SUMMARY

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This investigation has been carried out in two consecutive seasons (1996/97 & 1997/98) in the citrus grove of the Hort. Res. Sta. At El Kassasin Ismailia Governorate. Seven year- old Washington navel orange trees budded on sour orange rootstock, grown on sandy soil and irrigated by the drip system were devoted for this study. The selected trees were nearly uniform in size and vigor, planted in square system of five meters apart and subjected to the same cultural practices used by the orchard management.

At all events, the present investigation involved three experiments: Experiment {I} Effect of irrigation: Three levels of irrigation water were used 1850,3700 and 5550 m^3 per feddan yearly. Experiment {II} Effect of fertilization: Four doses of nitrogen 30&60&90and 120 kg N/feddan/year in the form of ammonuim nitrate devided into 14 equal ammounts from early March till the end of September. Besides three levels of K : 100&168and 250 kg as K_2SO_4 per feddan/year added in three doses in March ,June and August. Experiment {III} Effect of mulching: Two soil mulchs were used i.e. 10 and 20 cm thickness of straw mulch beside control treatment (unmulched). The most important results could be summarized as follows:

Experiment: (I) Effect of irrigation

6-I-1-Vegetative growth

Through two seasons of application trees of uppermost irrigation rate (5550 m^3 /fed. /yr.) significantly increased tree canopy volume, shoot length, shoot thickness, number of

leaves/shoot, leaf surface area and leaf dry matter content. Meanwhile, trees of the lowermost irrigation water rate (1850 m^3/fed./ yr.) recorded the least values.

6-I-2- Leaf nutrients content

Leaf nutrients content (N, K, Mn. and Fe) were significantly increased as irrigation water rate increased. Meanwhile, leaf phosphorus content showed insignificant effect in this respect.

6-I-3- Fruit set

Fruit set percentage indicated an obvious response to increasing irrigation water rate.

6-I-4- Fruit drop

Trees received lowermost irrigation water rate (1850 m^3/fed./yr.) dropped most of their fruits early during June fruit drop stage and then, relatively fewer amounts in the following stages. (fruit development and per- harvest stages). Trees received intermediate irrigation rate (3700 m^3/ fed./yr.) showed relatively slower fruit drop curve throughout fruit growth season. On the other hand, trees received uppermost irrigation water rate (5550 m^3/fed./yr.) showed narrow reduction differences between three stages of periodic fruit drop.

6-I-5- Yield

The uppermost irrigation rate recorded the highest number of fruits / tree and highest yield / tree. On the other hand, lowermost irrigation rate attained the least values. Water use efficiency recorded the highest value with intermediate irrigation water rate, descendingly followed by uppermost rate then, the least values came from lowermost rate

6-I-6- Fruit quality

6-I-6-a-Fruit physical properties

The heaviest fruits resulted from the intermediate rate, closely followed by the uppermost rate, the lightest fruits came from the lowermost rate. Increasing irrigation water rate over (1850 m^3/fed. /yr.) increased fruit axial and equatorial dimensions. The differences between intermediate and uppermost rates were insignificant in both seasons.

6-I-6-b-Fruit chemical constituents

Increasing irrigation water rate significantly decreased TSS : acid ratio values and increased fruit juice acidity and ascorbic acid content.

Experiment (II) Effect of fertilization

6-II-1-Nitrogen Fertilization

6-II-1-a-Vegetative growth

Nitrogen fertilization rates significantly affected vegetative growth parameters. Increasing nitrogen rate to 120 kg/fed./yr. significantly increased tree canopy volume , shoot length and thickness, leaf number / shoot, leaf surface area and leaf dry weight content. Opposite trend was detected by the lower- most nitrogen rate 30 kg / fed ./yr.

6-II-1-b-Leaf nutrients content

Uppermost nitrogen level (120 kg/ fed. /yr.) occupied the first rank and recorded the highest values of leaf N, P, K, Mn, Zn and Fe followed by (90 kg /fed./ yr.) rate in the second rank. Meanwhile, lowermost nitrogen level (30kg /fed. /yr.) was the least in this respect.

