PRECISION SCHEDULING FOR WATER AND SALT MANAGEMENT

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INTRODUCTION

- Pressure on irrigated agriculture to use water more efficiently
  - adoption of better irrigation technology, irrigation scheduling, site-specific management.
- The predicament – salts added through irrigation water and fertiliser build-up in soils.
  - Building up of salts identified as a major threat to agriculture
  - Reduces farm income.

- Management of water and salts is very important to the sustainability of irrigation agriculture
- Research focuses on improving irrigation and drainage practices
- Armour and Viljoen (2008) evaluate the feasibility of installing drainage systems.
- Reinders et al. (2015) developed technical and financial norms, and standards for draining irrigation fields.
- Other research focussed on the biophysical impact of salinity and the management thereof (Herold and Bailey, 1996; Du Preez et al., 2000 and Ehlers, 2003)

- Nell et al. (2015) used remote sensing to identify, classify and monitor the degree of waterlogging and salt accumulation in the irrigation schemes of South Africa.
- WRC funded project (WRC project K5/2499) with the aim of developing guidelines and a decision support system for site-specific management of salt loads.
- Given the changes in electricity and input costs, the question becomes how financially feasible is the guidelines for site-specific management of water and salt loads

AIM

- WRC project - *Economic Management Of Water And Salt Stress For Irrigated Agriculture: A Precision Agriculture Case Study* (K5/2708//4),

- To develop and apply an integrated bio-economic model to economically manage site-specific water and salt stress in irrigated agriculture
  - To develop economic guidelines for managing site-specific water and salt stress

METHODOLOGY

- Soil Water Irrigation Planning (SWIP) water budget (Venter and Grové, 2016).
  - Adapted for different crop responses during the growth-phases
- MOPECO salt balance (Domínguez et al., 2011)

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- The adopted yield equation are given by the following equation (Steward et al., 1977):
- $$Ya = Ym \prod_{g=1}^{4} (1 - Ky \left(1 - \left(\frac{ET_a}{ET_m}\right)_k\right))$$

- The following equation was proposed by Allen et al. (1998) to evaluate the combined effect of water and salinity stress on Eta:

$$\frac{\mathrm{ET}_{\mathrm{a\ ws}}^{(1)}}{\mathrm{ET_m}} = K_{\mathrm{sc}} = K_{\mathrm{ss}} K_{\mathrm{sw}}^{(1)} = \left[1 - \frac{b}{k_{\mathrm{y}} 100}\left(\mathrm{EC_e} - \mathrm{EC_{et}}\right)\right] \frac{\mathrm{TAW} - \mathrm{Dr}}{(1 - p)\mathrm{TAW}}$$

$$\mathrm{SCr}_i = \mathrm{SCr}_{i-1} + \mathrm{Is}_i + \mathrm{Gs}_i - \mathrm{Psr}_i$$

$$\mathrm{Is}_i = \mathrm{Iw}_i \mathrm{EC}_{iw} 640$$

$$\mathrm{Gs}_i = \frac{\mathrm{SCg}_{i-1}(\mathrm{Zr}_i - \mathrm{Zr}_{i-1})}{\mathrm{Zt} - \mathrm{Zr}_{i-1}}$$

$$\mathrm{Psr}_i = \frac{(\mathrm{SCg}_{i-1} + \mathrm{Is}_i + \mathrm{Gs}_i)\mathrm{Pwr}_i}{\vartheta_{\mathrm{FC}}\mathrm{Zr}_i + (\mathrm{Pwr}_i/2)}$$

$$\mathrm{SCg}_i = \mathrm{SCg}_{i-1} + \mathrm{Psr}_i - \mathrm{Gs}_i - \mathrm{Psg}_i$$

$$\mathrm{Psg}_i = \frac{(\mathrm{SCg}_{i-1} + \mathrm{Psr}_i - \mathrm{Gs}_i)\mathrm{Pwg}_i}{\vartheta_{\mathrm{FC}}(\mathrm{Zt} - \mathrm{Zr}_{i-1}) + (\mathrm{Pwg}_i/2)}$$

