- Transparent polyethylene
3- Black polyethylene
4- Silver polyethylene

Measurements: The following data were recorded

1- Vegetative growth i. e., (plant height, leaf number and leaf area)
2- Soil temperature (was measured once a week at noon time)
3- Fresh and dry weight of the plants
4- Total chlorophyll content measured using Minolta Chlorophyll Meter Spade-501.
5- Yield per m^2
6- K content in leaves (photometrically using flame photometer, Jackson 1958)
7- Na content of leaves (Shapman and Pratt 1961)

The experiment was subjected to statistical analysis of variance (Snedecor and Cochran 1980).

RESULTS

1- Effect of water levels

The effect of water level treatments on vegetative growth of cucumber plants was shown in Table (1). High water levels (100% and 125% of pan) enhanced the vegetative growth of plants. The highest vegetative growth i. e., plant height, leaf number and leaf area were recorded for those treatments, while the low water level (75% of pan) had the lowest vegetative growth**.** On the other hand, low water level (75% of pan) had the highest chlorophyll content in cucumber leaf tissues (Table 1 and Figure 1) while, the high level (125% of pan) gave the lowest content.

Table (1) and Figure (2) shows the effect of water levels treatments on Na, K leaf content and soil Nitrate-N content. The high water treatment (125% of pan) resulted in a significant decrease in Na content of cucumber leaves, while it resulted in significant increasing K content. However soil nitrate-N recorded the highest level with moderate water level (100% of pan) and the lowest value was recorded with low level of water.

The results in Table (1) and Figure (3), shows that high levels of water resulted in a significant increase in total yield of cucumber.

Water levels treatments had obvious effect on soil temperature, where high level of water treatment (125% of Pan) had the highest soil temperature while low water treatment had the lowest soil temperature (Table 2 and Figure 4).

Fig 1-4

Table 1

2- Effect of polyethylene mulch

Cucumber vegetative growth as influenced by plastic mulch treatments is illustrated in Table (1). Generally, plastic much enhanced vegetative growth of cucumber plants i.e., plant height, leaf number and leaf area. Silver plastic mulch gave the best vegetative growth in comparison with clear and black polyethylene mulch.

The same trend was observed with fresh and dry weight per plant (Table 1). The greatest fresh and dry weights were recorded with silver plastic mulch followed by clear and black mulch, whereas the lowest fresh and dry weight was recorded with un-mulched soil.

Concerning chlorophyll content, black plastic mulch had the lowest chlorophyll content while the highest chlorophyll content was recorded with Clear plastic mulch. There were no significant differences between sliver and un-mulched soil in terms of chlorophyll content in cucumber leaves (Table 1 and Figure 5).

There were no significant differences due to plastic mulch on Na content of cucumber leaves (Table 1 and Figure 6). Clear and un-mulched plants had higher content of K while those of black and silver mulch had the lowest K content. Plastic mulch had a significant effect on soil nitrate-N, where soil mulched treatments contained the higher Nitrate-N comparing with un-mulched soil.

It is clear from Table (1) and Figure (7) that plastic mulch increased cucumber yield in comparison with unmulched soil. The greatest yield was recorded by using black polyethylene mulch followed by silver and then by clear polyethylene mulch.

Using of polyethylene mulch (Table 2 and Figure 8) enhanced soil temperature. Clear plastic mulch increased soil temperature more than black and silver plastic mulch especially in the first weeks after transplanting where plants did not have enough canopy to shade the soil. The difference between black and silver plastic mulch was not significant.

3- Effect of the interaction between water levels and polyethylene mulch.

Results in Table (3), indicate that silver polyethylene mulch with all water levels treatment resulted in a significant increase in plant height, leaf number and leaf area compared with the other mulch treatments (Black and Clear). In the mean time, the lowest vegetative growth was recorded with un-mulched soil+75% of pan of water level treatment. The results showed also that, silver mulch+high water level treatment gave the highest fresh and dry weight followed by clear and black mulch with the same level of watering (125% of pan) and the lowest fresh and dry weight were recorded with un-mulched soil+75% of pan treatment. Similar trend was found on chlorophyll content.

The highest Na content in cucumber leaves were recorded with lowest level of water under all types of polyethylene mulch, where high level of water treatment (125% of pan) and all types of polyethylene much had the lowest content of Na.

Concerning K content in cucumber leaves, data showed that leaves of un-mulched soil+low water level (75% of pan) and clear plastic mulch+ low water

Fig 5-8

Table 2

Table 3

level (75% of pan) had the highest K content in comparison with the other treatments as shown in Table (3).

