Zagazig J.Agric. Res., Vol. 32 No. (1) 2005 35 - 56

COMPARATIVE STUDY OF SOME INTEGRATED WEED CONTROL TREATMENTS ON WASHINGTON NAVEL ORANGE TREES AND ASSOCIATED WEEDS

Abou Sayed –Ahmed, T. A.; R. A. Al-Ashkar ; L.A. El-Mashad* and A. R. Bdr El-Deen*

Hort. Dept. , Fac. Agric., Zagazig Univ.
***Central Lab. Weed Res.,Agric. Res. Center, Egypt**

Accepted 31 / 10 / 2004

ABSTRACT: During 2000/ 2001 and 2001-2002 seasons, 32–year–old Washington navel orange trees were grown under 11 soil management regimes as follows : (1-4) mulching with black polyethylene (PM) and rice straw (SM) before or after winter tillage (TPM and TSM), (5-6) hand mowing (TM_{O4}) and hand hoeing (TH_4) 4 times a year for each , (7) Gesagard followed by sting followed by round-up (TGStR) , (8) Gesagard followed by Basta (TGB), (9) Gramoxone followed by Fusilade (TGrF), (10) Gesagard followed by sting followed by select (GStSe) in comparison with unweeded control (UC). Treatments 5, 6, 7, 8 and 9 were carried out after winter tillage (T). The tested herbicides were applied at the recommended rate for each .

The highest efficiency in controlling broad- leaved , grassy and perennial weeds was recorded for mulching treatments before (PM and SM) or after (TPM and TSM) winter tillage. It also prevented subsequent regrowth of the perennial weeds. The herbicidal treatments surpassed mowing and hand hoeing ones in controlling the existed weed species with the superiority for TGStR and TGB treatments. All weed control treatments increased yield / tree and improved fruit quality in comparison with the unweeded trees. Controlling weeds with TH4 treatment reduced yield/ tree by 9.50%, while unweeding decreased it by 54.69% as compared with PM treatment which gained the highest yield / tree in both seasons, but it was highly expensive. The general evaluation of the tested integrated weed control treatments revealed that rice straw mulching treatments recorded the highest scores, followed by the 4

herbicidal treatments (TGStR, TGB, TGrF and GStSe), while unweeded (control) treatment recorded the lowest score. This means that rice straw mulching may replace herbicides for efficient weed control in citrus orchards.

So , it is necessary to control weeds in citrus orchards using any of mulching or herbicidal treatments according to the existed weeds and the respective costs of each treatment.

Key Wards: Washington navel orange, Integrated weed control. Mulching, Hoeing, Mowing, Tillage, Yield, Fruit quality.

INTRODUCTION

Extension and improvement of the Egyptian citrus industry demands overcoming all production problems. Weed competition is one of these chronic problems. It restricts growth directly and severely limits the ability of citrus trees to respond to favorable nutritional and soil moisture conditions, resulting in poor tree growth and reduced yields and fruit quality (Jordan, 1981). In addition, weeds harbour insect and disease organisms and reduce the efficiency of cultural practices and impede harvesting operations. So, it is necessary to control weeds in citrus orchards.

Mowing, tillage, mulching (smothering) and treating with chemical herbicides are the four primary weed control methods used in citrus. Each method has its advantages and disadvantages. Deciding on which one to use depends on the weed problems and orchard conditions and it is better to use a combination of methods (Jordan and Day, 1973). Mowing is quite widely used in orchards where cultivation or other forms of non- cultivation are not practicable.

Mechanical weed control (tillage) is commonly used as an effective method worldwide. But it usually damages surface feeder roots and causes soil compacting even in sandy soils resulting in the formation of a plow sole which retards water penetration (Anonymous, 1964).

Chemical weed control in citrus is widely accepted and continues to increase. Herbicides employed in citrus orchards are applied either before or after weed emergence. Pre-emergence herbicides are soil–active, while post–emergence contact or translocated (systemic) herbicides are foliar – active. Some herbicides are foliar- and soil - active and can be used to control both emerged seedlings and germinating seeds.

Recently, integrated weed control represents one of the most

effective means not only to limit weed growth and spreading, but also to reduce production costs. So, integrated weed control has become a common practice in many citrus growing regions (Li-Qing *et al.*, 2002).

Therefore, the present investigation was planned to evaluate the effect of some integrated weed control treatments on vegetative growth, yield and fruit quality of Washington navel orange trees and the associated weeds.

MATERIALS AND METHODS

This investigation was carried out during 2000/2001 and 2001/ 2002 seasons on 32–year–old Washington navel orange [*Citrus sinensis* (L.) Osbeck] trees budded on sour orange rootstock. The trees were grown in heavy loam soil at 6 m apart in a private citrus orchard at Aga district, Dakahlia Governorate. The chosen trees were subjected to the same agrotechnical practices in respect to irrigation and fertilization.

Ninety nine, healthy, uniform in size and vigour trees were equally distributed among the following eleven weed control treatments:

(1)Black polyethylene (120 micron thickness) mulching (PM), (2) winter tillage followed by black polyethylene mulching (TPM), (3) rice straw mulching (SM) in a layer of 7-10 cm height, (4) winter tillage followed by rice straw mulching (TSM), (5) winter tillage followed by mowing 4 times a year (TMo4) at the end of March, May, July and September (6) winter tillage followed by hand hoeing 4 times a year (TH4) at the previous same dates, (7) winter tillage followed by Gesagard at 1 kg / feddan followed by sting at 1.5 l/ feddan followed by round – up at 4 l/feddan (TGStR), (8) winter tillage followed by Gesagard at 1 kg / feddan followed by Basta at 21/ feddan (TGB), (9) winter tillage followed by Gramoxone at 1.5 l / feddan followed by Fusilade super at 2 l/feddan (TGrF) , (10) Gesagard at 1 kg/feddan followed by sting at 1.5 l/ feddan followed by select super at 1 l/feddan (GStSe), and (11) unweeded (control). Gesagard as a pre-emergence herbicide was applied at early January of each season after winter tillage. Sting, Gramoxone, and Basta as contact post– emergence herbicides were applied at early May. But select , Fusilade and round–up as systemic post–emergence herbicides, were applied at early August during both seasons. The spray volume in herbicidal treatments was 200 l/feddan.

