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Quinoa yield response to deficit irrigation and nitrogen levels, in presence of saline shallow groundwater

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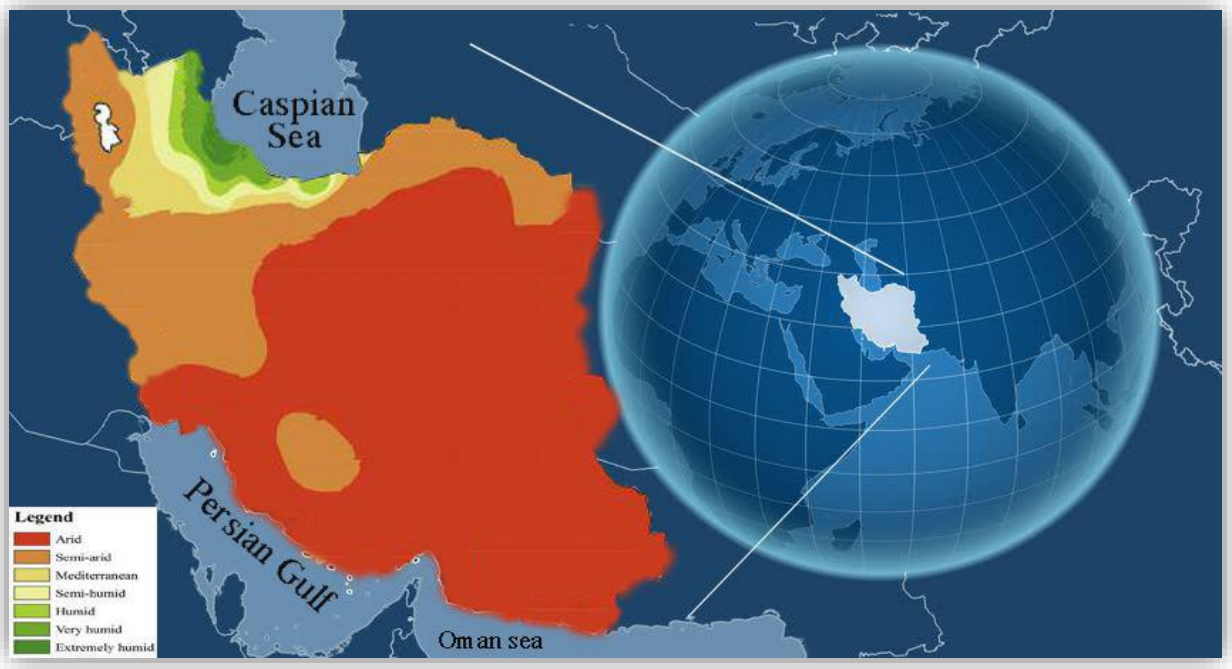
Introduction

Key challenges in arid and semi-arid regions are:

- Increasing water demand and low amount of precipitation cause **water scarcity**
- Lack of enough water has force farmers to use poor-quality water such as **saline water** for irrigation
- Well water is the main water resource for irrigation which **suffer increasing salinity**
- **Shallow saline groundwater** often exist in irrigated areas of these regions



Introduction

Some strategy that followed in this study:

- Utilize the **species capable of tolerating drought and high soil salinities (**such as halophytes) to guarantee acceptable yields

- Applying **deficit irrigation** to increase the water productivity

- Investigate of **mineral nutrient management for salinity and drought stresses** will improve plant resistance under both of these stresses

- **Shallow groundwater is a valuable source of water supply** to supply crop water requirements in arid and semi-arid regions

Introduction

Study targets:

Quinoa yield response under:

- ✓ Nitrogen fertilizer rates
- ✓ Different irrigation levels
- ✓ Saline irrigation water (20 dS m^{-1})
- ✓ Saline shallow groundwater depth (0.8m)