Differences in NO3-N content due to the interaction of plastic mulch and water irrigation levels were highly significant (Table 3). Un-mulched soil+low water level treatment (75% of pan) recorded the lowest NO3-N content in comparison with other treatments and highest soil NO3-N content were recorded with both clear plastic mulch+water level of 100% of pan and clear plastic mulch+high water levels+high water levels (125%of pan).

Table (3) shows the effect of interaction between plastic mulch and water treatment on cucumber yield. It was obvious from the results that application of plastic mulch with high water level (125% of pan) led to a progressive increase in the yield. The highest yield was obtained from high water level treatment(125% of pan) with black plastic mulch and the lowest yield was recorded with unmulched soil with low water level (75% of pan).

Table (4) shows the effect of the interaction between plastic mulch and irrigation. The highest soil temperature was recorded under clear plastic mulch+ high water level (125% of Class A pan), while the lowest temperature was recorded with un-mulched soil+low water level treatment (75% of Class A pan)

DISCUSSION

Using plastic mulch with cucumber under unheated plastic house resulted in an increase in vegetative growth i.e.… plant height, leaf number, leaf area, fresh weight, dry weight and yield of plants. These results are in agreement with those reported by Hopen and Oebker on sweet corn (1976), Chen and Katan on tomato (1980) and Bhella on watermelon (1988).

At the beginning of the experiment, the increase in soil temperature resulted in an increase in water consumption by plants, and hence, increasing plant growth, that led to increasing K uptake. In the mean time, it had a significant decrease in Na uptake due to increasing the amount of irrigation water.

There was an increase in No3-N concentration in the soil due to covering with plastic mulch, This increasing related to the improved cation availability under covered beds. Similar result was reported by Geraldson (1970) and Jones *et al.* on tomatoes (1977).

Increased yield has been largely attributed to the increase in soil temperature due to mulching cover which resulted in enhancement of soil environmental around roots of cucumber plants which led to more efficiency in nutrient absorption and uptake. These results were in line with those obtained by Clarkson and Frazier (1957) on cantaloupe and salman *et al.*(1990) on cantaloupe and cucumber.

Clear plastic mulch may result in an increase in weed growth. This can be disadvantage. While, the absences of light with black plastic mulch didn't allow photosynthesis under the film and therefore weed growth was suppressed, this result was in agreement with those found by Gorske (1979) and Vicaria (1986).

A significant effect due to increasing of water level was occurred. Vegetative growth of cucumber plants was promoted with increasing the amount of irrigation water. The levels of 125% of Class A pan had the best vegetative growth and yield. Besides, increasing of water decreased Na and increased K content in the cucumber Leaves, this result in agreement with Hsiao (1973).

Under the condition of this investigation, mulching has contributed positively to higher soil temperature and consequently improving growth and yield of cucumber. The water requirements for cucumber plants requires further work to determine the best method for calculation of water requirements.

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تأثير مستويات مختلفة من كميات مياه الري وألوان مختلفة من أغطية التربة البلاستيكية على نمو ومحصول خيار الصوبات.

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قسم بحوث البساتين - المركز القومي للبحوث - مصر

****شعبة بحوث الخضر - مركز البحوث الزراعية - مصر.**

خلال موسمين متعاقبين 1997و 1998 تم تقدير كميات مياه الري اللازمة لنمو محصول الخيار النامي في التربة الطمبية تحت ظروف الصوبات البلاستكية الغير مدفأة وذلك على أساس معدلات وعاء البخر وقد استخدم معها أيضا ألوان مختلفة من أغطية التربة البلاستيكية .

وكانت معاملات الري هي 75% و 100% و 125 % من حساب وعاء البخر وكانت معاملات أغطية التربة البلاستيكية هي البلاستيك الشفاف والأسود والفضي على التوالي بالإضافة إلى التربة الغير مغطاة ككنترول. وقد تم اخذ بيانات النمو متمثلة في ارتفاع النبات و عدد الأوراق ومساحة الأوراق والمحصول كما سجلت أيضا درجة حرارة التربة.

وقد أوضحت النتائج أن مستويات المياه المرتفعة قد أعطت أعلى نمو خضري ومحتوى بوتاسيوم بالأوراق ومحصول كلى مع نقص في محتوى الأوراق من الكالسيوم بالمقارنة بالمعاملات الأخرى. كما سجلت احسن النتائج بالنسبة للنمو الخضري عندما استخدمت أغطية التربة البلاستيكية ذات اللون الفضي ينما أعلى محصول كلى سجل عند استخدام الأغطية البلاستيكية ذات اللون الأسود.

