International Journal of Agricultural Engineering, Vol. 4 No. 1 (April, 2011) : 56 -59

Research Paper :

Selection of water production function for sunflower

ASHOK KUMAR SINHA, SUDARSHAN PRASAD AND S.P. NIKAM

Received : January, 2011; Accepted : February, 2011

See end of the article for authors' affiliations

Correspondence to:

ASHOK KUMAR SINHA
Department of Irrigation and Water Management Engineering, College of Technology and Engineering, Maharana Pratap University of Agriculture and Technology, UDAIPUR (RAJASTHAN) INDIA

ABSTRACT

The experimental data of sunflower, which was carried out at RAU, Pusa to study the response of irrigation and nitrogen on the yield, were analysed to develop water production function of sunflower. Stress day (SD) was considered to quantify crop water stress and it was measured in different stages of crop growth sub- periods. The yield ratio (Y/Ym) was related to stress day (SD) in different stages of crop growth sub – periods. It was found that the linear model was best suitable and for this the IInd stage, vegetative to seed development was most sensitive to water stress for sunflower.

Sinha, Ashok Kumar, Prasad, Sudarshan and Nikam , S.P. (2011). Selection of water production function for sunflower. *Internat. J. Agric. Engg.*, **4**(1) : 56-59.

Key words : Production function, Sunflower, Stress day, Crop growth sub- periods

The backbone of the economy of an agriculture-based country is its agricultural production. Irrigated agriculture often suffers from inadequate water supply leading to production much below the potential level. Optimum amount of water application at the appropriate time is of paramount importance in increasing crop yield. With limited available water supplies, sequencing of crop water deficits can result in increased irrigation efficiency. Such sequencing can be possible if the effect of different irrigation levels on crop yield could be quantified and evaluated. In order to quantify effect of irrigation on crop production, water production function can be used as a tool. Various methods have been used to developed water production function for finding out a suitable schedule of irrigation for sunflower. Harbovesiky *et al.* (1968) discussed the properties of some important production function and indicated some guidelines for selection of function. Gupta *et al.* (1987) developed production function for groundnut and finger millet. Dabral (1986) and Tripathy (1988) reported various types of production function for different crops. Hossain (1999) work to response of rapeseed (*Brasica napus*) to irrigation at different growth stage. Prabhudeva *et al.* (1998) found soil moisture stress and drought susceptibility index in sunflower.

Sunflower popularly known as 'Surajmukhi' is a familiar plant in India. Sunflower as an oilseed crop is a new introduction in India. Since it has 45-50 per cent good quality oil and high amount of quality protein in cake, it has good scope in Indian agriculture. Sunflower holds great promise because of its short duration, photo-insensitivity, wide adaptability and drought tolerance. It can be grown at any time of the year and can serve as an ideal catch crop during the periods when land is otherwise left fallow. Sunflower oil is a rich source of linoleic acid, which helps in washing out cholesterol deposition in the coronary arteries of heart and thus is good for heart patients. Oil is also used in manufacture of soaps and cosmetics. This paper mainly deals with the selection of water production function based on stress day, for sunflower in Bihar.

METHODOLOGY

The experimental data regarding the effect of irrigation and nitrogen on yield of sunflower were collected during the period 1993-94 and 1994-95. These experiments were conducted at the Research Farm of Rajendra Agricultural University, Pusa, Bihar located at 25.98^0 N latitude, 85.67^0 E longitude and at an altitude of 52.00 m above MSL. The experiment was conducted with four levels of nitrogen *i.e.* 9, 20, 40 60 kg/ha with three replications under Randomized Block Design (R.B.D).

Irrigation applications for levels were done at IW/CPE ratio of 0.4, 0.6 and 0.8. The sowing was done in the month of March. The depth of water applied was 6 cm at each irrigation. The recommended doses of potash (40 kg/ha) and phosphorus (90 kg/ha) were applied at the time of sowing. The seed rate was maintained at recommended rate of 5 kg/ha with spacing of 50 cm x 30 cm. Since the present paper deals with selection of water production function requiring data of effect of water application on crop yield solely, so all input other than water, are at levels which do not limit crop yields. For this the crop yield obtained at different nitrogen levels were averaged. Table 1 presents the crop yield at different levels of irrigation. The yield of second year was relatively far low than the first year due to higher temperature and no rainfall.