The 11 treatments were arranged in a completely randomized block design with 3 replicates and 3 trees for each replicate. The responses of the applied treatments were evaluated with the following fruiting characteristics of Washington

navel orange trees as well as weed control of the associated weeds .

1.The effect on weed control

Weed survey was conducted in one square meter from the middle part of each plot 30 days after the last application through classifying the different types of dominant weeds; i.e., grass weeds, broad-leaved , perennial and total weeds. Fresh weight (g/m^2) of each weed type, and total fresh weight were recorded. The costs (L.E.) of each weed control treatment were also estimated.

2.The effect on yield and fruit quality

At the commercial harvesting date of Washington navel orange (early Jan.), the retened fruits on each three trees (replicate) were picked and weighed. The average yield / tree (kg/ tree) was recorded. Afterwards, 15 fruits were randomly collected from each replicate to determine the following fruit characteristics: average fruit weight (g), pulp and peel weights (g), pulp/ fruit ratio, fruit dimensions (cm), peel thickness (mm), juice volume (ml/ fruit), titratable acidity percentage and vitamen C content (mg / 100 ml juice) were estimated in fruit juice (A. O. A. C., 1970). Total soluble solids percentage (TSS%) was determined in fruit juice using a hand refractometer. TSS/ acid ratio was also calculated.

3.General evaluation of the tested weed control treatments

Scoring evaluation of the studied integrated weed control treatments was calculated through its effect on yield/tree, some physical and chemical fruit characteristics, leaf area, fruit set and fruit retention percentages, reduction percentage in weed fresh weight and total costs of weed control / feddan. Hundered units were shared between the following characteristics: yield / tree (20 units), reduction percentage and total costs/ feddan. (15 units for each), 10 units for fruit weight , fruit set percentage and TSS / acid ratio. Whereas each of juice volume / fruit , vitamin C content , fruit retention percentage and leaf surface area received 5 units. Within each of these parameters, except total costs/ feddan, the treatment that recorded the uppermost value received all the units specified for it. But within total costs/ feddan the treatment which gained the lowermost value received all the specified units for it. Relative values due to the other tested treatments were calculated.

The obtained data were statistically analysed according to complete randomized block design with 3 replicates and 3 trees for each replicate (Snedecor and Cochran, 1980). The individual comparisons between the obtained

values were carried out using LSD at 5% level.

RESULTS AND DISCUSSION

1.Effect of Weed Control Treatments on Weed Population

The dominant weed species encountered in the experimental plots during the two seasons could be arranged as follows

a. Annual broad – leaved weeds: *Rumex dentatus* L. (dentated dock), *Stellaria pallida* (Dumort) Pire (chick weed), *Malva parvillora* L. (small follwered mallow), *Chenopodium album* L. (white goosefoot), *Urtica urens* L. (small nettle), *Euphorbia peplus* L. (petty spurge), *Oxalis corniculta* L. (yellow sorrel), and *Amaranthus retroflexus* L. (pig weed red root).

b. Annual grassy weeds: *Bromus willdenowii* Kunth (brome grass), *Setaria viridis* (L.) Beauv. (green bristle grass), *Dinebra retroflexa* (Forssk) Panz (tiger grass), *Echinochloa calonum* (L.) Link. (deccan grass), and *Brachiaria eruciformis* (Sibth and sm) Griseb (signal grass).

c.Perennial weeds: *Cynodon dactylon* (L.) Pers. (bermuda grass) *Cyperus rotundus* L. (nutgrass) and *Convolvulus arvensis* L. (lesser bind weed).

Fresh weight of broad- leaved, grassy , perennial and total weeds in g/m^2 as affected by the tested weed control treatments (30 days after the last application) during both seasons are presented in Table 1. The obtained results indicated that different weed control methods revealed significant influences on fresh weight of broad- leaved, grassy and perennial weeds in the two seasons of study.

1.1 Broad – leaved weeds

As shown in Tables 1 and 2 mulching treatments before or after winter tillage completely controlled broad- leaved weeds existed in the experimental Washington navel orange orchard in both seasons (100% reduction percentage). The herbicidal treatments; i.e., TGB, TGStR, TGrF and GStSe significantly reduced fresh weight of the considered weeds as compared with unweeded (control) treatment which recorded the highest fresh weight (4.21 and 5.12 kg / m^2) in the first and second seasons, respectively. The herbicidal treatments were more effective in controlling the broad- leaved weeds in the second season. This may be attributed mainly to the accumulative effect of these treatments in the second season. Hand mowing and hand hoeing four times a year treatments significantly decreased the fresh weight of the associated weeds in

comparison with the control, but their effects were lower than those of herbicidal treatments in both seasons.

1.2 Grassy weeds

It is clear from Tables 1 and 2 that the different mulching treatments (PM, TPM, SM and TSM) were more effective in controlling the annual grassy weeds spread in the tested Washington navel orange orchard (100% reduction percentage), followed by the herbicideal treatments (32.12-57.24% reduction percentage in the first season and 87.06-100% in the second one). Hand mowing and hand hoeing four times/year treatments came in the third rank with similar effects on the associated grassy weeds in the two seasons. The highest fresh weight of the annual grassy weeds was recorded for control treatment (2.26 and 2.47 kg / m^2) in both seasons, respectively .

1.3 Perennial weeds

Data in Tables 1 and 2 reveal that different mulching treatments beside TGStR one, entirely controlled the existed perennial weeds in the two seasons (100% reduction percentage) and prevented subsequent regrowth of these weeds. The other herbicidal treatments were more effective in reducing fresh weight of the associated perennial weeds than the mechanical ones and consequently increased reduction percentages (39.04 and 54.91% for TGrF, 32.23 and 48.98% for GStSe and 21.8 and 43.61% for TGB treatments in first and second seasons, respectively. Mowing and hand hoeing treatments were less effective in this respect without significant differences between them in the first season only. The total fresh weight of these weeds under control treatment reached 1.12 and 1.24 kg/ m^2 in the two seasons, respectively.