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Table (1) Effect of irrigation levels (A) and plastic mulch (B) on different studied parameters.

	(1997-1998)									
	A			LSD		B				LSD
	75%	100%	125%	at (5%)		bar soil	Clear	Black	Silver	at (5%)
plant height 30day	49.87	50.81	52.29	0.276	Plant height 30day	47.69	52.90	51.16	52.23	0.244
` 60day	153.95	149.77	147.10	0.783	` 60day	130.87	147.90	159.49	162.83	1.635
` 90day	189.16	195.97	204.88	1.789	` 90day	188.45	201.04	196.54	200.66	0.643
leaf number 30day	6.95	7.07	7.14	0.002	leaf number 30day	6.58	7.19	7.14	7.29	0.033
` 60day	28.16	30.79	31.12	0.367	` 60day	27.73	28.82	31.44	32.10	0.211
` 90day	37.85	41.75	42.18	0.541	` 90day	36.93	40.80	41.88	42.76	0.255
Leaf area 30day	195.65	186.06	193.48	1.141	Leaf area 30day	162.63	195.59	202.23	206.48	1.970
` 60day	395.08	413.49	459.39	7.517	` 60day	333.31	459.83	444.08	453.40	6.266
Chlorophyll	50.74	49.54	48.88	0.427	Chlorophyll	49.73	50.64	48.81	49.70	0.050
Fresh weight	275.11	327.34	374.49	11.283	Fresh weight	273.70	341.40	337.64	349.84	3.498
Dry weight	30.78	37.41	39.99	1.078	Dry weight	29.49	38.27	37.17	39.33	0.456
Na content	4.33	3.98	3.60	0.60	Na content	4.03	3.90	3.90	4.03	0.129
K content	1.92	2.15	2.13	0.19	K content	1.80	2.23	1.87	2.10	0.252
Soil nitrate-N (20cm)	14.18	14.60	14.31	0.049	Soil nitrate-N (20cm)	8.85	15.63	16.50	16.47	0.374
Yield (Kg/m2)	3.72	4.26	4.82	0.124	Yield (Kg/m2)	3.47	4.35	4.75	4.49	0.057
	(1998-1999)									
plant height 30day	50.87	51.83	53.34	0.705	plant height 30day	48.64	53.95	52.18	53.27	0.623
` 60day	158.57	154.26	151.52	2.010	` 60day	134.80	152.33	164.27	167.72	4.210
` 90day	196.73	203.81	213.08	4.650	` 90day	195.99	209.08	204.40	208.69	1.870
leaf number 30day	7.10	7.22	7.29	0.056	leaf number 30day	6.72	7.34	7.29	7.45	0.084
` 60day	29.03	31.75	32.08	0.948	` 60day	28.59	29.71	32.42	33.10	0.544
` 90day	39.40	43.46	43.91	1.630	` 90day	38.45	42.48	43.59	44.51	0.947
Leaf area 30day	200.55	190.71	198.32	2.920	Leaf area 30day	166.69	200.48	207.29	211.64	5.072
` 60day	408.91	427.96	475.47	19.450	` 60day	344.97	475.92	459.62	469.27	16.210
Chlorophyll	51.48	51.10	54.67	1.111	Chlorophyll	52.10	52.03	52.50	53.02	0.123
Fresh weight	281.99	335.52	383.85	2.890	Fresh weight	280.54	349.94	346.08	358.59	8.960
Dry weight	31.55	38.35	40.99	2.760	Dry weight	30.22	39.22	38.10	40.32	1.170
Na content	4.11	3.78	3.42	0.195	Na content	3.83	3.71	3.71	3.83	0.121
K content	2.00	2.20	2.18	0.063	K content	2.15	2.29	1.91	2.15	0.064
Soil nitrate-N (20cm)	13.47	13.87	13.60	0.116	Soil nitrate-N (20cm)	8.41	14.85	15.68	15.64	0.889
Yield	3.89	4.35	4.87	0.279	Yield	3.59	4.48	4.84	4.57	0.141

Table (2) Effect of irrigation levels (A) and plastic mulch (B) on soil temperature.