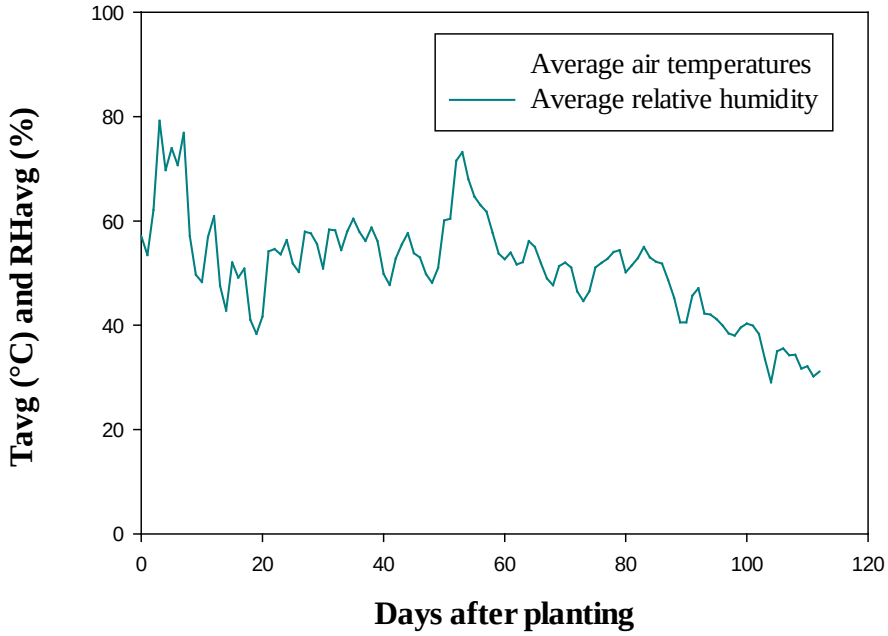
Introduction

Materials and Methods

Experimental site

Greenhouse located at College of Agriculture, Shiraz University, Shiraz, I.R. Iran :

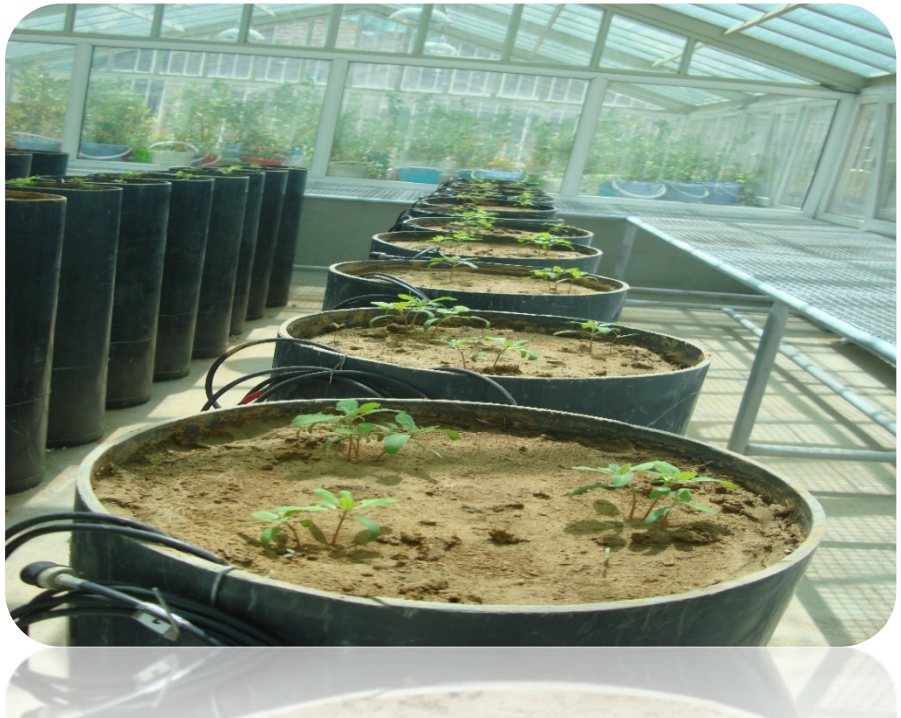
- Latitude 29° 56′ N, Longitude 52° 02′ E, Altitude 1810 m