6-II-1-c-Fruit set

Fruit set percentage indicated an obvious response to increasing nitrogen levels. The tested N levels were always significant between the two upper rates (90& 120 kg / fed. /yr.)

6-II-1-d-Fruit drop

Lowermost nitrogen rate (30kg /fed./yr.) induced higher total fruit drop. However, the picture was changed to the reverse when uppermost nitrogen rate (120kg/fed./ yr.) was concerned. Most of fruit drop occurred during June fruit drop stage and relatively lower content (percentage) throughout fruit development stage.

Meanwhile, during pre-harvest stage the trend of fruit drop showed opposite direction with lower values compared to that recorded during fruit / June drop stage.

6-II-1-e-Yield

Uppermost nitrogen rate (120 kg / fed. /yr.) significantly increased number of fruits/tree, yield per tree and calculated yield per feddan compared with other tested nitrogen rates. Intermediate nitrogen rates (60 and 90 kg/fed./yr.) showed insignificant differences as compared with the lowermost nitrogen rate 30kg /fed. /yr.).

Nitrogen use efficiency showed an opposite trend to that of yield /tree. Thus, the lowermost N rate recorded the highest value followed by 60 kg N / fed./ yr. However, upper two N rates (90 and 120 kg / fed. /yr.) recorded least values.

6-II-1-f-Fruit quality

6-II-1-f-1-Fruit physical properties

Nitrogen rates exerted an obvious effect on some fruit physical properties. Increasing N rates significantly increased fruit weight, fruit dimensions, juice volume and peel thickness compared to lower N rate.

6-II-1-f-2-Fruit chemical constituents

Applied nitrogen rates induced clear effect on some fruit chemical constituents. The least values of TSS, TSS acid ratio and ascorbic acid content developed from 30 kg N rate. However, increasing N dosage significantly increased these contents. On the contrary, fruit acidity content showed opposite trend.

6-II-2-Potassium fertilization

6-II-2-a-Vegetative growth

The tested potassium rates significantly affected in yearly increment of tree canopy volume, shoot length and thickness, leaves number / shoot leaf surface area and leaf dry weight. Least vegetative growth parameters recorded by lowermost K rate (100 kg / fed./yr.) and the highest values were gained by uppermost K rate (250 kg/fed./yr.).

6-II-2-b-Leaf nutrients content

Increasing potassium fertilization rate increased leaf K content.. It was obvious that increasing K rate promoted N, Mn , Zn and Fe nutrients in leaves, while had insignificant effect on leaf phosphorus content.

6-II-2-c-Fruit set

Fruit set percentages indicated an obvious response to increasing potassium fertilization. Uppermost K rate (250 kg/ fed. / yr.) obtained highest set fruits percentage, while the least percentage resulted by lowermost K rate (100 kg / fed. /yr.).

6-II-2-d-Fruit drop

Lowermost K rate (100 kg / fed. /yr.) induced the highest total fruit drop. Intermediate K rate (168 kg) decreased the fruit drop percentage then uppermost K rate (250 kg) depressed total fruit drop again to reach lowest values.

Concerning periodic fruit drop, most of fruits were dropped during June fruit drop stage, descendingly indicated relative lower values during fruit development stage. Meanwhile, during pre – harvest stage, fruit drop was clearly inferior and recorded the lowest values, this trend was true for the three tested K rates.

6-II-2-e-Yield

Effect of potassium fertilization was obvious on yield and potassium use efficiency. The effect of K fertilization was significant. The uppermost K rate resulted in more number of fruits per tree and total gained yield, descendingly followed by intermediate K rate, then the lowermost K rate.

Moreover,Potassium use efficiency decreased as potassium fertilization rate increased.

6-II-2-f-Fruit quality

6-II-2-f-1-Fruit physical properties

Potassium fertilization exerted obvious effect on fruit weight, fruit dimensions, and fruit peel thickness. The heaviest,

juicy fruits were resulted by uppermost K rate, descendingly followed by intermediate K rate then lowermost K fertilization rate. Increasing K fertilization subsequently increased fruit peel thickness.