Weeks	(1997-1998)									
	A			LSD	Weeks	B				LSD
	75% of pan	100%of pan	125% of pan	at (5%)		Bare soil	Clear mulch	Black mulch	Silver mulch	at (5%)
1	22.40	23.18	23.95	0.035	1	22.26	24.00	23.35	23.10	0.014
2	22.85	23.64	24.43	0.035	2	22.70	24.48	23.82	23.56	0.014
3	21.95	22.71	23.47	0.034	3	21.81	23.52	22.88	22.64	0.014
4	18.78	20.35	21.91	0.071	4	19.65	21.20	20.20	20.33	0.012
5	19.34	20.96	22.57	0.073	5	20.24	21.84	20.81	20.94	0.013
6	19.31	20.42	21.53	0.050	6	19.75	21.38	20.25	20.30	0.014
7	18.00	19.15	20.30	0.052	7	17.85	20.00	19.45	19.30	0.018
8	17.35	17.73	18.10	0.017	8	17.20	18.65	17.50	17.55	0.012
	(1998-1999)									
1	22.85	23.64	24.43	0.449	1	22.70	24.48	23.82	23.56	0.184
2	23.53	24.35	25.16	0.462	2	23.38	25.21	24.53	24.27	0.190
3	22.83	23.62	24.41	0.448	3	22.68	24.46	23.80	23.54	0.184
4	19.23	20.83	22.44	0.910	4	20.12	21.71	20.68	20.82	0.166
5	19.79	21.44	23.09	0.937	5	20.71	22.34	21.28	21.42	0.171
6	19.74	20.87	22.00	0.641	6	20.18	21.85	20.70	20.75	0.179
7	18.40	19.57	20.75	0.666	7	18.24	20.44	19.88	19.72	0.240
8	17.78	18.17	18.55	0.218	8	17.63	19.12	17.94	17.99	0.161

Table (3) Effect of the interaction between water irrigation levels and plastic mulch on different studied parameters.

Water treatment	(1997-1998)												
	75% of pan				100% of pan				125% of pan				LSD
Mulch treatment	bar soil	Clear	Black	Silver	bar soil	Clear	Black	Silver	bar soil	Clear	Black	Silver	at (5%)
Plant height 30day	47.52	50.30	50.30	51.36	47.52	52.70	50.98	52.05	48.02	55.68	52.19	53.28	0.423
` 60day	128.8	140.6	171.36	174.9	130.42	147.36	158.98	162.31	133.38	155.6	148.12	151.23	2.832
` 90day	181.2	188.5	191.42	195.4	187.78	200.30	195.84	199.95	196.33	214.2	202.34	206.59	1.114
leaf number 30day	6.43	6.91	7.15	7.30	6.62	7.30	7.10	7.25	6.69	7.37	7.18	7.33	0.057
` 60day	26.06	27.79	29.09	29.70	28.42	29.18	32.45	33.13	28.71	29.49	32.79	33.47	0.365
` 90day	34.56	37.68	39.17	39.99	37.92	42.14	43.01	43.91	38.32	42.58	43.46	44.37	0.441
Leaf area 30day	164.3	197.5	208.16	212.5	157.82	189.81	196.25	200.37	165.68	199.4	202.28	206.53	3.428
` 60day	338.7	401.2	415.84	424.5	323.45	459.42	431.01	440.06	337.75	518.8	485.39	495.58	10.853
Chlorophyll (spad)	49.35	48.88	49.816	49.95	48.5	49	48.933	50.1	52.45	52.2	52.7	52.9	0.088
Fresh weight (g/plant)	230.0	282.9	290.72	296.8	273.70	347.80	337.64	350.20	317.40	393.5	384.56	402.50	6.060
Dry weight (g/plant)	25.39	32.10	32.48	33.16	29.49	40.90	37.17	42.10	33.58	41.80	41.86	42.74	0.791
Na content (%)	4.20	4.30	4.40	4.40	4.10	3.80	3.90	4.10	3.80	3.60	3.40	3.60	0.023
K content (%)	2.20	2.30	1.40	1.90	2.20	2.10	2.10	2.20	1.90	2.30	2.10	2.20	0.043
Soil nitrate-N (20cm)	8.20	16.20	16.50	15.80	8.30	16.50	16.40	17.20	10.05	14.20	16.60	16.40	0.648
Yield (Kg/m2)	3.03	3.80	4.12	3.93	3.54	4.43	4.49	4.58	3.84	4.81	5.64	4.97	0.099
	(1998-1999)												
plant height 30day	48.47	51.31	51.31	52.39	48.47	53.76	52.00	53.09	48.98	56.79	53.23	54.35	1.070
` 60day	132.7	144.8	176.50	180.2	134.33	151.78	163.75	167.18	137.38	160.3	152.56	155.77	7.290
` 90day	188.5	196.0	199.08	203.2	195.29	208.32	203.67	207.95	204.18	222.8	210.44	214.85	2.890
leaf number 30day	6.57	7.06	7.30	7.46	6.76	7.45	7.25	7.41	6.83	7.53	7.33	7.48	0.146
` 60day	26.87	28.65	29.99	30.62	29.30	30.09	33.45	34.16	29.60	30.40	33.80	34.51	0.943
` 90day	35.98	39.22	40.77	41.63	39.47	43.87	44.77	45.71	39.89	44.33	45.24	46.19	1.640
Leaf area 30day	168.5	202.4	213.37	217.8	161.77	194.56	201.15	205.38	169.82	204.4	207.34	211.70	8.780
` 60day	350.5	415.2	430.39	439.4	334.77	475.50	446.09	455.46	349.58	537.0	502.38	512.93	28.080
Chlorophyll (spad)	51.32	50.84	51.81	51.95	50.44	50.96	50.89	52.10	54.55	54.29	54.81	55.02	0.229
Fresh weight (g/plant)	235.7	289.9	297.99	304.2	280.54	356.50	346.08	358.96	325.34	403.3	394.17	412.56	15.520
Dry weight (g/plant)	26.03	32.90	33.29	33.99	30.22	41.92	38.10	43.15	34.42	42.85	42.91	43.81	2.020
Na content (%)	3.99	4.09	4.18	4.18	3.90	3.61	3.71	3.90	3.61	3.42	3.23	3.42	0.056
K content (%)	2.26	2.36	1.44	1.95	2.26	2.15	2.15	2.26	1.95	2.36	2.15	2.26	0.112
Soil nitrate-N (20cm)	7.79	15.39	15.68	15.01	7.89	15.68	15.58	16.34	9.55	13.49	15.77	15.58	1.540
Yield	3.25	4.07	4.24	4.00	3.61	4.52	4.58	4.67	3.92	4.86	5.70	5.02	0.244