1.4 Total weeds

The obtained data in Tables 1 and 2 show that mulching treatments either with black polyethylene sheets or rice straw before or after winter tillage were more effective not only in killing all weed species spread in the experimental Washington navel orange orchard than the other tested treatments in both seasons, but also prevented subsequent regrowth of the perennial weeds. The respective reduction percentage under mulching treatments was always 100%, so the plots treated with these treatments were kept weed free for long time throughout the growth season. The herbicidal treatments surpassed mowing and hand hoeing ones in controlling the different existed weed species with the superiority for TGStR and TGB treatments. Moreover, hand mowing and hand hoeing treatments came in the third rank

Table 1: Effect of integrated weed control treatments on fresh weight of broad – leaved , grassy and perennial weeds (g/m^2) in Washington navel orange orchard during first season (2000/ 2001)

Weed control treatments	Annual broad-leaved weeds		Annual grassy weeds		Perennial weeds		Total weeds	
	Fresh weight (g/m^2)	Reduction (%)	Fresh weight (g/m^2)	Reduction (%)	Fresh weight (g/m^2)	Reduction (%)	Fresh weight (g/m^2)	Reduction (%)
Polyethylene mulch (PM)	0.0	100.00	0.0	100.00	0.0	100.00	0.0	100
Tillage + Polyethylene mulch (TPM)	0.0	100.00	0.0	100.00	0.0	100.00	0.0	100
Straw mulch (SM)	0.0	100.00	0.0	100.00	0.0	100.00	0.0	100
Tillage + straw mulch (TSM)	0.0	100.00	0.0	100.00	0.0	100.00	0.0	100
Tillage + mowing (4) times (TMo_4)	2823.3	32.93	1430.0	36.63	886.7	20.59	5140.0	32.21
Tillage + hand hoeing (4) times (TH_4)	2770.0	34.20	1448.3	35.82	906.7	18.81	5125.0	32.41
Tillage+gesagard + sting + round-up (TGStR)	2061.7	51.02	965.0	57.24	0.00	100	3026.7	60.08
Tillage + gesagard + Basta (TGB)	1940.0	53.92	1278.3	43.35	1023.3	21.80	4241.7	44.06
Tillage + gramoxone + fusilade ($TGrF_1$	2553.3	39.35	1531.7	32.12	676.7	39.40	4761.7	37.21
Gesagard + sting + select (GStSe)	2321.7	44.85	1316.7	41.65	756.7	32.23	4395.0	42.04
Unweeded control (UC)	4210.0	0.00	2256.7	0.00	1116.7	0.0	7583.3	0.0
L.S.D. at 0.05	109.7	5.83	63.2	4.93	38.6	3.36	129.9	4.93

Table 2: Effect of integrated weed control treatments on fresh weight of broad – leaved grassy and perennial weeds (g/m^2) in Washington navel orange orchard during second season (2001/ 2002).

Weed control treatments	Annual broad-leaved weeds		Annual grassy weeds		Perennial weeds		Total weeds	
	Fresh weight (gm^2)	Reduction (%)	Fresh weight (gm^2)	Reduction (%)	Fresh weight (gm^2)	Reduction (%)	Fresh weight (gm^2)	Reduction (%)
Polyethylene mulch (PM)	0.0	100.00	0.0	100.00	0.0	100.00	0.0	100
Tillage + Polyethylene mulch (TPM)	0.0	100.00	0.0	100.00	0.0	100.00	0.0	100
Straw mulch (SM)	0.0	100.00	0.0	100.00	0.0	100.00	0.0	100
Tillage + straw mulch (TSM)	0.0	100.00	0.0	100.00	0.0	100.00	0.0	100
Tillage + mowing (4) times (TMo_4)	1479.9	71.11	1308.4	47.11	750.0	39.43	3538.3	59.95
Tillage + hand hoeing (4) times (TH_4)	1554.5	69.66	1307.8	47.12	853.3	31.09	3715.6	57.94
Tillage+gesagard + sting + round-up (TGStR)	200.0	96.1	0.00	100.00	0.00	100	200.0	97.73
Tillage + gesagard + Basta (TGB)	193.3	96.2	320.0	87.06	698.3	43.61	1211.7	86.28
Tillage + gramoxone + fusilade ($TGrF_1$	220.0	95.7	0.0	100.00	558.3	54.91	778.3	91.19
Gesagard + sting + select (GStSe)	393.3	92.32	0.0	100.00	631.7	48.98	1025.0	88.39
Unweeded control (UC)	5123.6	0.00	2473.6	0.00	1238.3	0.00	8835.5	0.0
L.S.D. at 0.05	102.3	6.16	26.8	20.9	39.4	4.81	135.8	4.45

in reducing total fresh weight of the existed weed species with similar effects in the two seasons. Mowing treatment surpassed hand hoeing mainly because its useful effect on fruit retention percentage and total yield / tree , besides it was less expensive .

These results are in agreement with those found by Ferrero *et al.* (1994), Abd El-Rahman *et al.*(1996), Eissa and Helail (1997), Koloren and Uygur, (1998) and Shirgure *et al.* (2003). They reported that mulching with rice straw or black polyethylene sheets were the most effective weed control treatments and enhanced tree growth of different fruit species but they were more expensive, especially black polyethylene. Lim Hyungkee *et al.* (1997) mentioned that weeding efficacies for black polyethylene and rice straw mulching in sweet persimmon orchard were 91 and 97%, respectively. As for hand hoeing , Hassan and Abd El-Naby (1998), Koloren and Uygur (1998), El-Shammaa and Hassan (2001) and Hassan (2001) revealed that hand hoeing significantly depressed fresh weight of grassy , brood – leaved and total weeds in fruit orchards compared with the unweeded control. Whereas weight of perennial weeds in sour orange nursery was greatly increased (Abd El-Rhman *et al.* 1994).

Dealing with herbicides effect, several investigators reported that herbicides were more effective in controlling perennial grassy weeds in different fruit plantations. Glyphosate at 2.2 kg / ha with 0.4 kg paraquat gave 78-98% control for *Rhynchelytrum repens* and *Cenchrus incertus* in orange orchard. Atrazine, glyphosate, diuron, and paraquat herbicides caused a significant reduction in weed populations over hand weeding and cultivation by tractor in citrus orchards. Diuron followed by glyphosate application controlled the weed population effectively , killing 80.27% of monocotyledonous and 82.30% of dicotyledonous weeds compared with no weeding treatment (Koloren and Uygur, 1998; Kordana *et al.*,1999; Adamczewski and Paradowski , 1999 ; Askew *et al.* 2000; El-Shammaa and Hassan, 2001; Hassan, 2001; Chen GuiHu *et al.* , 2002 ; Martini *et al.*, 2002).

