Effect of irrigation level and nitrogen fertilizer on water consumption and faba bean growth

Zaid A. Ali¹  Diaa F. Hassan²  Rafal J. Mohammed³

¹Al-Qasim Green University
²Al-Qasim Green University, Water Resources Engineering College
³Al-Qasim Green University, College of Agriculture

Corresponding Author: diaafliah@wrec.uoqasim.edu.iq

Abstract

A field experiment was conducted in Babil governorate to find out the effect of water tightening with different irrigation levels and fertilization with different urea levels on water consumption of pests and some of its characteristics. Agricultural land was selected and prepared for cultivation and the field was divided. It was treated with three levels of irrigation, which are (30, 50, 70) % of the ready water, and three levels of urea, which are (0, 50, 100) kg urea.

After the end of the experiment, the actual water consumption, the reference water consumption and the yield factor were calculated. The water consumption was (562, 482, 382) mm for each of the levels of irrigation (30, 50, 70)% of the prepared water, respectively.

As for the characteristics of the plant, it was found that the best treatment that achieved good productive and vegetative characteristics is the treatment of depletion of 30% and the level of urea 100 kg, as the values reached (75.3, 83.2, 20, 5284) for each of the plant height, dry weight, number of branches and seed yield respectively. . The water stress reduces plant productivity due to water stress, as well as the high level of urea, which helped improve plant properties.

Key Words: Hydroelectricity; Urea; Remnants; Water consumption
Introduction

Water consumption or evaporation is one of the most important elements of the water cycle, as it affects the water balance in all its stages, and its knowledge is important in the field of planning and managing water resources, (Al- Naqshbandi, 2002). Water consumption is defined as the sum of what the plant loses through evaporation and transpiration. Water consumption is usually called the term evapotranspiration, as it is difficult to separate the effect of evaporation and transpiration from each other under field conditions. Water consumption or evaporation is defined as transpiration as the amount of water consumed by plants in the process of transpiration or building their tissues and evaporation from the soil surface, and transpiration is the process of losing water in the form of vapor from respiratory stomata scattered on the surface of the leaf mainly, which constitutes 0.9% of the total transpiration. As for evaporation, it is defined as the physical process by which a liquid substance turns into steam. It is a method in which water is lost in the form of vapor from the surface of leaves that intercept rain water.

Maximum water consumption is used to determine the effect of climatic factors for a given field on the extraction of moisture from soil and water. (Penman, 1956) This term has been defined as the amount of water lost per unit time from a standard crop under conditions of adequate soil moisture. ET (Al-Taif, 1988) The calculation of the maximum value of water consumption is a guide for estimating potential water consumption rates under different climatic conditions and critical plant growth stages. Reference Evapotranspiration ETo is defined as the evaporation of ETo from a broad surface of a theoretical, waterless weed crop of 0.1 - 0.15 m long (Venture, 1999) which is a function of climatic factors only and can be calculated from climate data (Doorenbos, 1977). The water needs of the faba bean crop increase with the advancement of the growing season, especially in the mid-growth stage of the crop (flowering and maturation), which requires an increase in the number of irrigation at this stage and the irrigation process when 25% of the ready water is exhausted in order to obtain the best growth and yield of 16, 20 and 20 pods. 13 The decrease in the amounts of irrigation water added to the crop of faba bean leads to an increase in the water stress of the crop, which affects most of the indicators of crop growth. Providing irrigation water for the crop with more than 70% of the soil's ability to hold water WHC will encourage the growth
of the crop and increase its various growth indicators and productivity (Alderfasi et al., 2010; Abed El Aziz, 2008).

Nitrogen is the most important element in plant nutrition, as it enters into the processes of plant cell growth, development and division, and enters the formation of protein and amino acids, and nitrogen comes first in terms of the amount needed by the plant, so its readiness in the soil during the plant growth stages, especially at the stage Branching and elongation of plant growth is necessary to obtain good crop yields (Jan et al., 2010). Organic matter also affects soil characteristics in general by improving soil-water and plant relationship, surface density and overall porosity of the soil and water use efficiency (Shaaban and Okasha, 2007, Liu et al., 2020). Nitrogen is a plant nutrient that is required in relatively greater amounts than other elements for plant growth. Nitrogen is an essential component of many plant compounds such as chlorophyll, nucleotides, proteins, alkaloids, enzymes, hormones, and vitamins. The nitrogen supply should be in sufficient quantity for the planting to obtain an ideal yield. Lack of nitrogen generally leads to stunted growth, yellowed leaves because lack of nitrogen limits protein and chlorophyll synthesis (da Silva et al., 2020; Al Hasnawi et al., 2020).