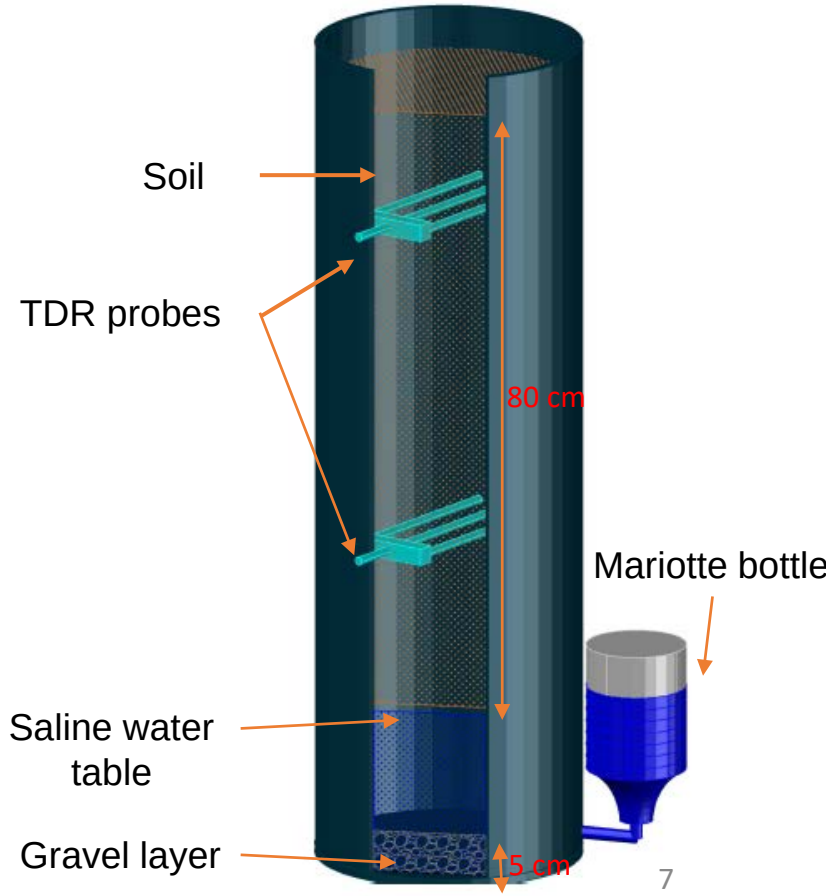


Materials and Methods

Experimental site

- Quinoa (*Chenopodium quinoa* Willd.) cv. Titicaca were sown per parcel with triangle arrangement (three parcel per column)
- Sowing day: 15th March 2015
- Loam soil