2.Effect of Weed Control Treatments on Yield and Fruit Quality of Washington Navel Orange Trees

2.1 Effect on total yield / tree

As shown in Tables 3 and 4, the highest and lowest yield/ tree were recorded for polyethylene mulch and control (unweeded) treatments, respectively. Treatments of SM, TMo4, TGStR , TGrF and GStSe gave higher yields than the control without significant differences between them in the two seasons. Therefore, any of them may be used to control weeds in citrus orchards according to the respective costs of each treatment.

Controlling weeds with hand heoing four times a year markedly decreased tree yield by about 9.50% less than PM treatment which gained the highest yield / tree. This means that frequent hand hoeing throughout growth season led to decrease fruit yield / tree mainly because damaging feeder roots. As an average of both seasons, unweeding treatment reduced total fruit yield / tree by 54.69% compared with the highest yield which was recorded for PM treatment. So, it is necessary to control weeds in citrus orchards.

These results are in harmony with those found by Sinbel *et al.* (1997), El-Seginy (2000), Carvalho *et al.* (2001, 2002), El-Shammaa and Hassan (2001), Kassem and Marzouk (2001), Li-Qing *et al.* ((2002) and Lal *et al.*(2003). They reported that covering the soil with black polyvinyl chloride plastic sheets had the highest effect in weed control method, which led to earlier fruit maturity and increased fruit yield, but increased drop of over–mature navel orange. Shirgure *et al.* (2003) cleared that the highest fruit yield of Nagpure mandarin was recorded for black polyethylene (73.7 kg / tree), followed by grass mulching (69.0 kg / tree). Also, Solaiman (1993) on Navel orange, Saied *et al.* (1993) on pear and Carvalho *et al.* (2001) on sweet orange stated that production of fruit trees was increased by using both herbicide and mowing out methods than untreated trees (control), while cultivation methods decreased it. The previous authors added that tree growth and production were markedly increased by using different herbicides than the untreated trees.

2.2 Effect on fruit weight, size and fruit dimensions

Data in Tables 3 and 4 reveal that fruit weight and size as well as fruit diameter and length were significantly affected by the studied weed control treatments in the two seasons. Anyhow, PM, GStSe and TGB treatments resulted in the highest fruit weight and size, followed by TGrF treatments. The lowest corresponding values of fruit characters were recorded for unweeded (control) treatment in both seasons. Since unweeding treatment reduced fruit weight, size, length and diameter by 36.58, 39.65, 21.23 and 19.76%, respectively as compared to the highest values in this respect. The other treatments showed intermediate values without significant differences between them in most cases.

These results are in line with those reported by Sinbel *et al.* (1997) and Kassem and Marzouk (2001) on Washington navel orange trees, Carvalho *et al.* (2002) on Pera orange and Saied *et al.* (1993), Minhas *et al.* (1994) and El-Seginy (2000) on Le – Conte pear. They pointed out that

herbicidal (round up , Basta and Goal) and mulching (polyethylene and rice straw) treatments increased fruit weight, length and diameter in comparison with control. The increase in fruit weight of mulched trees was attained by suitable water supply under mulching conditions.

2.3 Effect on weight of fruit pulp

The obtained data in Tables 3 and 4 indicated significant effect of the tested weed control treatments on pulp weight in the two seasons. The highest pulp weight was recorded for GStSe (155.4 and 155.9 g) and PM (153.9 and 154.7g) treatments without significant differences between them in the first and second seasons, respectively. In this respect, TSM (144.2 and 145.2g) treatment came in the second order, followed by TGB one (141.1 and 141.7 g) in both seasons, respectively. The other treatments recorded intermediate pulp weights. Weight of fruit pulp of unweeded trees was lower than those of GStSe treatment by 35.66%.

2.4 Pulp /fruit weight ratio

It is clear from Tables 3 and 4 that TSM, TMo4 , GStSe, UC and PM treatments recorded the highest pulp / fruit weight ratio without significant differences between them in both seasons. The lowest pulp/ fruit weight ratio was gained byTGB and TGrF treatments without significant differences between them. Values of pulp / fruit weight ratio of Washington navel orange fruits ranged between 0.68 – 0.79 in the first season and 0.69 – 0.78 in the second one.

2.5 Weight of fruit peel

Fruit peel weight was significantly affected by the tested weed control treatments in the two seasons (Tables 3, 4) . It is worthy to notice that peel weight followed an opposite trend to that of pulp / fruit weight ratio. Therefore, the highest peel weight was recorded for TGB and TGrF treatments without significant differences between them, followed by TGStR and SM treatments in both seasons. Unweeded treatment gained the lowest peel weight followed by TMo4 one . The other treatments revealed intermediate values in this respect.

2.6 Peel thickness

As shown in the same previous Tables , the tested weed control treatments significantly affected fruit peel thickness of the studied orange *cv* in the two seasons. However, TGStR (5.13 and 4.6 mm), TGrF (4.76 and 4.60mm) and TGB (4.50 and 4.43 mm) treatments gave the thickest fruit peel without significant differences between them, while the thinnest peel (3.00 and 3.40 mm) was recorded for unweeded treatment in the two seasons,

Table 3: Effect of integrated weed control treatments on yield and physical characteristics of Washington navel orange fruits (season 2000/2001)