EMPIRICAL APPLICATION

- Center pivot
  - 10% losses
- Two initial soil water EC scenarios
  - M1= 0.7 dSm-1
  - M2= 2 dSm-1
- Two irrigation water EC
  - 0.7 dSm-1
  - 2 dSm-1
- Economic data for maize production in Douglas area obtained from GWK

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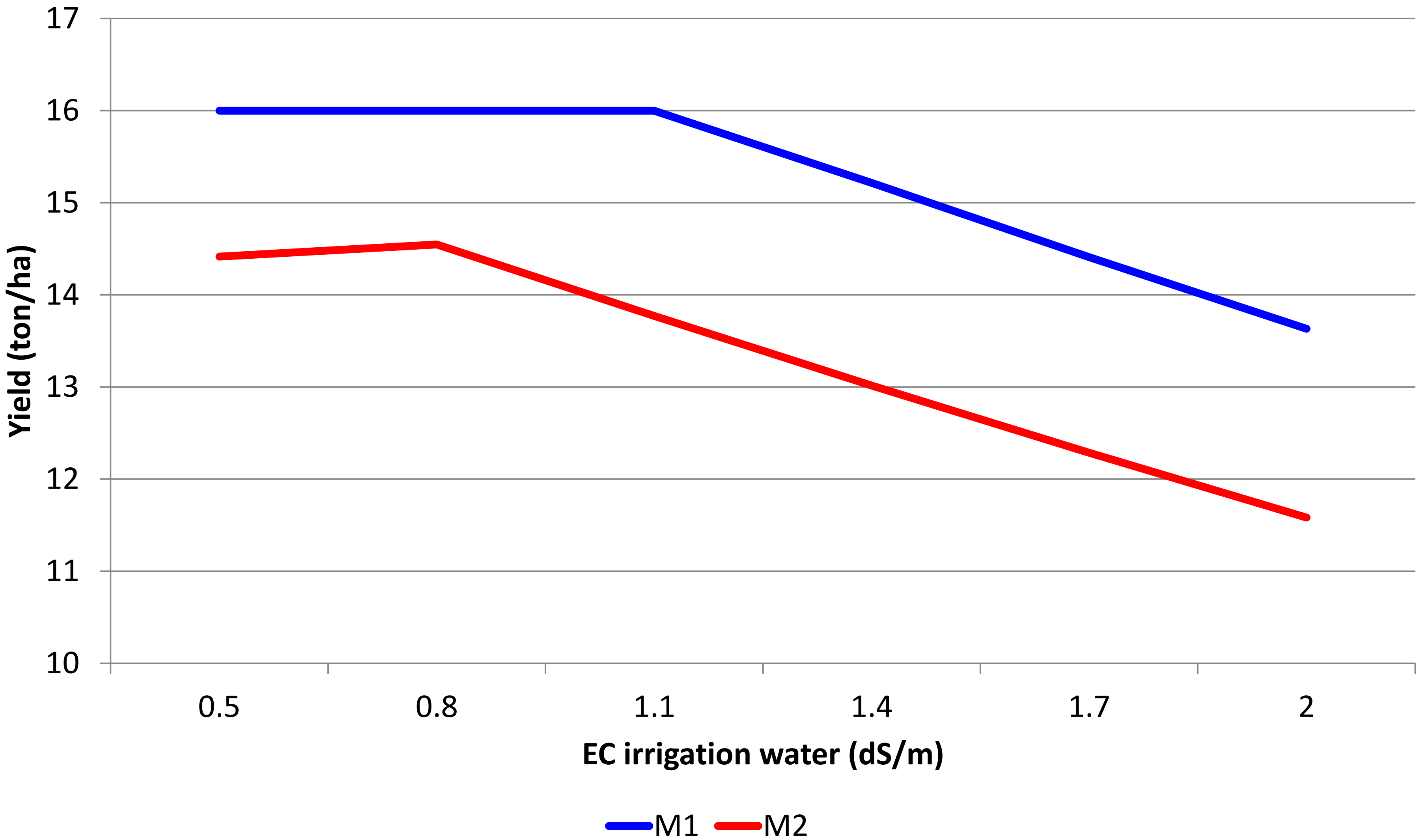