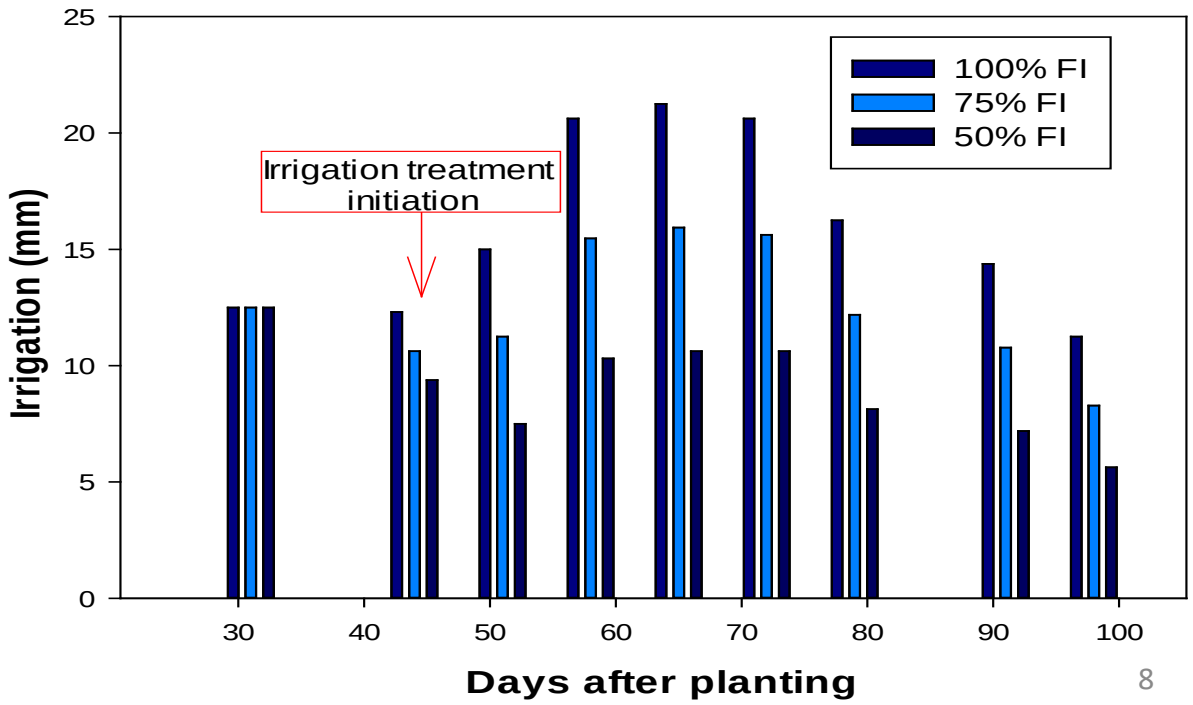
Materials and Methods

Applied treatments

➢ Irrigation treatment

- Three different irrigation treatments, **full irrigation** and two deficit irrigation of **50 % and 75 % of full irrigation**
- All treatments were irrigated using **saline water with electrical conductivity of 20 dS m^{-1}**

$$d = \sum_{i=1}^{n} (\theta_{fc} - \theta_i) \Delta z_i$$



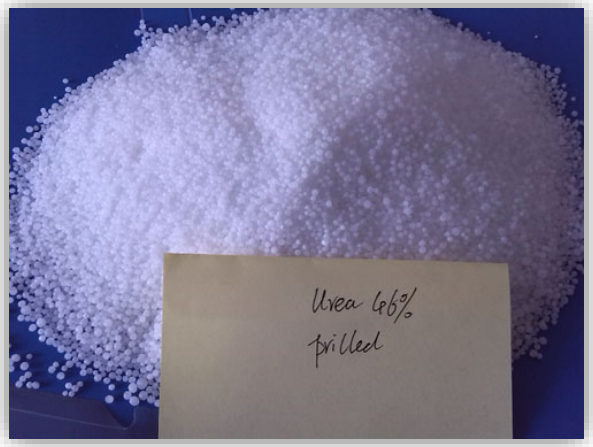
Materials and Methods

Applied treatments

➢ Nitrogen treatment

- The fertilizer levels were 0, 0.71, 1.41 and 2.12 g N column^{-1}

  (Equivalent to 0, 100, 200, 300 kg N ha^{-1})



- The amount of nitrogen in each treatment was divided in two equal parts

Early vegetative growth (28 DAP)

Early flowering period (58 DAP)

Materials and Methods

Measurements and calculations

- Daily crop evapotranspiration

$$ET_c = IW + GWC \pm \Delta S$$

Irrigation water depth (mm)

Upward flow of water (mm)

Change in soil water content (mm)