Weed control treatments	Total yield (kg / tree)	Fruit characteristics				Pulp weight	Peel weight	Peel thickness	Pulp/ fruit ratio	Juice volume/ fruit
		Weight	Size	Diameter	Length					
		(g)	(cm^3)	(cm)	(cm)	(g)	(g)	(mm)		(cm^3)
Polyethylene mulch (PM)	154.0	201.0	205.0	7.40	7.55	153.9	48.33	3.96	0.77	87.51
Tillage + polyethylene mulch (TPM)	146.0	172.6	174.0	7.15	7.49	126.7	44.93	3.80	0.73	73.62
Straw mulch (SM)	150.3	167.0	158.0	6.88	6.67	123.2	45.00	3.66	0.74	74.00
Tillage + straw mulch (TSM)	147.7	181.6	172.3	7.03	6.93	144.2	39.13	3.80	0.79	88.78
Tillage + mowing (4) times (TMo4)	150.7	170.0	168.0	7.09	6.85	136.1	35.96	3.46	0.79	85.73
Tillage + hand hoeing (4) times (TH4)	137.0	171.6	165.3	7.29	7.24	128.7	46.00	3.66	0.75	84.10
Tillage+Gesagard +Sting +Round-up(TGStR)	150.0	184.3	184.0	7.10	7.29	132.2	52.33	5.13	0.72	75.44
Tillage + Gesagard + Basta (TGB)	148.3	206.0	201.0	7.48	7.82	141.1	62.26	4.50	0.68	73.88
Tillage +Gramoxone + Fusilade (TGrF)	150.0	193.0	186.0	7.35	7.56	134.8	60.40	4.76	0.69	80.33
Gesagard + Sting + Select (GStSe)	150.7	200.3	202.6	7.48	7.63	155.4	44.33	3.66	0.78	99.02
Unweeded control (UC)	76.0	129.6	126.6	6.26	6.33	101.1	30.20	3.00	0.78	65.10
L.S.D. at 0.05	2.92	2.63	2.33	0.57	0.79	0.74	2.96	0.71	0.03	4.62

Table 4: Effect of integrated weed control treatments on yield and physical characteristics of Washington navel orange fruits (season 2001/2002)

Weed control treatments	Total yield (kg / tree)	Fruit characteristics				Pulp weight	Peel weight	Peel thickness	Pulp/ fruit ratio	Juice volume fruit (cm^3)
		Weight (g)	Size (cm^3)	Diameter (cm)	Length (cm)	(g)	(g)	(mm)		
Polyethylene mulch (PM)	159.3	203.7	206.0	7.50	7.62	154.7	48.63	3.96	0.76	88.56
Tillage + polyethylene mulch (TPM)	151.0	174.7	176.7	7.28	7.56	127.7	45.40	3.86	0.73	74.75
Straw mulch (SM)	154.0	180.7	158.3	7.05	6.81	124.6	55.34	3.83	0.69	74.51
Tillage + straw mulch (TSM)	151.3	189.7	175.0	7.22	7.16	145.2	43.76	3.90	0.77	89.24
Tillage + mowing (4) times (TMo4)	159.0	176.0	171.0	7.30	7.11	137.5	37.60	3.73	0.78	86.50
Tillage + hand hoeing (4) times (TH4)	146.7	178.7	168.0	7.19	7.49	130.7	46.75	4.33	0.73	84.86
Tillage+Gesagard +Sting +Round-up (TGStR)	159.1	187.3	186.3	7.14	7.46	133.4	51.00	4.60	0.71	75.16
Tillage + Gesagard + Basta (TGB)	151.0	204.0	203.7	7.53	8.00	141.7	61.90	4.43	0.69	80.63
Tillage +Gramoxone + Fusilade (TGrF)	158.7	194.3	188.0	7.43	7.73	135.9	56.57	4.60	0.70	80.80
Gesagard + Sting + Select (GStSe)	156.7	202.3	204.3	7.60	7.80	155.9	45.66	4.03	0.77	99.53
Unweeded control (UC)	66.0	130.3	121.3	5.83	6.13	99.0	31.00	3.40	0.76	59.96
L.S.D. at 0.05	5.32	6.54	2.21	0.47	0.63	2.12	5.78	0.58	0.02	4.47

respectively. The other treatments gained inbetween values of peel thickness.

The effects of the studied weed control treatments on pulp weight, pulp / fruit weight ratio, peel weight and thickness were not traced through the available literature.

2.7 Juice volume / fruit

Data in Tables 3 and 4 indicate that the largest (99.20 and 99.53 cm^3) and smallest (65.10 and 59.96 cm^3) juice volume / fruit were recorded for GStSe and control treatments in the first and second seasons, respectively. Moreover, TSM, PM, TMo4 and TH4 treatments gained somewhat higher values of juice volume / fruit without significant differences between them in both seasons. Juice content of Washington navel orange *cv* ranged between 65.10–99.02 cm^3 and 59.96 – 99.53 cm^3 in the first and second seasons, respectively. These findings are mostly in line with those reported by Saied *et al.* (1993), Solaiman (1993), Minhas *et al.* (1994), Sinbel *et al.* (1997), El-Seginy (2000), El-Shammaa and Hassan (2001) and Shirgure *et al.* (2003). They stated that mulching with black polyethylene or grass and herbicidal treatments increased juice content in citrus fruits as compared with the control. Meanwhile, Kalyan *et al.* (1993) cleared that glyphosate at 1, 2 and 3 l/ha had insignificant effect on mandarin juice content.

2.8 Effect on chemical fruit characteristics

The obtained data in Table 5 show that chemical characteristics ; i.e. TSS, total acidity and TSS/ acid ratio as well as vitamin C content of Washington navel orange fruit juice were significantly affected by the tested weed control treatments in the two experimental seasons. The lowest TSS percentage and TSS/ acid ratio as well as the highest acidity percentage and vitamin C content in fruit juice were found in the fruits of the unweeded trees in both seasons. Fruits of SM, TMo4, TGB, TGrF and GStSe treated trees contained the highest TSS percentage and TSS / acid ratio and the lowest acidity percentage . Moreover, vitamin C content in the fruits of the herbicidal treatments (TGStE, TGB, TGrF and GStSe) was slightly lower than those of the other treatments, especially unweeded one which recorded the highest content of vitamin C (47.55 and 48.31 mg/100 ml juice in the two seasons, respectively).

The corresponding values of the previous chemical characteristics of Washington navel orange *cv* throughout both seasons ranged between 9.0 - 11.5% for TSS % , 0.26 – 0.53% for total acidity percentage, 16.96-39.08 for TSS/ acid ratio and 43.10-48.31 mg/100 juice for vitamin C content .