The crop of faba bean Vicia faba L. occupies great importance in many areas, including the use of its seeds in the human diet because they contain a high percentage of protein ranging from 25% to 40% in addition to being an important source of plant amino acids, glucose and some vitamins, which leads to its use in animal diets (FAO, 2000).

This study aims to estimate the reference water consumption (ETo), actual water consumption (ETa), and the yield factor (Kc) of pea crops grown under conditions of different irrigation levels and different percentages of supplementation on some indicators of legume growth and yield and its water consumption.

**Materials and methods**

A field experiment was conducted in the Abi Ghark area in Babylon governorate in loamy soil, as Babylon Governorate is described as a semi-arid region located in the middle of Iraq. The land was prepared for cultivation using a
dump plow, and then the soil was smoothed. The field was divided into experimental units, leaving a 1m interval between the experimental units. The planting was carried out on 10/15/2018 in the form of lines and 2-3 seeds were placed in each hole.

Fertilization was carried out according to the fertilizer recommendations in effect for each of N, P and K. A field soil sample was transferred to determine its physical and chemical properties and measured according to the methods contained in (Esfhan et al, 2013) whose characteristics. The water tension was measured at 33 kPa and 1500 kPa for determination of available water. The field soil was irrigated, irrigated by germination, and brought to the limits of the field capacity. After that, the irrigation process was carried out according to the depletion ratios studied by our current research, i.e. depletion rates of 30, 50 and 70% of available water. The current study included 3 treatments of depletion and 3 treatments of urea addition to demonstrate their effect on plants, which are (0, 50, 100) kg dunum-1, so the number of treatments is 3 levels of irrigation * 3 levels of urea * 3 replicates = 27 and the design was RCBD. At the end of the experiment, field measurements were taken for growth and total yield on 3/28/2019.

Equations used.

\[ d = (\theta_{fc} - \theta_w)D \]  
\[ (I + P + C) - (ET_a + D + R) = \Delta S \]  
\[ I = \text{irrigation (mm)}, P = \text{precipitation (mm)}, C = \text{capillaries (mm)}, ET_a = \text{actual evapotranspiration (mm)}, D = \text{deep percolation (mm)}, R = \text{runoff (mm)}, \Delta S = \text{changes in the water storage during soil profile}, R = 0 \text{ (plain soil)}, C = 0 \text{ (limited contribution, water table depth = 3m)}, \Delta S = 0 \text{ and } D = 0 \text{ (because irrigation is limited to depletion at field capacity)} \]

Equation (3) becomes:

\[ I + P = ET_a \]  

Crop coefficient was determined according the following equation:
\[ ET_a = (k_c)(ETo) \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (4) \]

Where: \( k_c \) = crop coefficient, \( ETo \) = reference evapotranspiration (mm)

The figures below (1) show the climate data since period study.

![Climate Data](image_url)

Fig (1) show the climate data since period study.

**Result and Discussion**

Table 1 shows the values of the yield coefficient \( Kc \) for survival, since the yield factor is the quotient of dividing the actual evapotranspiration \( ET_a \) by the reference evapotranspiration \( ETo \), during crop growth stages, irrigation treatment is shown when 30% of the prepared water was depleted, the highest values were, where the yield factor values ranged from 0.71 - 1.42, after which the irrigation treatment was treated when 50% was exhausted, and the yield factor values ranged between 0.68-1.23
Table (1) show the crop coefficient, actual evapotranspiration Eta and reference evapotranspiration ETo

| Irrigation level | Stage            | Eta  | ETo  | Kc  |
|-----------------|------------------|------|------|-----|
| 30%             | vegetative stage | 155.8| 172  | 0.90|
|                 | flowering stage  | 320.2| 224  | 1.42|
|                 | maturation stage | 86.0 | 120  | 0.71|
| 50%             | vegetative stage | 172  | 172  | 0.72|
|                 | flowering stage  | 224  | 224  | 1.23|
|                 | maturation stage | 120  | 120  | 0.68|
| 70%             | vegetative stage | 83   | 172  | 0.48|
|                 | flowering stage  | 236  | 224  | 1.05|
|                 | maturation stage | 63   | 120  | 0.52|