Materials and Methods

Measurements and calculations

- Seed yield

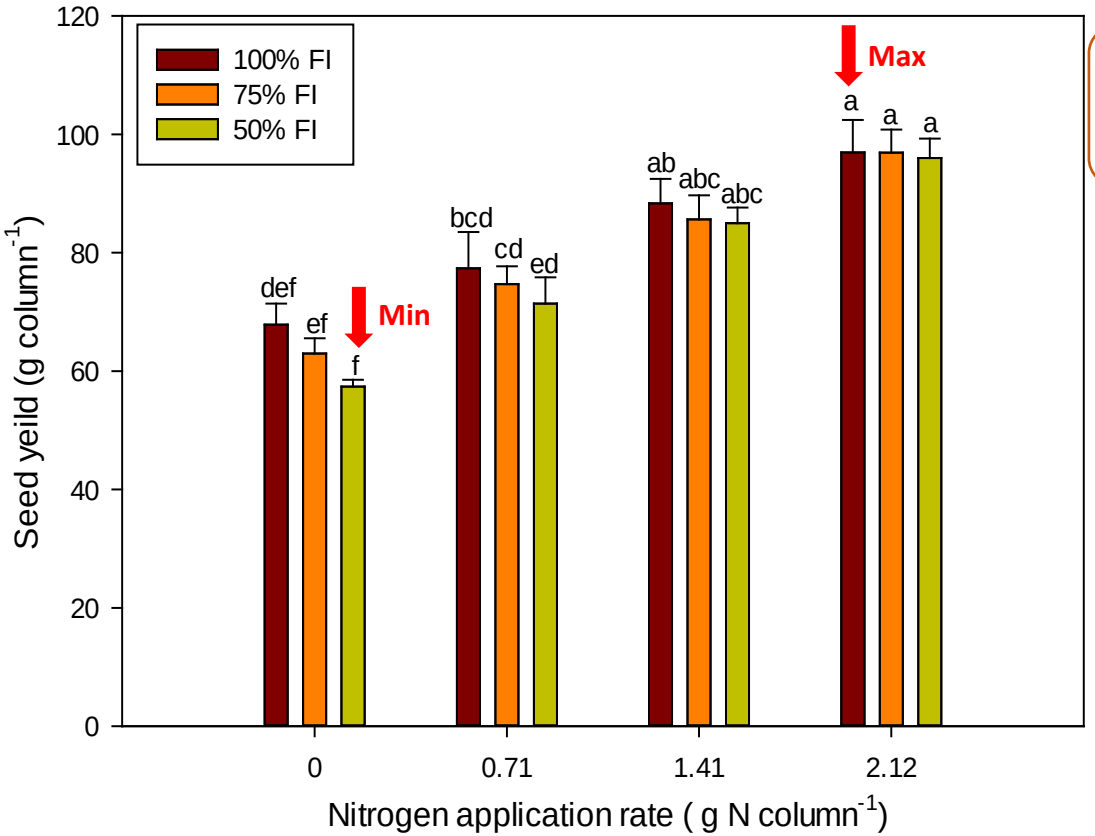
- Shoot dry matter

- Harvest index

$$\mathrm{HI}(\%) = \frac{\text{Seed yield}}{\text{Seed yield} + \text{Shoot dry matter}} \times 100$$