Table 5: Effect of integrated weed control treatments on some chemical characteristics of Washington navel orange fruits

Weed control treatments	First season 2000/2001				Second season 2001/2002			
	TSS (%)	Total acidity (%)	TSS/acid Ratio	Vitamin C content (mg/100 cm^3)	TSS (%)	Total acidity (%)	TSS/acid Ratio	Vitamin C content (mg/100 cm^3)
Polyethylene mulch (PM)	10.50	0.33	32.20	44.34	10.63	0.31	35.57	44.05
Tillage + polyethylene mulch (TPM)	10.23	0.28	36.53	45.89	10.40	0.26	39.08	44.92
Straw mulch (SM)	11.33	0.39	28.89	46.82	11.40	0.36	31.70	46.81
Tillage + straw mulch (TSM)	10.66	0.40	27.14	46.20	10.73	0.36	29.79	46.52
Tillage + mowing (4) times (TMo4)	11.50	0.32	36.75	45.89	11.30	0.34	33.02	45.22
Tillage + hand hoeing (4) times (TH4)	11.00	0.37	29.64	46.51	10.46	0.31	33.40	46.20
Tillage+Gesagard +Sting +Round-up (TGStR)	10.50	0.29	36.21	45.38	11.23	0.35	31.80	45.09
Tillage + Gesagard + Basta (TGB)	11.23	0.39	28.55	43.41	11.20	0.37	29.85	43.44
Tillage +Gramoxone + Fusilade (TGrF)	11.10	0.40	27.75	43.10	10.66	0.36	29.56	43.83
Gesagard + Sting + Select (GStSe)	10.50	0.40	26.16	45.89	10.56	0.37	28.14	45.75
Unweeded control (UC)	9.16	0.51	17.89	47.55	9.00	0.53	16.96	48.31
L.S.D. at 0.05	0.41	0.08	7.81	2.42	0.35	0.05	6.35	2.00

These results are, generally, in harmony with those reported by El-Seginy (2000) on pear, El-Shammaa and Hassan (2001) on grapevines and Shirgure *et al.* (2003) on mandarin trees. They stated that juice TSS , acidity and total sugar content were highest with black polyethylene and grass mulching and glyphosate treatments as compared with the control. Also, Sinbel *et al.*(1997) demonstrated that black plastic and wheat straw mulch as well as Gramoxone and round – up treatments increased juice TSS percentage and maturity ratio (TSS/ acid ratio) over the control (hand hoeing) and decreased juice acidity and ascorbic acid contents. On the other hand, TSS and total acidity percentages in pear fruits were not significantly affected by herbicide application (Basta and Goal) , mulching (black or clean polyethylene), hand hoeing and cutting treatments (Saied *et al.*, 1993). Kalyan *et al.* (1993) cleared also that glyphosate at 1,2 and 3 l/ha had no significant effect on TSS and acidity percentages in mandarin fruit juice. Meanwhile , Solaiman (1993) stated that round–up spraying led to decrease TSS and acidity percentages in fruit juice of navel orange trees, while cultivation treatments increased it .

3.Costs of the Tested Weed Treatments

It is evident from Table 6 that black polyethylene mulching treatments were the highly expensive weed control methods (3613 and 3493 L.E. / feddan / year), followed by those of rice straw mulching (1206.6 and 1086.6 L.E. / feddan/ year) before or after winter tillage, respectively. The least weed control costs (243 L.E/ feddan / year) were recorded for GStSe treatment.

Regardless mulching treatments , hand hoeing four times/ year recorded higher costs (520 L.E./ feddan /year), followed in descendingly order by TGStR (483 L. E. / feddan / year), TGrF (452.5 L. E./ feddan/ year), TMo4 (400 L.E. / feddan / year) and TGB (288 L.E. / feddan /year) treatments . It is worthy to notice that hand hoeing costs were about 23.08 % higher than those of hand mowing despite their effect on weed control was nearly similar, but mowing surpassed hand hoeing in increasing fruit retention percentage and yield / tree.

However, the studied integrated weed control treatments could be arranged with regard to their costs / feddan/ year in the following descendingly order: TPM > PM> TSM> SM> TH4> TGStR> TGrF> TMo4 > TGB> GStSe.

4.General Evaluation of the Tested Weed Control Treatments

Data in Table 7 represent the general evaluation of the studied

Table 6: Basic of calculating weeding costs (L.E.) for the tested integrated weed control treatments

Weed control treatments / Costs items (L.E./fed.)	PM	TPM	SM	TSM	TMo4	TH4	TGStR	TGB	TGrF	GStSe	UC
Price of polyethylene sheets	3428.0	3428.0									-
Price of rice straw			1066.6	1066.6							-
Wage of spread polyethylene or straw	20	20	20	20							-
Wage of collecting and respreading for fertilization	45	45									-
Wage of winter tillage	-	120	-	120	120	120	120	120	120	-	-
Wage of mowing 4 times a year					280						-
Wage of hand hoeing 4 times a year						400					-
Price of herbicides*							333	148	312.5	213.0	-
Wage of sprayer							30	20	20	30.0	-
Total costs/fed.	3493.0	3613.0	1086.6	1206.6	400	520	483	288	452.5	243	0.0

* Price of 11 or kg: Round up = 50, Gesagard = 58, Basta = 45, Gramoxone = 35, Fusilade = 130 and Select = 80 L.E.

Table 7 : General evaluation of the tested integrated weed control treatments according to yield / tree, fruit characteristics, weed control and total costs/ feddan (average of the two seasons)

Weed control treatments	Yield / tree (20units)	Reduction % of total weeds (15units)	Fruit weight (10units)	Juice volume (5units)	Fruit set (10units)	Leaf area (5 units)	Fruit retention (5 units)	TSS/Acid ratio (10units)	Vitamin C (5 units)	Total costs/ fed. (15units)	Total score (100units)
PM	20.00	15.00	9.85	4.42	9.07	4.89	4.32	8.93	4.60	0.49	81.57
TPM	18.95	15.00	8.46	3.73	9.14	5.00	4.26	9.97	4.73	0.00	79.24
SM	19.42	15.00	8.48	3.73	9.36	4.63	4.76	7.98	4.88	10.48	88.72
TSM	19.08	15.00	9.05	4.48	9.67	4.70	5.00	7.50	4.83	9.99	89.30
TMo4	19.76	6.91	8.43	4.33	8.50	4.72	4.43	9.22	4.75	13.33	84.38
TH4	18.10	6.77	8.54	4.25	8.32	4.71	2.88	8.30	4.83	12.84	79.54
TGStR	19.72	11.83	9.06	3.79	8.35	4.73	3.90	8.99	4.71	12.99	88.07
TGB	19.10	9.77	10.00	3.89	8.56	4.62	3.84	7.69	4.52	13.80	85.79
TGrF	19.70	9.62	9.44	4.05	8.88	4.94	4.02	7.55	4.53	13.12	85.85
GStSe	19.62	9.77	9.81	5.00	8.12	4.81	4.53	7.15	4.77	13.99	87.57
UC	9.07	0.00	6.33	3.14	7.91	3.01	2.10	4.59	5.00	15.00	56.15