6-II-2-f-2-Fruit chemical constituents

Total soluble solids, TSS : acid ratio and ascorbic acid content generally increased as potassium fertilization rates increased. Effect of potassium fertilization on fruit juice acidity indicated opposite trend to that of juice TSS content.

Experiment (III) Effect of soil mulch

6-III-1-Vegetative growth

Soil mulch treatments (10 –20-cm straw thickness) significantly affected yearly increases in tree canopy volume, shoot length and thickness, leaves number / shoot, leaf surface area and leaf dry matter content compared to bare soil (control). However, more thickness of soil mulching (20-cm straw thickness) induced more significant increases of previous vegetative growth parameters.

6-III-2-Leaf nutrients content

Soil mulching promoted all determined nutrients (N, K, Fe, Zn and Mn) in leaves, with exception, of phosphorus, compared with that of unmulched control.

6-III-3-Fruit set

Fruit set percentage indicated an obvious response to soil mulching procedure. Differences between treatments (0, 10 and 20-cm thickness) were always significant. Fruit set percentage

recorded the highest value with 20-cm soil cover, descendingly followed by 10-cm soil cover, then un covered soil treatment.

6-III-4-Fruit drop

Control treatment induced the highermost fruit drop percentages. Mulched soil significantly decreased total fruit drop with leading to more thickness (20-cm) of soil mulching.

In respect of periodic fruit drop, most fruit drop occurred during June drop stage and control treatment recorded the highest values. During fruit development stage, results showed opposite trend and highest fruit drop percentages recorded by soil mulch treatments. During pre- harvest stage, control treatment returned again to record the highest fruit drop percent.

6-III-5-Yield

Soil mulching exerted relatively higher yield/tree compared to that obtained by unmulched soil (control). Increasing soil cover thickness added an other increments in yield/ tree .

Effect of soil mulching on water use efficiency was significant. Thus, control treatment recorded least values, then increased with increasing soil straw mulch thickness.

6-III-6-Fruit quality

6-III-6-a-Fruit physical properties

Soil mulch treatments significantly affected some fruit physical properties compared to unmulched soil (control). Increasing straw thickness (20- cm) significantly increased fruit weight, fruit dimensions, and peel thickness.

6-III-6-b-Fruit chemical constituents

Soil mulching showed clear effect on fruit chemical constituents. Highest values of TSS, TSS : acid ratio and ascorbic acid produced from unmulched soil (control) Soil mulching tended to decrease TSS/ acid ratio compared with that of uncovered soil. The difference between 10 and 20-cm straw thickness treatments was insignificant. Highest fruit juice acidity produced from soil mulch treatments.

6-III-7-Root parameters

6-III-7-a-Roots number, weight and length

Soil mulch treatments significantly increased roots number, weight and length per soil sample (included the four tree directions) compared to that of unmulched soil (control), this trend was true with the three types of roots (fibrous, intermediate and skeletal). Such effect was more pronounced with 20- cm straw thickness treatment followed by 10-cm straw thickness treatment.

6-III-7-b-Root activity indices

Amount of growing roots, root growth activity, absorbing root percentage, root coefficient value and relative weight of growing roots were clearly affected by soil mulch treatments. Previous root growth parameters were increased as soil mulch thickness increased.

6-III-7-c-Root distribution

Root vertical distribution was significantly affected by soil mulch treatments. Differences of root penetration limits could be detected between mulched and unmulched soil. Deeper roots

belonged to unmulched soil while soil mulching induced relatively shallow roots. Meanwhile, horizontal roots distribution gave an opposite behavior, then root spread and extension was increased as soil mulch thickness increased.

6-III-7-d-Root density

General average of root density per tree samples were obviously increased as soil mulch thickness increased.Samples taken from the north direction recorded the uppermost root density values, descendingly followed by east ,west and south direction.

Root density decreased from inside to outside of the tree canopy, this trend was detected with the three tested treatments. The outer samples (i.e. 200-250 cm from the tree trunk) gained the lowermost root density values in the thickest soil mulch treatment (20- cm straw thickness) while root- free samples appeared especially with unmulched soil of control treatment.