Table (4) Effect of the interaction between water irrigation levels and plastic mulch on soil temperatur.

Week	(1997-1998)												
	75% op pan				100% op pan				125% op pan				LSD
	bar soil	Clear	Black	Silver	bar soil	Clear	Black	Silver	bar soil	Clear	Black	Silver	at (5%)
1	21.50	23.40	22.40	22.30	22.26	24.00	23.35	23.10	23.01	24.60	24.30	23.90	0.025
2	21.93	23.87	22.85	22.75	22.70	24.48	23.82	23.56	23.47	25.09	24.79	24.38	0.025
3	21.07	22.93	21.95	21.85	21.81	23.52	22.88	22.64	22.55	24.11	23.81	23.42	0.024
4	18.20	19.50	18.80	18.61	19.65	21.20	20.20	20.33	21.10	22.90	21.60	22.05	0.022
5	18.75	20.09	19.36	19.17	20.24	21.84	20.81	20.94	21.73	23.59	22.25	22.72	0.023
6	18.60	19.95	19.30	19.40	19.75	21.38	20.25	20.30	20.90	22.80	21.20	21.20	0.024
7	17.10	18.90	18.10	17.90	17.85	20.00	19.45	19.30	18.60	21.10	20.80	20.70	0.032
8	16.80	18.20	17.20	17.20	17.20	18.65	17.50	17.55	17.60	19.10	17.80	17.90	0.021

Week	(1998-1999)												
	75% op pan				100% op pan				125% op pan				LSD
	bar soil	Clear	Black	Silver	bar soil	Clear	Black	Silver	bar soil	Clear	Black	Silver	at (5%)
1	21.93	23.87	22.85	22.75	22.70	24.48	23.82	23.56	23.47	25.09	24.79	24.38	0.319
2	22.59	24.58	23.53	23.43	23.38	25.21	24.53	24.27	24.17	25.84	25.53	25.11	0.329
3	21.91	23.85	22.83	22.73	22.68	24.46	23.80	23.54	23.45	25.07	24.77	24.36	0.319
4	18.64	19.97	19.25	19.06	20.12	21.71	20.68	20.82	21.61	23.45	22.12	22.58	0.287
5	19.18	20.55	19.81	19.61	20.71	22.34	21.28	21.42	22.23	24.13	22.76	23.24	0.296
6	19.01	20.39	19.72	19.83	20.18	21.85	20.70	20.75	21.36	23.30	21.67	21.67	0.311
7	17.48	19.32	18.50	18.29	18.24	20.44	19.88	19.72	19.01	21.56	21.26	21.16	0.415
8	17.22	18.66	17.63	17.63	17.63	19.12	17.94	17.99	18.04	19.58	18.25	18.35	0.280