As for the irrigation treatment when 70% of the ready water was depleted, it gave values for the yield factor from 0.48 - 1.05. The yield (maturity) and this is in agreement with (Tolk, 2000; El-Harty, 2015) The reason for the decrease in the yield factor in the emergence and vegetative growth stage is due to the decrease in the evaporation of the actual yield of the crop at this stage due to the small size of the plant, the lack of its water needs and the increase in evaporation, the reference transpiration, and with the progression of the growing season The size of the shoots will increase, and the water needs will increase in its physiological processes and building its tissues, as we explained earlier, thus increasing the evaporation of the actual yield of the crop, which leads to an increase in the yield factor (Mansour et al., 2019). Whereas, at the end of the crop growing season, the leaves of the crop begin to fall, which leads to a decrease in the leaf area and thus a decrease in the productivity of the crop, which leads to a decrease in the actual water consumption and the concomitant decrease in the yield factor, and this is consistent with what he found (Al-Murad, 1998).

Table (2) shows the values of water consumption, the amount of added irrigation water, the number of irrigation, the depth of rain, and water storage for the studied irrigation levels, as it is noticed that the highest value of water consumption was 562 mm with irrigation treatment at a depletion rate 30% of the prepared water.
Table (1) show the relation between irrigation level and actual evapotranspiration Eta

| Irrigation Level | No. of irrigation | Rain Depth mm | Net Irrigation depth mm | Water storage mm | actual evapotranspiration Eta mm |
|------------------|-------------------|---------------|-------------------------|-----------------|---------------------------------|
| %30              | 13                | 284           | 286                     | 28              | 562                             |
| %50              | 9                 | 284           | 218                     | 16              | 482                             |
| %70              | 7                 | 284           | 156                     | -22             | 382                             |

It was followed by the 50% depletion treatment and the water consumption amounted to 482 mm. The water consumption by 70% consumption of the available water was 382 mm.

The quantities of rain falling have had a significant impact in reducing the added irrigation quantities and the number of irrigation, as the number of irrigation irrigation reached 13, for a depletion rate of 30%, and reached 9 for an depletion rate of 50%, and 7 for a depletion rate of 70%. Arid and semi-arid areas added to the increase in depletion when treating 30% of the treatment of 50%, which in turn was greater than 70%. The reason for the increase in water consumption of the depletion rate of 30% is that the humidity is close to the field capacity with its moisture content throughout the growing season which was consumed More water (FAYED et al., 2018 ; El-Hadidi et al., 2012 ; Hassan et al., 2019).

The results in Table (3) showed significant differences in plant height resulting from different irrigation levels and added urea levels. The highest value of 30% depletion treatment and 100 kg urea level were recorded and reached 73.3 cm. It reached (83.2, 20 and 5284) for each of the dry weight, the number of branches, and the seed yield respectively. , Dry weight, number of branches, and seed yield) respectively.

The reason for this is that the addition of urea has achieved an increase in the absorption of elements and nitrogen and the improvement of plant characteristics as well, and this is due to the effect of water tension in reducing the relative water content that determines the division and expansion of cells and the associated decrease in the amount of absorption when the water effort in the soil decreases (Zein El-Abdeen, 2018).
Table (3) show some characterize of plant

| Irrigation level | Urea level Kg dounem\textsuperscript{-1} | Plant height cm | Dry weight Gm plant\textsuperscript{-1} | No. of branches | Seed yeiled |
|------------------|------------------------------------------|-----------------|----------------------------------------|----------------|-------------|
| %30              | 0                                       | 65.9            | 72.8                                   | 12             | 4873        |
|                  | 50                                      | 71.7            | 77.3                                   | 17             | 5025        |
|                  | 100                                     | 75.3            | 83.2                                   | 20             | 5284        |
| %50              | 0                                       | 55.8            | 70.4                                   | 11             | 4710        |
|                  | 50                                      | 59.1            | 74.1                                   | 14             | 4826        |
|                  | 100                                     | 67.4            | 79.6                                   | 18             | 5012        |
| %70              | 0                                       | 52.1            | 65.9                                   | 10             | 4519        |
|                  | 50                                      | 56.2            | 70.7                                   | 13             | 4620        |
|                  | 100                                     | 60.6            | 75.3                                   | 16             | 4895        |

Also, a decrease in phosphorus growth was observed with an increase in moisture tension due to an increase in its permeability speed, and the growth and elongation of roots decreased with increasing moisture tension (Hsiao, 1973; Malcolm, 2000)

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