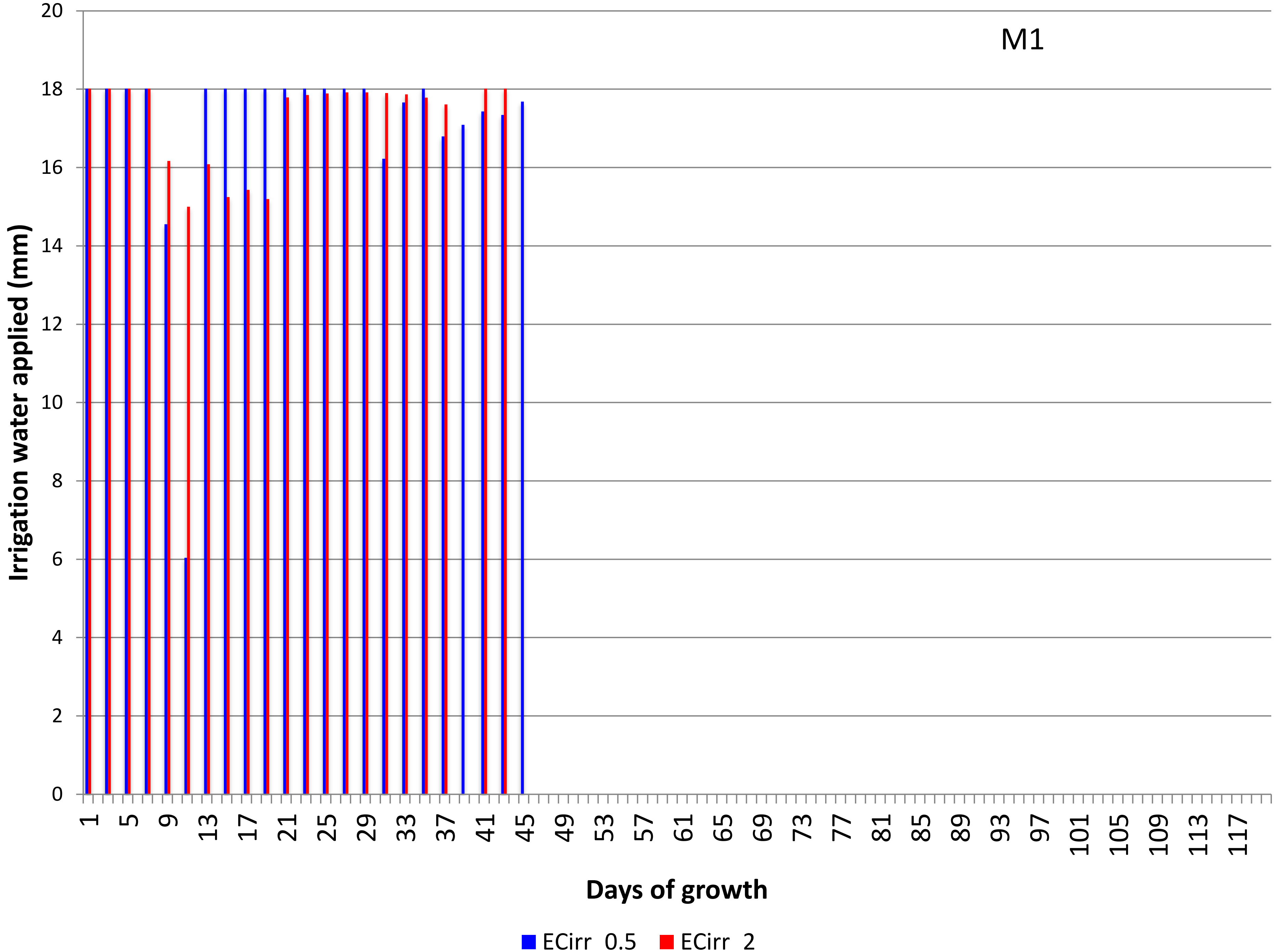
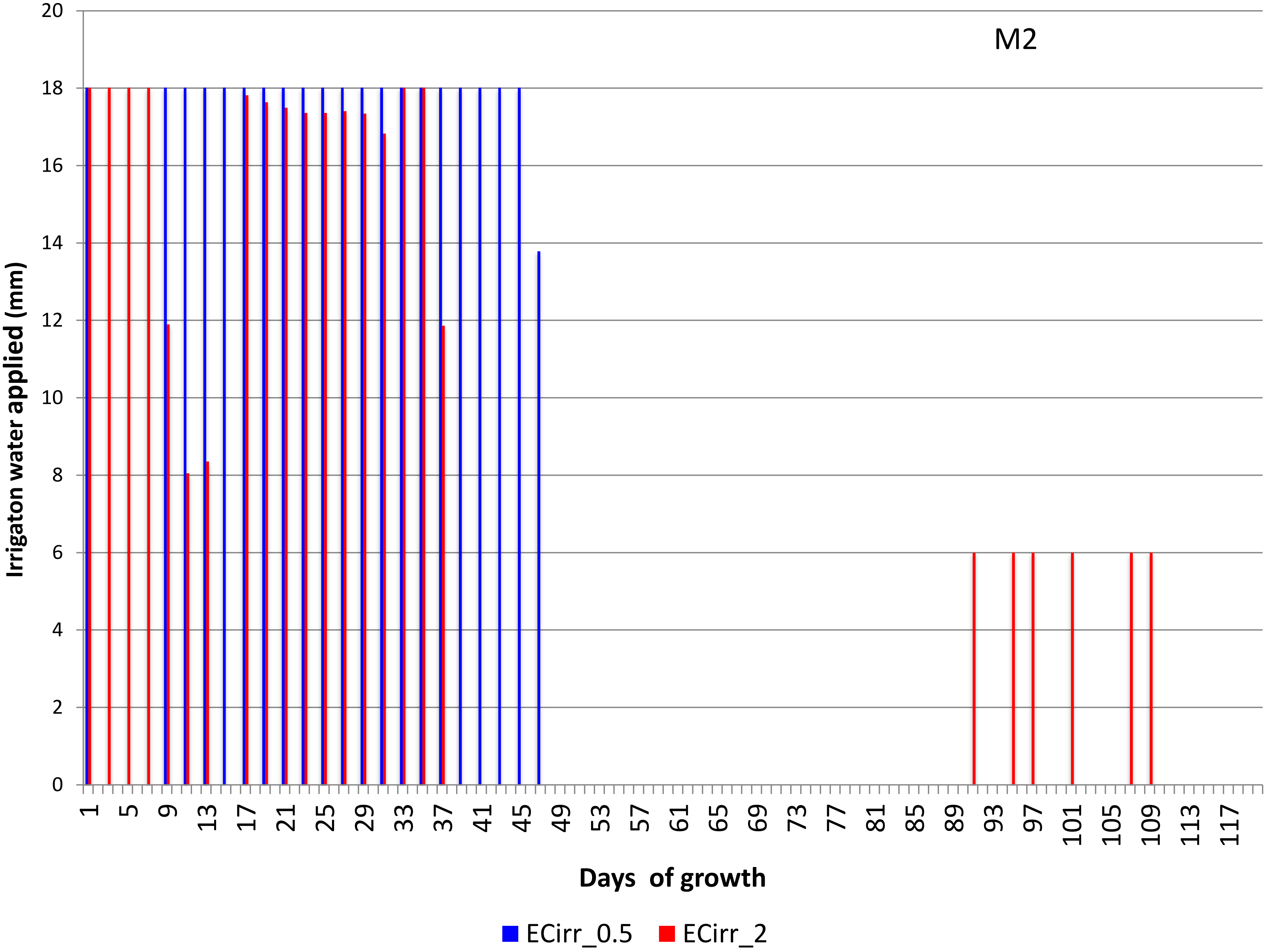
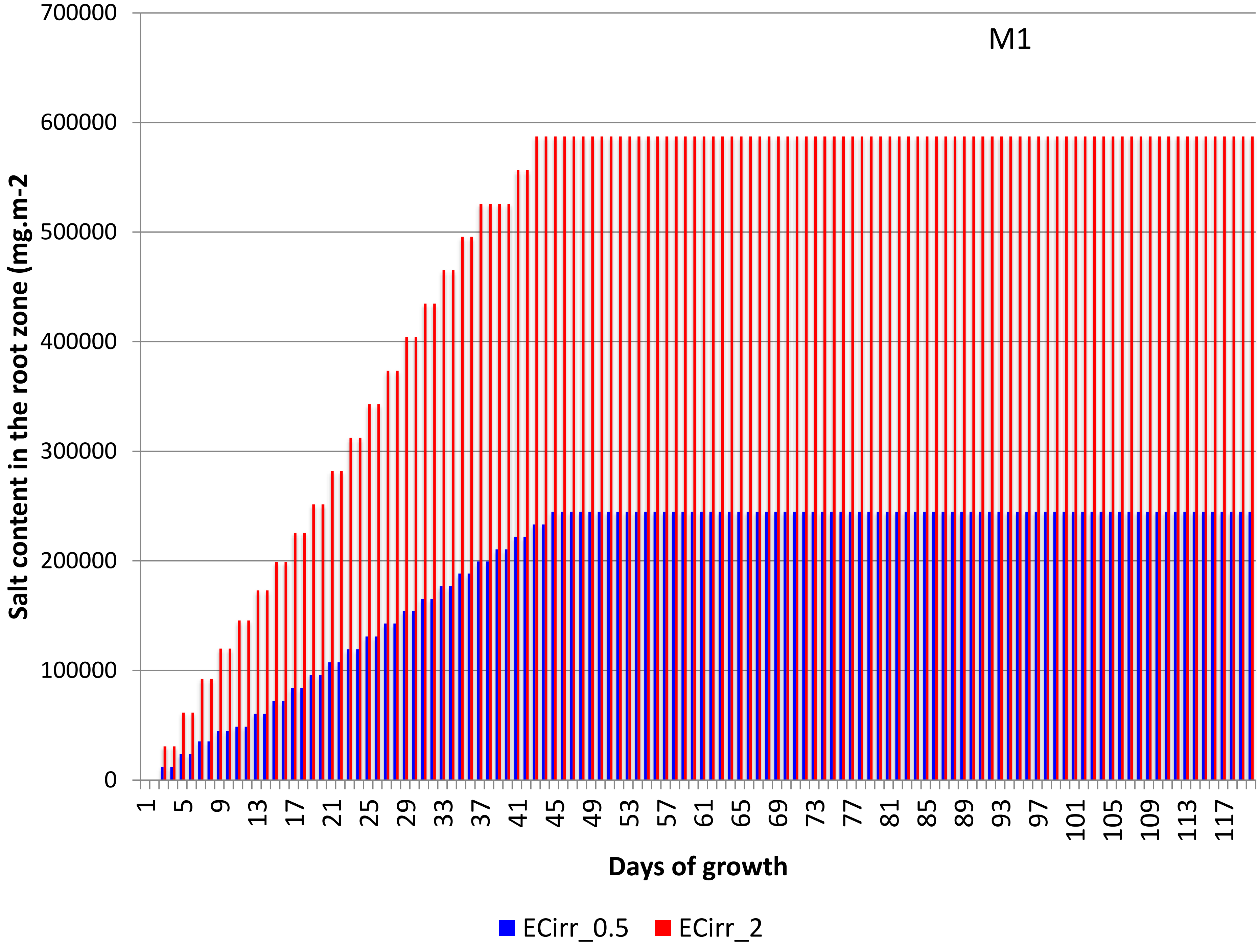
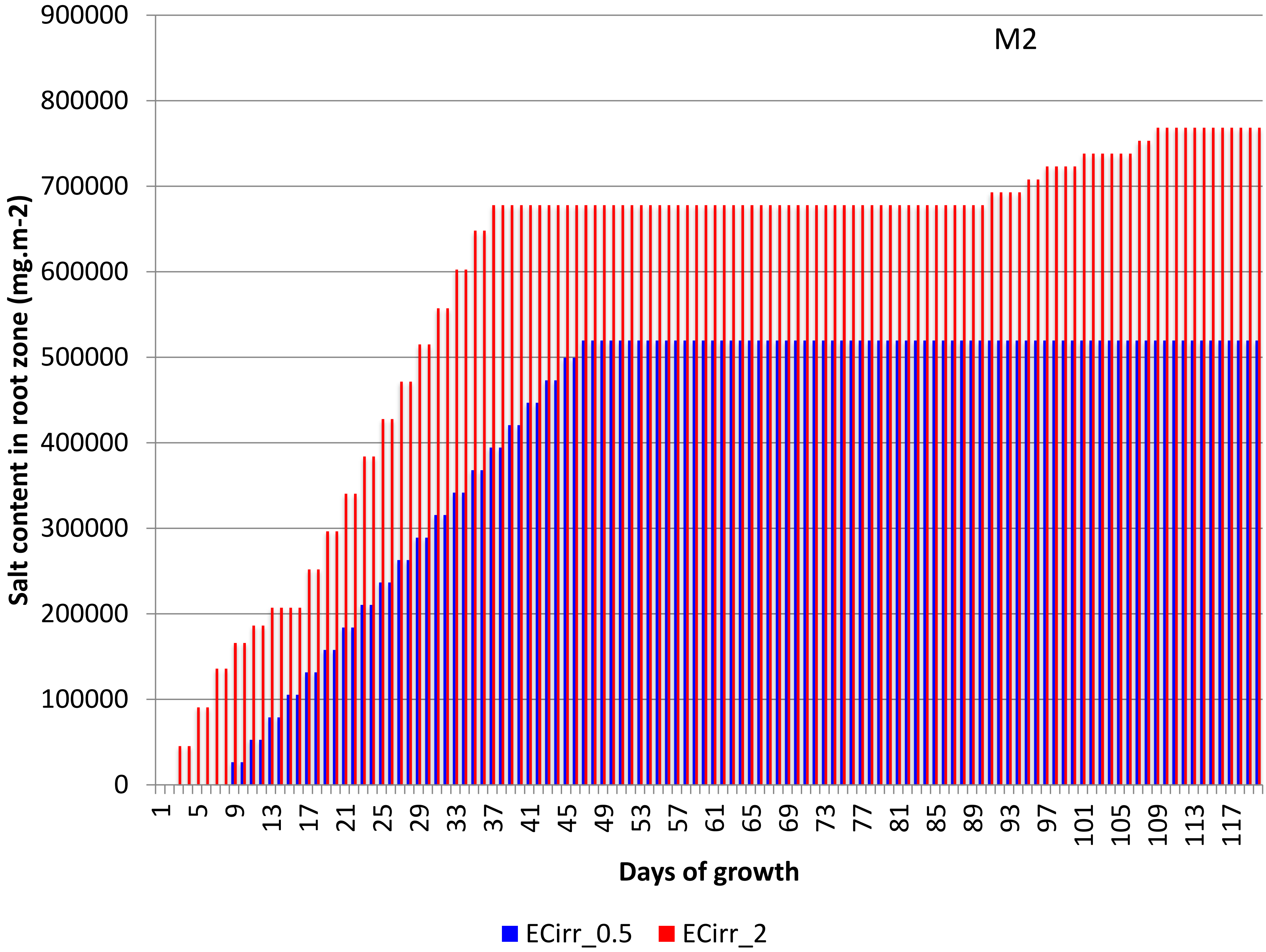
PRELIMINARY RESULTS




M1
Irrigation water applied (mm)
0
2
4
6
8
10
12
14
16
18
20
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
77
81
85
89
93
97
101
105
109
113
117
Days of growth
ECirr_0.5
ECirr_2


M2
Irrigaton water applied (mm)
Days of growth
0
2
4
6
8
10
12
14
16
18
20
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
77
81
85
89
93
97
101
105
109
113
117
ECirr_0.5
ECirr_2


M1
Salt content in the root zone (mg.m-2
700000
600000
500000
400000
300000
200000
100000
0
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
77
81
85
89
93
97
101
105
109
113
117
Days of growth
ECirr_0.5
ECirr_2


M2
Salt content in root zone (mg.m-2)
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
77
81
85
89
93
97
101
105
109
113
117
Days of growth
ECirr_0.5
ECirr_2

CONCLUSIONS

- Are able to model the effect of salt on yields in a dynamic manner
- Percolation in the salt balance highly non-linear
  - Problem optimising the nonlinear model
  - Alternative to optimisation is the use of evolutionary algorithms

ACKNOWLEDGEMENTS

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Thank You
Dankie

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