weed control treatments (average of the two seasons) according to yield/tree, fruit and leaf characteristics, fruit set and fruit retention percentages as well as reduction percentage in weed fresh weight and total costs/ feddan. However, rice straw mulching treatments recorded the highest scores [TSM (89.3 units) and SM (88.72 units] , followed by the four herbicidal treatments [TGStR (88.07 units), GStSe (87.57 units), TGrF (85.85 units) and TGB (85.79 units)]. The 7^{th} and 8^{th} position were occupied by TM_O4 (84.38 units) and PM (81.57 units) treatments, respectively. TH4 and TPM treatments gained similar total scores (79.54 and 79.24 units, respectively), occupying the 9^{th} and 10^{th} positions. Unweeded (control) treatment recorded the lowest score (56.15 units) and the last position.

REFERENCES

Abd El-Rahman, A. M., M. A. Myhob and S. A. Dawood. 1996. Evaluation of some weed control treatments in young citrus groves. The first Egyptian –Hungarian Horticultural Conference Kafr El-Sheikh; Egypt.(1): 275-280.

Abd El-Rahman, A. M., S. E. Salem, and S. S. Moustafa. 1994. Studies on chemical weed control in citrus seedbeds. Bull. Fac. Agric., Cairo Univ. 45 (4): 905-918.

Adamczewski, K. and A. Paradowski. 1999. New graminicides for weed control in winter oilseed rape. Rosliny-Oleiste 20 (1), 251-257 (Comp. Search CAB Abst. 2002/ 8-2003/ 10).

Anonymous. 1964. Report by the statewide weed control committee of the California state chamber of commerce . 39 pp.

Askew, S. D. , D. R. Show and J. E. Street. 2000. Graminicide application timing influences red rice *(Oryza sativa)* control and seed head reduction in soybean *(Glycine max)*. Weed – Technology 14 (1) : 176-181. (Comp. Search CAB Abst. 1998/ 09 – 2000/ 07).

Association of Official Agricultural Chemists. 1970. Official methods of analysis of the association of official agricultural chemists. Published by the A.O. A. C., P. O. Box 540. Washington D. C.

Carvalho, J. E. B. De, L. A. De Jorge and W. F. Ramos. 2001. Soil cover management and root system development of the combination Pera sweet orange /Rangpur lime in Bahia and Sergipe. Laranja 22 (1): 259-269. (Comp. Search CAB Abst. 2002/08 – 2002/10).

Carvalho, J. E. B. De, L. D. A. S. Souza, R. C. Coldas, P. E. U. T. Antas, A. M. Aroujo , L. C. Lopes , R. C. Santos , N. C. M. Lopes, A. L. V. Souza, and A. M. Araujo. 2002. Legumes in integrated weed control for

increase of Pera orange productivity. Revista, Brasileira, de Fruticultura , 24: (1) : 82 – 85. (Comp. Search CAB Abst. 2002/08-2003/10).

Chen-GuiHu,Yang– Banglun; HU-PingZheng; Yu – Yuancai; G. H. Chen; B. L. Yang; P. Z. Hu, and Y. C. Yu. 2002. Study on the effect of glyphosate on the growth of trifoliate orange and weeds. South China– Fruits 31 (5): 16-17. (Comp. Search CAB Abst. 2002/08-2003/10).

Eissa, M. A. and B. M. Helail. 1997. A comparative study on some weed control treatments in Balady lime nursery . Ann. Agric. Sci. Moshtohor 35 (2) : 935-947.

El-Seginy, Amal M. 2000. The effect of mulching and clean cultivation Le – Conte pear trees grown in new reclaimed area. J. Agric. Sci., Mansoura Univ. 25 (12): 8053-8061.

El-Shammaa, M. S. and A. A. A. Hassan. 2001. A comparative study of some weed control methods on Thompson Seed-less vines. Assiut J. Agric. Sci. 32 (1) : 145-155.

Ferrero, A.; P. Balsaria, and G. Airoldi. 1994. Preliminary results of flame weeding in orchards. Quetigny Cede x , France; Association Colloque IFOAM Ed. 2. 389-394 [C. F. Weed Abstr. 45 (1) : 328].

Hassan, A. A. A. 2001. Effect of weed control and irrigation systems on Balady mandarin trees (*Citrus deliciosa* L.) . J. Agric. Sci. Mansoura Univ. 26 (4): 2277-2286.

Hassan, A. A. A. and S. K. M. Abd El-Naby. 1998. Response of Washington navel orange trees and associated weeds to weed control methods, Menofiya . J. Agric. Res. 23 (5): 1327-1343.

Jordan , L. S. 1981. Weeds affect citrus growth, physiology, yield and fruit quality. Proceedings of the International Society of Citriculture 2, 481-483.

Jordan , L. S. and B. E. Day. 1973. Weed control in citrus . In : Reuther, W. (Ed.) . The citrus industry. III: 82-97, Univ. Calif. Press, Berkeley and California.

Kalyan, D. S., B. S. Daulta, and R. K. Malik. 1993. Weed control in Pearl mandarin. Agric. Sci. Digest (Karnal) 13 (1): 13-16 [C. F. Hort. Abstr. 65 (12): 11080].

Kassem, H. A. and H. A. Marzouk. 2001. Effect of different soil management on growth, leaf mineral and chlorophyll content, yield and fruit quality of Washington navel orange trees. J. Adv. Agric. Res. 6 (4) : 957-969.

Koloren, O. and F. N. Uygur. 1998. A comparative study on efficiency and cost of weed control methods in citrus orchards. Turkiye–Herboloji Dergsi. 1:2, 31–40. (Comp. Search CAB Abst. 1998 /08-2000/07).

Kordana, S., W. A. Kucharski , R. Mordalski and B. Gnusowski. 1999. Broad- leaved and grass weeds control in great plantain (*Plantago lanceolata* L.). Progress in Plant Protection , 39 (2): 721-723 (Comp. Search CAB Abst. 2000/08– 2002/01).

