

## List of Contents

No.	Title	Page
-	Dedication .....	i
-	Acknowledgement .....	ii
-	Abstract .....	iii
-	موجز الأطروحة .....	v
-	List of contents .....	vii
-	List of tables .....	xv
-	List of plates .....	xvii
-	List of figure .....	xvii
<b><u>CHAPTER(I)</u></b>		
1.	Introduction.....	1
<b><u>CHAPTER(II)</u></b>		

### The Literature Review

2.1	Definition of tillage .....	4
2.2	Importance and objectives of tillage .....	5
2.3	Evaluation of tillage Operations .....	8
2.4	Classification of tillage and kinds of used equipments.....	8
2.5	Practices and methods of tillage.....	11
2.5.1	Conventional tillage .....	12
2.5.2	Minimum, Optimum, Reduced and Economy tillage .....	13
2.5.3	Conservation and mulch tillage .....	13
2.5.4	Till plant and Zero till planting .....	14
2.6	Multipowered rotating tillage machines .....	14
2.6.1	Vertical – axis rotary tillers.....	16
2.6.2	Longitudinal- axis rotary tillers.....	16
2.6.3	Rotary spading tillers.....	17
2.6.4	Conventional Rotary tillers .....	17

No.	Title	Page
2.7	Pulverization effect and energy requirements of conventional rotary tillers .....	19
2.8	Vegetables .....	20
2.8.1	Definition of vegetables .....	20
2.8.2	Origin of vegetables .....	20
2.8.3	World centers of origin of vegetables .....	20
2.8.4	Importance of vegetables in nutrition .....	21
2.8.5	Vegetables as a source of nutrients .....	23
2.8.6	Classification of vegetables .....	24
2.8.7	Sudan vegetables production .....	26

No.	Title	Page
2.8.8	Rocket (Gargeer) .....	27
2.8.8.1	Scientific name	
2.8.8.2	Family	
2.8.8.3	Origin	
2.8.8.4	Botany	
2.8.8.5	Nutritive Value	
2.8.8.6	Usage of Rocket	
2.8.8.7	Medical value	
2.8.8.8	Cultural Practices .....	29
2.8.8.8.1	Varieties	
2.8.8.8.2	Seed rate	
2.8.8.8.3	Fertilization	
2.8.8.8.4	Irrigation	
2.8.8.8.5	Harvest	
2.8.8.8.6	Yield	
2.8.9	Jew's Mallow.....	31
2.8.9.1	Scientific name	
2.8.9.2	Family	
2.8.9.3	Origin	
2.8.9.4	Botany	
2.8.9.5	Nutritive value	
2.8.9.6	Usage of Jew's Mallow	
2.8.9.7	Medical value	
2.8.9.8	Cultural practices .....	32
2.8.9.8.1	Varieties	
2.8.9.8.2	Seed rate	
2.8.9.8.3	Fertilization	
2.8.9.8.4	Irrigation	
2.8.9.8.5	Harvest	
2.8.9.8.6	Yield	
2.9	Soil Consistency.....	33
2.9.1	Atterberg Limits.....	33
2.9.2	Liquid Limit (LL).....	34
2.9.3	Plastic Limit (PL(.....	35
2.9.4	Shrinkage Limit (SL) .....	35
2.9.5	Plasticity index (PI).....	35
2.9.6	Liquidity Index (LI).....	35
2.9.7	Moisture content.....	36
2.9.8	Bulk density.....	36

### CHAPTER(III)

### Materials and Methods

<b>No.</b>	<b>Title</b>	<b>Page</b>
3.1	Materials.....	37
3.1.1	Experimental Site.....	37
3.1.2	Soil.....	37
3.1.3	Meteorological Data.....	40
3.1.4	Experiment Layout.....	43
3.1.5	Experimental design .....	45
3.1.6	Tractor.....	48
3.1.7	Implements.....	48
3.1.7.1	Tillage Machines.....	50
3.1.7.1.1	Disc Plough	
3.1.7.1.2	Disc Harrow	
3.1.7.1.3	Rotary tiller	
3.1.7.1.4	Locally made leveler (Kammarra)	
3.1.7.2	A Rake	
3.1.7.3	A Wasoog	
3.1.7.4	Measuring tape.....	53
3.1.7.5	Balance.....	53
3.1.8	Seed material.....	53
3.1.8.1	Rocket	
3.1.8.2	Jew's Mallow	
3.1.9	Bulk density measurement equipment.....	54
3.1.10	Moisture content Measurement equipment.....	54
3.2	Methods.....	55
3.2.1	Land Preparation.....	55
3.2.2	Seeds.....	55
3.2.3	Planting method.....	55
3.2.4	Irrigation .....	56
3.2.5	Fertilization.....	56
3.2.6	Date of emergence.....	56
3.2.7	Plant parameters.....	56
<b>No.</b>	<b>Title</b>	<b>Page</b>
3.2.8	Determination of number of plants /hectare.....	57
3.2.9	Harvest.....	57
3.2.10	Determination of yield.....	57
3.2.11	Water content measurement.....	58
3.2.12	Bulk density determination .....	58
3.2.13	Determination of liquid limit (LL) .....	59
3.2.14	Determination of plastic limit (PL).....	60
3.2.15	Shear box test.....	61

