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Designing the Model for Chickpea Biomass (Cicer Arietinum L.) in Khuzestan

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Abstract

This study aimed to obtain basic values of extinction coefficient (Ks) and Radiation Use Efficiency (RUE) in chickpea cultivated under suitable agricultural conditions and also the evaluation of these parameters was conducted under different condition of planting dates and density. Two agricultural experiments were conducted with the treatments of planting duration at three levels and density at four levels in the years of 2010-2012. Therefore, the amount of Ks is equal to 0.5 that is used for simulation models. The average RUE obtained was equal to 1. RUE was constant during the growth period.

Keywords: modeling, radiation use efficiency, dry matter

Introduction

In many crop simulation models is calculated by estimation of daily production of biomass (dry matter) as a product of the received radiation (MJ per square meter per day), fraction of radiation absorbed by product and the radiation efficiency of converting the absorbed radiation into dry matter (g MJ) or radiation use efficiency (RUE). The fraction of radiation received by leaf area index (LAI) and canopy shading extinction coefficient (K) is determined (Robertson et al., 2002, Hassani *et al*., 2014). There is little information about K and RUE on chickpea (Cicer aritinium L.). Hughes et al (1987) reported the extinction coefficient based on the total solar radiation (Ks) for the chickpea genotypes with the habits of growing as direct and lying with the amounts of 0.47 and 0.55, respectively. Hughes et al (1987) reported the amounts of RUE between 0.3 and 0.93 g MJ based on location, season and planting date and also based on the density and genotype. The effect of plant density on K and RUE in chickpeas was not reported. RUE is affected by desirable environmental conditions such as temperature (Andrieu *et al*., 1993) and relative moisture (Kiniry *et al*., 1998). The aim of this experiment was to obtain RUE and K under desirable agricultural conditions of these parameters under various conditions including planting date and density.

Materials and Methods: Two experiments were conducted in Khuzestan in the agricultural year of 2010-2011 and 2011-2012. The experiment was conducted as factorial with two factors, one the planting date at three levels and other the planting density at four levels, in a completely randomized block design with four replications in the condition of Khuzestan. In experiment 1 the treatments of planting date including 5 January 2011, 6 March 2011, 28 April 2011 and in experiment 2 the treatments of planting date including 6 December 2011, 21 January 2012 and 20 March 2012 were conducted (Gomez *et al*., 1984). The treatments of density for both experiments included 15, 30, 45 and 60 plants per square meter. Common variety of peas in Khuzestan, the city of Sardasht, was used. In experiment 1, LX-103 light meter, LT Lutron Taiwan, was used to measure the ratio of absorbed radiation (FI) lux meter device was used. The ration of radiation measured at the bottom of canopy (I) to the radiation received at the top of canopy (I_o) was considered as follows. (1)

$$FI = 1 - (I/I_o)$$

In experiment 2, the vertical shooting was used for this purpose. After that, the films were immediately developed, scanned and transferred to the computer. Then, the ratio of vegetation that is equal to the radiation received (FI) were measured by image tools and Photoshop. The equation was used to determine the extinction coefficient. Considering the amount of radiation received at the top and bottom of the canopy, the equation was used to determine the extinction coefficient.

$$(2) \quad y = 1 - \exp^{(-k_{PAR} \times LAI)}$$

$$(3) \quad K_S = 0.75 K_{PAR}$$

In this equation, y is the ratio of received radiation (FI) or the ratio of vegetation, K_{PAR} (extinction coefficient), LAI (leaf area index) and Ks (extinction coefficient) based on the total solar radiation.

Table 1. Some physical and chemical characteristics of the soil

Depth (Cm)	salinity EC (ds/m)	acidity (PH)	Soil texture	organic carbon OC%	Nitrogen N%	Phosphorus P%	Potassium K (ppm)	Zn (ppm)	Iron Fe (ppm)	Manganese Mn (ppm)	Br (ppm)	Cu (ppm)
0-30	0.88	7.6	Sandy loam	0.68	0.05	7.9	238	0.69	5.39	7.9	0.89	1.12

Results and Discussion

In this study, many changes were observed in the maximum LAI from 3.2 to 7.3 and 2.6 to 8 for experiment 1 and 2, respectively. There was a similar case for maximum dry matter. It means that the maximum dry matter of 486 to 1160 and 551 to 1736 g/m^2 was observed for Experiments 1 and 2, respectively. The average K_{PAR} for both experiments was 0.67 which in this case LAI is 4.4 that receives 95% of solar radiation. The extinction coefficient for total solar radiation (K_s) for the experiment 1 was 0.47 and for experiment 2 was 0.54. Simple linear regression model was well described in the relationship between the cumulative radiation received and the cumulative dry matter from planting to maturity. Coefficient of determination (R^2) were higher than 0.88. RUE was varied between 0.79 and 1.01 g MJ in experiment 1 and between 0.89 and 1.18 g MJ in experiment 2. In each of planting dates and plant density, there was no effect on RUE, but a significant difference was observed between the planting dates. The average amount of RUE was obtained equal to 1.01 (±0.017) g MJ, indicating no significant effect on the temperature variations between 13 and 22 ° C was observed by RUE.

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