Results

Seed yield



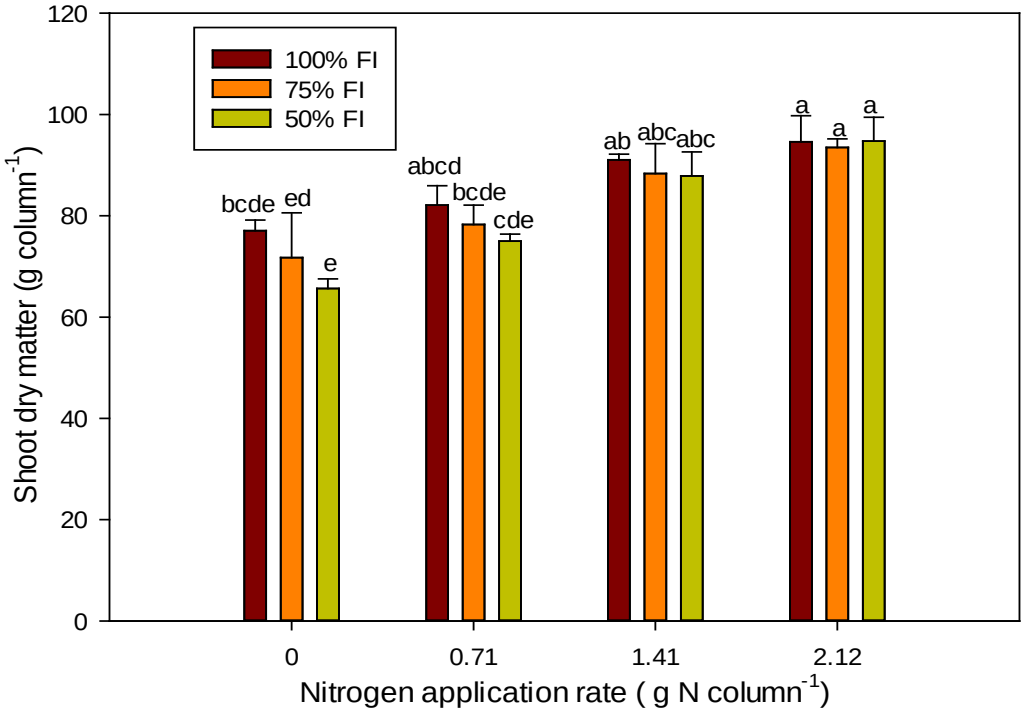
Max yield 96.96 g column^{-1}

Min yield 57.39 g column^{-1}

✓ At 100% FI:		✓ At 75% FI:		✓ At 50% FI:	
N1	14.1%	N1	18.6%	N1	24.4%
N2	30.2%	N2	36.0%	N2	48.1%
N3	42.9%	N3	53.9%	N3	67.3%

Results

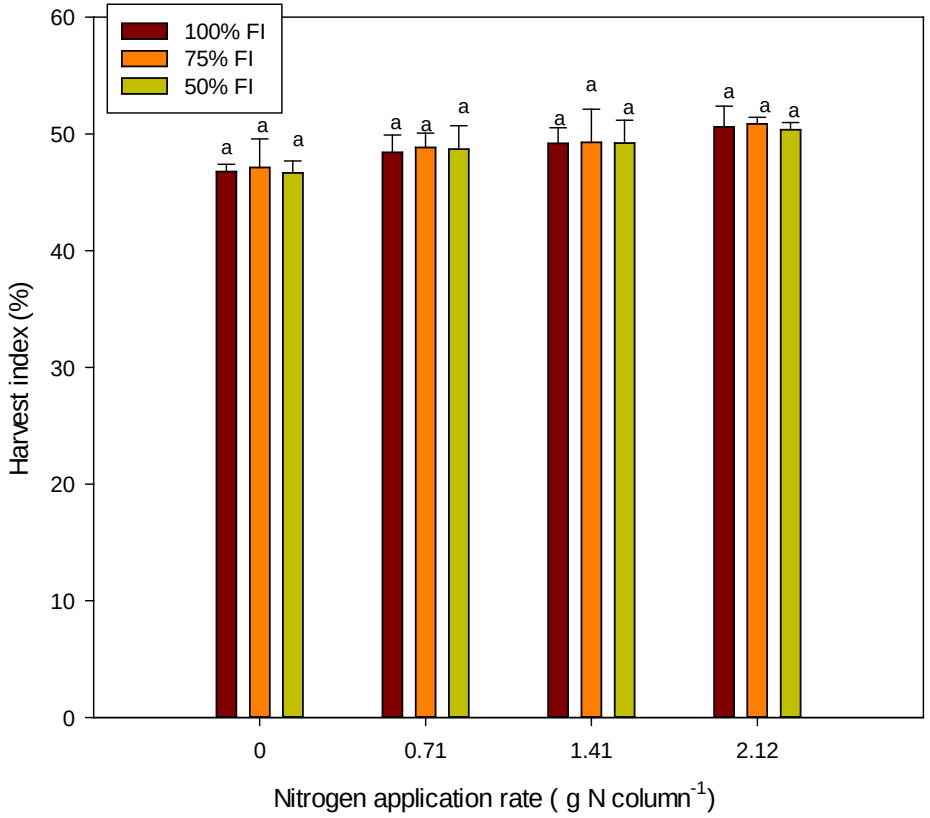
Shoot dry matter



✓ At 100% FI:		✓ At 75% FI:		✓ At 50% FI:	
N1	21.0%	N1	24.4%	N1	30.7%
N2	34.2%	N2	40.3%	N2	53.1%
N3	39.4%	N3	48.5%	N3	65.1%

