**A proposal to earn MSc degree in the field of irrigation**

**1. Name of proposal :** Interactive effects of emitter type, deficit irrigation and water salinity on yield, quality on water use efficiency of Red cabbage (*Brassica oleracea* L) in the semiarid region of Kirkuk

**2. Overview and justification**

Water is the most important resource and a limiting factor for agricultural development. Therefore, practices that lead to improve the water use efficiency (WUE) and reduce the amount of added water are of importance for conserving water (AlHarbi et al., 2014). Furthermore, the scarcity of good quality water forces growers to use water with moderate or high salinity levels. Irrigation with saline water leads to a successive accumulation of salts in the soil (Aktas et al., 2006). Saline water is an important resource in arid areas and areas with poor quality groundwater resources. Use of poor quality water poses serious loss in yield and plant growth (NAGM AL DEEN et al., 2018). Therefore, evaluating irrigation water quality is critical for optimum cultural practices and long-term productivity (Bauder et al., 2004).

Increasing world population demands more water for different uses such as water required for domestic, industrial, environmental, recreational and agricultural needs( Sepaskhah and Yousofi-Falakdehi, 2009). The advent of precision irrigation methods such as drip irrigation has played a major role in reducing the water required in agricultural and horticultural crops, but has highlighted the need for new methods of accurate irrigation scheduling and control. In recent years it has become clear that the maintenance of a slight water deficit can improve the partitioning of carbohydrate to reproductive structures such as fruit and also control excessive vegetative growth (Chalmers et al. 1981).

Drip irrigation, with its characteristic of low rate and high frequent irrigation applications over a long period of time, can maintain high soil matric potential in the root zone thus compensate the decrease of osmotic potential introduced by the saline water irrigation, and the constant high total water potential can be maintained for the crop growth (Kang, et al, 2004)

The multiple uses of red cabbage has made it a popular crop among the vegetables ( Sarkar and Rakshit, 2018). cabbage (*Brassica oleracea* L) is used mostly as an ingredient in raw vegetable salads containing a full range of vitamins and minerals with various beneficial impacts on human health (Majkowska-Gadomska and Wierzbicka 2008). It is one of the main crops for greenhouse cultivation and is classified as intermediately susceptible to water stress (Nortje and Henrico 1988).

Various kinds of unfavorable environmental stresses (such as drought, salinity, heat, cold and oxidative stresses) retard the growth and yield of vegetable plants (Kumar and Arumugam, 2013; Nouri et al., 2015 and Mickelbart et al., 2015; Joshi et al., 2018; Wu et al., 2018).

An optimal irrigation management is essential to maximize both water productivity and red cabbage fruit quality. These parameters depend to a large extent on the plant variety and the environment in which they are grown ( Mardani et al. 2017 and Yang et al. 2017).

Since there are limited studies dedicated to determine the effect of deficit irrigation and water quality on productivity of red cabbage in the area under investigation, this research is proposed to the target the objectives listed in the incoming section.

**3. Objectives**

**3.1. Main objective**

This study will be conducted to investigate the response of red cabbage to different levels of deficit irrigation and water salinity under two types of emitters

**3.2. Specific objectives**

The main objective can be attained by targeting the following specific objectives:

1.The reduction in fresh fruit yield per unit salinity of irrigation water

2. Mitigating the deleterious salinity effects by applying the high level irrigation water

3. The sensitivity of red cabbage to deficit irrigation via determining the crop response factor under each level of salinity stress.

4. Selection of the emitter type which offers the highest performance

5. Recommending the best treatment in term of highest yield and the best irrigation water productivity and acceptable quality for drip irrigated red cabbage grown under the semiarid condition of Kirkuk.

6. The effect of level of each of water deficit and salinity stress on red cabbage quality

**4. Null hypothesis:**

Red cabbage growth, yield and quality do not respond to different levels of deficit irrigation, water salinity under two types of emitters during drip irrigation.

**4. Brief outlines**

1. Prior to the experiment implementation, composite soil samples will be obtained from the experimental site for conducting routine soil physical and chemical properties. The properties encompass ( particle size distribution, organic content, lime equivalent, ECe, pH, soluble cations and anions, N. P and K). Furthermore the obtained water types will be subjected to analysis periodically.

2.A suitable genotype of red cabbage will be selected.

3.Seeds are sown in a nursery nearby the experimental site

4.Fourty-eight experimental plots will be established with dimensions of 1.8m x 2.0 m. ( row spacing =0.60 m and plant spacing = 0.33 m).