Lal, H., J. S. Samra, and Y. K. Arora. 2003. Kinnow mandarin in Doon Valley: I. Effect of irrigation and mulching on growth , yield and quality . Ind. J. Soil Conser 31 (2): 162-167 (Comp. Search CAB Abst. 2003/11-2004/01).

Lim Hyungkee, Lim Kyeongho , and Kwon Ohdo. 1997. Effect of mulching practices on the weed occurrence , soil physical properties and yield of sweet persimmon (*Diospyros kaki* L.) [C. F. Weed Abstr. 47(6): 2399].

Li-Qing; Yuan- Tao; Li- Qi and T. Yuan. 2002. Experiment of comparison of differing soil management in citrus orchard. South–China Fruits. 31:11–13 (Comp. Search CAB Abst. 2002/08- 2003/10).

Martini, G., A. F. F. Pedrinho – (Je), G. V. Felici, E. M. Piva , and J. C. Durigan. 2002. Efficacy of a new formulation of glyphosate for control of bermuda grass (*Cynodon dactylon*) in citrus orchards. Revista, Brasileira, de Fruticultura 24 (3): 683-686 (Comp. Search CAB Abst. 2002/08 – 2003/10).

Minhas, P. P. S. , Darshan Singh , A. S. Sandhu, and S. S. Mann. 1994. Chemical weed control in pear orchards of northern India. Acta Horticuturae 367: 331-341 [C. F. Weed Abstr. 45 (6): 2381].

Saied, I. A. , H. Mokhtar, and A. A. Salim. 1993. Comparative studies on weed control methods in pear trees. J. Agric. Sci., Mansoura Univ. 18 (1): 257-265.

Shirgure, P. S., R. K. Sonka, Shyam-Singh, P. Panigrah, and S. Singh. 2003. Effect of different mulches on soil moisture conservation, weed reduction , growth and yield of drip irrigated Nagpur mandarin (*Citrus reticulata*). Ind. J. Agric. Sci. 73 (3): 148-152 (Comp. Search CAB Abst. 2003/11-2004/01).

Sinbel, H. M., Aida S. Assal, and A. G. Elham. 1997. A comparative study of weed control methods effect on growth, yield and fruit quality of Washington navel orange trees. J. Agric. Sci., Mansoura Univ. 22 (7): 2403- 2411.

Snedecor, G. W. and W. G. Chochran. 1980. Statistical Methods. Iowa State Univ. Press 7th ed. Amer . Iowa. USA.

Solaiman, B. M. 1993. Mechanization of some processes used in horticultural production under Egyptian conditions. M. Sc. Thesis , Fac. Agric,. Zagazig Univ.

دراسة مقارنة لتأثير بعض معاملات المكافحة المتكاملة للحشائش على أشجار البرتقال بسره واشنجطن والحشائش المصاحبة

طلعت على أبو سيد أحمد، رزق عبد الحميد الأشقر،
لطفى على أبو العوضى المشد*، عبد الرافع رمضان بدر الدين*
قسم البساتين - كلية الزراعة - جامعة الزقازيق.
* المعمل المركزى لبحوث الحشائش - مركز البحوث الزراعية - مصر.

عوملت أشجار البرتقال بسره واشنجطن خلال موسمى ٢٠٠٠ /٢٠٠١ و ٢٠٠١ / ٢٠٠٢ بإحدى عشرة معاملة لمقاومة الحشائش هى : (١-٤) تغطية سطح التربة بالبولى إيثلين الأسود (PM) وقش الأرز (SM) قبل أو بعد العزيق الشتوى (TPM & TSM) ، (٥ - ٦) حش يدوى (TMo_4) وعزيق يدوى (TH4) ٤ مرات فى السنة لكل منهما ، (٧) رش مبيد الجيساجارد يليه الستينج يليه الراوند - أب ((TGStR) ، (٨) رش مبيد الجيساجارد يليه الباستا (TGB) ، (٩) رش مبيد الجرامكسون يليه الفيوزيليد (TGrF) ، (١٠) رش مبيد الجيساجارد يليه الستينج يليه السلكت (GStSe) مقارنة بترك الحشائش دون مقاومة (الكنترول) (UC). اجريت المعاملات رقم ٥، ٦، ٧، ٨، ٩ بعد العزيق الشتوى (T) وتم رش المبيدات المختبرة بالمعدل الموصى به لكل مبيد فى ٢٠٠ لتر ماء / فدان .

أظهرت النتائج أن :

* سجلت أعلى كفاءة لمقاومة الحشائش العريضة الأوراق ، النجيلية والمعمرة لمعاملات التغطية قبل (PM , SM) أو بعد العزيق الشتوى (TPM ,TSM) كما منعت استعادة الحشائش المعمرة لنموها .
* تفوقت معاملات المبيدات على معاملات الحش والعزيق اليدوى فى مقاومة أنواع الحشائش المختلفة الموجودة خاصة معاملتى TGB و TGStR .
* أدت كل معاملات مقاومة الحشائش تحت الدراسة إلى زيادة محصول الشجرة وتحسين جودة الثمار مقارنة بالكنترول .
* أدت مقاومة الحشائش بالعزيق ٤ مرات / سنة (TH_4) إلى تقليل محصول الشجرة بنسبة ٩,٥٠% بينما قل محصول أشجار الكنترول بنسبة ٥٤,٦٩% بالمقارنة بمعاملة التغطية بالبولى إيثلين الأسود (PM) التى حققت أعلى محصول للشجرة خلال موسمى الدراسة لكنها كانت مرتفعة التكاليف جدا بالمقارنة بالطرق الأخرى .
* أظهر التقييم العام لمعاملات المكافحة المتكاملة للحشائش المختبرة أن التغطية بقش الأرز كانت أفضل المعاملات تليها معاملات المبيدات الأربعة (TGB, TGStR, TGrF و GStSe) ، فى حين سجلت معاملة الكنترول أقل قيمة فى هذا الصدد .

لذلك فإنه من الضرورى مقاومة الحشائش فى بساتين الموالح باستخدام أى طريقة من طرق التغطية أو المبيدات طبقا لأنواع الحشائش الموجودة وتكاليف المقاومة الخاصة بكل طريقة .