Results

Harvest index



HI Range from

46.6% to 50.9%

Results

Seasonal crop evapotranspiration and applied irrigation water

Irrigation treatment	Crop evapotranspiration (ET_c) mm	Applied irrigation water mm	Irrigation water reduction %
100% FI	422.97	169.19	-
75% FI	415.81	137.81	19
50% FI	409.62	106.88	37

- ✓ Ground water contribution:

100% FI 245.20 mm

75% FI 262.91 mm

50% FI 284.90 mm

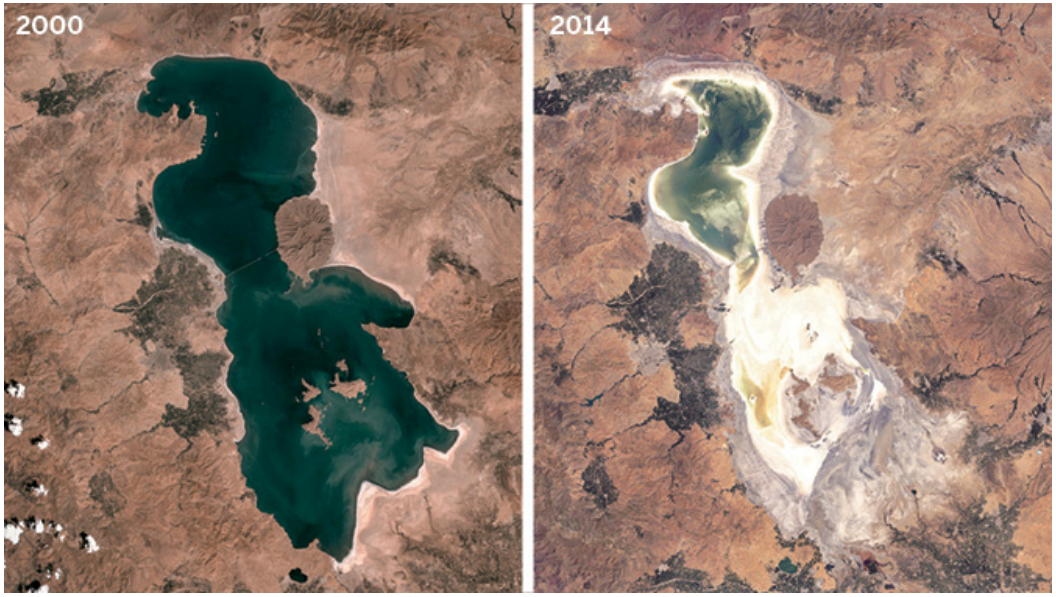
Conclusions

- ✓ Nitrogen fertilizer enhanced quinoa yield under both full and deficit irrigation. Moreover, seed yield response to nitrogen fertilizer was higher than shoot dry matter.
- ✓ Harvest index (HI) ranged was from 46.6 to 50.9% and this parameter was not shown significant effect under nitrogen fertilizer and irrigation treatments.
- ✓ There was not significant effects in different irrigation treatments on seed yield and shoot dry matter
- ✓ It is shown that under deficit irrigation, crop required water was obtained from groundwater
- ✓ Reduced applied irrigation water from 100%FI to 75%FI and 100%FI to 50%FI were 19 and 37% as water savings, respectively.
- ✓ Deficit irrigation with saline water and cultivation of crops in fields with a shallow saline groundwater table may resulted in salt accumulative in soil that should be counted in salt management

Background/Introduction

- Groundwater level in some coastal lands, a relatively large radius of lands was under influence of sea water or brackish lakes. it causes groundwater exploitation in this land been sensitive. especially at the months of vegetative growth, and excessive amounts authorized for hydrological balance, continued of irrigation by miscible water with salt cause an irreversible risk for the agricultural area

- For Example a part of urmia lake is located in the agriculture and horticulture land in East Azarbaijan, High rate of pumping at wells especially at shallow wells, increase ground water electrical conductivity, in some part electrical conductivity even reached to 10 dS m^{-1}



Urmia lake in north west of I.R. of Iran.

Tank you for your attention