No.	Title	Page
3.2.16	Cost determination.....	62
3.2.16.1	Tractor cost determination .....	62
3.2.16.1.1	Fixed costs	
3.2.16.1.2	Variable cost.	
3.2.16.2	Disc plough cost determination .....	63
3.2.16.2.1	Fixed costs	
3.2.16.2.2	Variable costs	
3.2.16.3	Disc harrow cost determination .....	63
3.2.16.3.1	Fixed costs.	
3.2.16.3.2	Variable costs	
3.2.16.4	Rotary tiller cost determination.....	64
3.2.16.4.1	Fixed cost.	
3.2.16.4.2	Variable costs	
3.2.16.5	Kammarra cost determination.....	65
3.2.16.5.1	Fixed cost.	
3.2.16.5.2	Variable costs	
3.2.17	Cost analysis for different tillage methods.....	66
3.2.17.1	First method	
3.2.17.2	Second method	
3.2.17.3	Third method	
3.2.17.4	Fourth method	

## CHAPTER(IV)

### Results and Discussion

4.1	Soil analysis .....	68
4.2	First season.....	68
4.2.1	Soil parameters.....	68
4.2.1.1	Effect of different tillage methods on percentage of water content at the first season of Rocket.....	69
4.2.1.2	Effect of different tillage methods on bulk density ( $\text{g}/\text{cm}^3$ ) at the first season of Rocket .....	70
4.2.1.3	Effect of different tillage methods on percentage of water content at the first season of Jew's Mallow.....	71
4.2.1.4	Effect of different tillage methods on bulk density ( $\text{g}/\text{cm}^3$ ) at the first season of Jew's Mallow.....	72
4.2.2	Plant parameters .....	73
4.2.2.1	Rocket (1st season).....	73
4.2.2.1.1	Effect of different tillage methods on the number of Rocket plants/ha .....	73
4.2.2.1.2	Effect of different tillage methods on the number of Rocket leaves/plant .....	74
4.2.2.1.3	Effect of different tillage methods on length of Rocket	

No.	Title	Page
	roots .....	75
4.2.2.1.4	Effect of different tillage methods on length of Rocket Plants.....	76
4.2.2.1.5	Effect of different tillage methods on the yield of Rocket ...	77
4.2.2.2	Jew's Mallow (1 <sup>st</sup> season) .....	78
4.2.2.2.1	Effect of different tillage methods on number of Jew's Mallow plants .....	78
4.2.2.2.2	Effect of different tillage methods on number of leaves/plant of Jew's Mallow .....	79
4.2.2.2.3	Effect of different tillage methods on the root length of Jew's Mallow .....	81
4.2.2.2.4	Effect of different tillage methods on length of Jew's Mallow plants .....	82
4.2.2.2.5	Effect of different tillage methods on the yield of Jew's Mallow .....	83
4.3	Second season.....	85
4.3.1	Soil Parameters .....	85
4.3.1.1	Effect of different tillage methods on percentage of water content (%) - Rocket .....	85
4.3.1.2	Effect of different tillage methods on bulk density (g/cm <sup>3</sup> ) - Rocket .....	86
4.3.1.3	Effect of different tillage methods on percentage of water content (%) - Jew's Mallow .....	87
4.3.1.4	Effect of different tillage methods on bulk density (g/cm <sup>3</sup> ) - Jew's Mallow .....	88
4.3.2	Plant Parameters .....	90
4.3.2.1	Rocket (2 <sup>nd</sup> Season) .....	90
4.3.2.1.1	Effect of different tillage methods on number of Rocket plants .....	90
4.3.2.1.2	Effect of different tillage methods on the number of leaves of Rocket.....	91
4.3.2.1.3	Effect of different tillage methods on length of Rocket roots .....	92
4.3.2.1.4	Effect of different tillage methods on length of Rocket plants .....	93
4.3.2.1.5	Effect of different tillage methods on yield of Rocket .....	94
4.3.2.2	Jew's Mallow (2 <sup>nd</sup> season) .....	95
4.3.2.2.1	Effect of different tillage methods on the number of jew's Mallow plants.....	95
4.3.2.2.2	Effect of different tillage methods on number of Jew's	

No.	Title	Page
	Mallow leaves/plant .....	96
4.3.2.2.3	Effect of different tillage methods on root length of Jew's Mallow .....	97
4.3.2.2.4	Effect of different tillage methods on length of Jew's Mallow plants .....	98
4.3.2.2.5	Effect of different tillage methods on the yield of Jew's Mallow .....	100
4.4	Economical study of different tillage methods .....	101