5.S ix-week old red cabbage transplants will be planted by hand in the field ( row spacing =0.60 m and plant spacing = 0.33 m).

6. The crop will be irrigated under drip system using split –split block plot design using emitter type in the main plot; water salinity stress and water stress in the submain and subsubmain plots respectively with three replicates. As stated earlier, The number of the experimental units will be 2 x 2 x 4 x 3 rep = 48.

7.The following factors will be selected

**Factor A: Type of emitter:**

E1= T-Tape and E2=Turbo

**Factor B = Deficit irrigation levels:**

I1= 1.2; I2 = 1.0; I3 = 0.75 and I4 = 0.5 of ETc

ETc = Epan x KpxKc

ETc = crop consumptive use (mm/day)

Epan= Evaporation from Colorado Class A evaporation pan

Kc = crop coefficient.

**Factor C = Water salinity stress level** (depending on the salinity of the neibouring wells)

S1 = River water ( EC = 0.6 dSm-1)

S2 = Well water ( EC = 4 dSm-1)

8. Type and Level of applied fertilizer in the permanent field will be according to the recommended type and level in the area under study. Additionally, the control of diseases and insects will be according to the recommendations specific for the area under study. Weeds will be controlled by hand.

9. Drought treatments will begin 30 days after seedling cultivation

10. The measured response variables encompass those displayed in Table 1.

Table 1. the suggested variables that are suggested to be measured during growing season and at harvest

|  |  |  |
| --- | --- | --- |
| **Parameter category** | **Specific parameter** | **Comments** |
| A) Growth characteristics | 1)Plant height  2)Leaf area  3)Aboveground biomass  4) Diameter | Using a stick meter  Measured by an electronic  leaf area meter |
| B- Yield and yield components | 1.Average fruit weight (g)  3) Total fresh fruit yield (t/ha) | Using a digital balance with a precession of 10 mg. |
| C- Quality parameters | 1)Total sugar content  2) organic acids  3)Chemical composition ( Na+, Cl-)  4)Proline content | As outlined Ross(1959)  Augustin et al. (1981)  Bates *et al*. (1973), |
| D- Water use efficiency | 3)Water use efficiency at biomass basis  4)Water use efficiency at fresh yield | Yield basis (WUEy) it will be calculated as the ratio of fruit yield  (at fresh and dry basis; t ha–1) and ET (mm). |
| E. Salt and water distribution in soil | 1. Horizontal distribution  2. Vertical distribution |  |
| F. Emitter’s emission uniformity | 1.CV%  2.Variation of emitter flow  3.Statistical Uniformity coefficient  4.Uniformity of field emission  5. design emission uniformity  Absolute uniformity of field emission. | They will be determined based on the formulas given in the attached sheet |

**11. Irrigation Schedule**

The irrigation schedule will be based on the following steps

1. Setting up the evaporation pan close to the experimental site and recording daily evaporation (mm/day)
2. Converting pan evaporation (Epan)to potential evaporation(ETo) through

ETo= Epan x Kpan

Kpan = pan coefficient

1. Establishment of crop coefficient (Kc)curve for red cabbage over the growing season and obtaining the crop consumptive use from;
2. ETc = ETo x Kc
3. Calculation of volume of applied water in liter/day /plant from:

V= ETc x WA x A

where: Wa = wetted area fraction or reduction factor (=0.5); A = area = Sp x Sr

6.Time of operation( T in hours) based on irrigation interval of 3days will be:

T = 3 V/ q; where q = emitter discharge in l/hr.

12. The best treatment will be selected based on the treatment which offers the best water use efficiency.

13. The soil moisture and salt distributions will be studied at the mid and the end of the growing season in both x- and z- directions after obtaining g samples with a small auger.

14. The obtained data will be processed using different softwares ( Surfer, SPSS, SAS, Excel, etc.).

15. Building models to relate fresh yield to water salinity and deficit irrigation levels .

**5. Requirements**

1. EC-meter

2. Colorado class A pan ( it can be made locally)

3. Tanks for storing water of different qualities

4. Gravity drip irrigation system

5. Small auger for soil sampling

6. Chemicals for routine soil analyses

7. A parcel of nearly level land ( about 1000 m2 with barbed wire fencing .

**6. Required budget ( Allocated money)**

About 10,000,000 ID is required to cover all the expenses of the experimental work.

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