## CHAPTER(V)

### Conclusion and Recommendations

5.1	Conclusion .....	102
5.2	Recommendation .....	103
-	References .....	104
-	المراجع العربية .....	107

### List of Tables

No.	Title	Page
-----	-------	------

3.1.2-a	The soil characteristics of the experimental site at Shambat ...	37
3.1.2-b	Available nutrient content in (mg/kg soil).....	38
3.1.3-a	Mean temperature, relative humidity and total rainfall at Shambat (2004).....	40
3.1.3-b	Mean temperature, relative humidity, total rainfall and day's length at Shambat (2005) .....	41
3.1.3-c	Mean temperature, relative humidity, total rainfall and day's length at Shambat (2006) .....	42
4.2.1.1	Mean values of water content (%) at the 1 <sup>st</sup> season of Rocket..	69
4.2.1.2	Mean values of bulk density at the 1 <sup>st</sup> season of Rocket.....	70
4.2.1.3	Mean values of water content (%)at the 1 <sup>st</sup> season of Jew's Mallow .....	71
4.2.1.4	Mean values of bulk density at the1 <sup>st</sup> season of Jew's Mallow.....	72
4.2.2.1.1	Mean number of Rocket plants /ha at the1 <sup>st</sup> season .....	73
4.2.2.1.2	Mean number of Rocket leaves /plant at the 1 <sup>st</sup> season.....	74
4.2.2.1.3	Mean length (cm) of Rocket roots at the 1 <sup>st</sup> season .....	75
4.2.2.1.4	Mean length (cm) of Rocket plants at the l <sup>st</sup> season.....	76
4.2.2.1.5	Mean yield (t/ha) of Rocket at the 1 <sup>st</sup> season .....	77
4.2.2.2.1	Mean number of Jew's Mallow Plants/ha at the 1 <sup>st</sup> season.....	78
4.2.2.2.2	Mean number of leaves/ Plant of Jew's Mallow at the 1 <sup>st</sup> season .....	79
4.2.2.2.3	Mean length (cm) of Jew's Mallow roots at the 1 <sup>st</sup> season.....	81
4.2.2.2.4	Mean length (cm) of Jew's Mallow plants at the 1 <sup>st</sup> season ...	82
4.2.2.2.5	Mean yield of jew's Mallow (t/ha) at the 1 <sup>st</sup> season.....	83
4.3.1.1	Mean values of water content (%)at the 2 <sup>nd</sup> season of Rocket.....	85
4.3.1.2	Mean values of bulk density (g/cm <sup>3</sup> ) at the 2 <sup>nd</sup> season of Rocket .....	86

No.	Title	Page
4.3.1.3	Mean values of water content (%) at the 2 <sup>nd</sup> season of Jew's Mallow.....	87
4.3.1.4	Mean values of bulk density (g/cm <sup>3</sup> ) at the 2 <sup>nd</sup> season of Jew's Mallow .....	88
4.3.2.1.1	Mean number of Rocket plants /ha at the 2 <sup>nd</sup> season.....	90
4.3.2.1.2	Mean number of Rocket leaves / plant at the 2 <sup>nd</sup> season.....	91
4.3.2.1.3	Mean length (cm) of Rocket roots at the 2 <sup>nd</sup> season.....	92
4.3.2.1.4	Mean length (cm) of Rocket plants at the 2 <sup>nd</sup> season.....	93

4.3.2.1.5	Mean Rocket yield (t/ha) at the 2 <sup>nd</sup> season .....	94
4.3.2.2.1	Mean number of Jew's Mallow plants/ha at the 2 <sup>nd</sup> season.....	95
4.3.2.2.2	Mean number of Jew's Mallow leaves /plant at the 2 <sup>nd</sup> Season .....	96
4.3.2.2.3	Mean length of Jew's Mallow roots at the 2 <sup>nd</sup> season.....	97
4.3.2.2.4	Mean length (cm) of Jew's Mallow plants at the 2 <sup>nd</sup> season....	98
4.3.2.2.5	Mean yield (t/ha) of Jew's Mallow at the 2 <sup>nd</sup> season.....	100
4.4.1	Cost of different tillage methods (SDG).....	101

## List of Plates

No.	Title	Page
1	Experimental Site.....	39
2	First tillage method - Rotovator only.....	46
3	Second tillage method- Disc plough + Rotovator.....	46
4	Third tillage method - Disc plough + Disc harrow.....	47
5	Fourth tillage method- Disc plough + Kammarra.....	47
6	The disc plough.....	49
7	The disc harrow.....	49
8	The rotary tiller (Rotovator).....	52
9	The Kammarra.....	52

## **List of Figures**

<b>No.</b>	<b>Title</b>	<b>Page</b>
3.1.4	Experimental layout .....	44