Table 1 : Yield response data at different irrigation levels for sunflower

Irrigation levels	Yield (q /ha)	
	1993-94	1994-95
I_1 (0.8)	15.68	13.55
I_2 (0.6)	13.74	11.97
I_3 (0.4)	11.93	10.27

In the present work soil water stress has been quantified by stress day (SD). It is the degree and duration of stress; a crop suffers during its growth period. In calculation of stress day (SD), the first is the calculation of Ra (IW/CPE) for the crop growth period. The variation of Ra during the crop growth period are graphically presented in Fig. 1 to 3. It was assumed that the crop suffers water stress when Ra falls below 0.8. The entire crop growth period was divided into three stages *i.e.* Ist stage- sowing to vegetative (0-40 days after sowing), IInd stage- vegetative to seed development (40- 80 days after sowing) and IIIrd stage–seed development to maturity (80–120 days after sowing). The area under the curve laying below Ra = 0.8 in different stages of crop growth period were measured using planimeter. This gave the stress day (SD) in different stages of crop growth period. The data of yield ratio (Y/Ym) and stress day (SD) in different stages of crop growth period are presented in Table 2.

Different forms of mathematical relationships have been used to relate crop yield ratio (Y/Ym) and stress day (SD) for different stages of crop growth period.

Linear model

$$\frac{Y}{Ym} = A + \Sigma \lambda i \, (SDi)$$

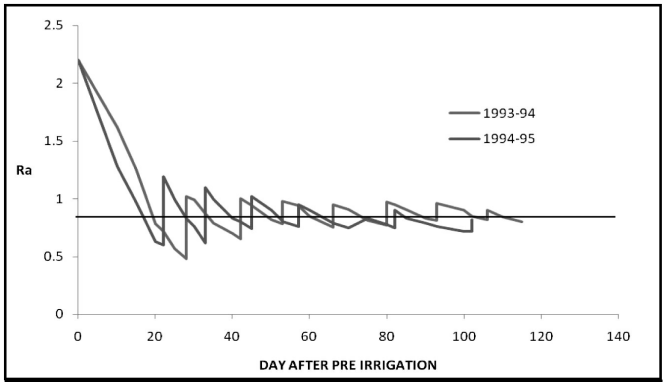

Fig. 1 : Variation of Ra during crop growth period of sunflower for I_1 (0.8) irrigation level

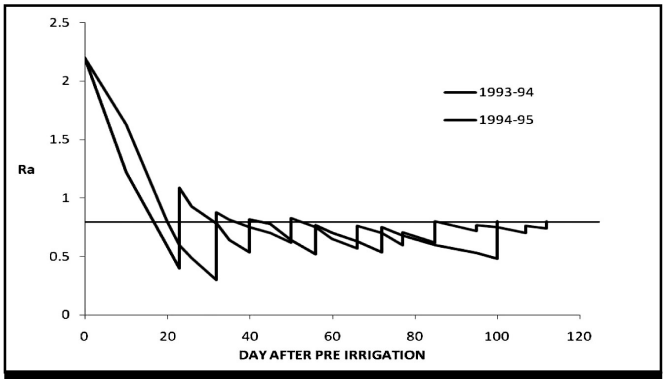

Fig. 2 : Variation of Ra during crop growth period of sunflower for I_2 (0.6) irrigation level

Table 2 : Data as stress day (SD) in different growth sub-period and yield ratio (Y/Ym) for sunflower

Irrigation level	Ist stage SD (degree day)	IInd stage SD (degree day)	IIIrd stage SD (degree day)	Yield ratio (Y/Ym)
1993-94				
0.8	2.28	0.04	0.00	1.00
0.6	6.16	3.20	1.95	0.88
0.4	15.00	8.50	4.50	0.76
1994-95				
0.8	0.85	0.30	0.40	1.00
0.6	6.50	5.45	1.40	0.88
0.4	21.90	4.50	1.90	0.76

Table 3 : Solution of different models with multiple correlation coefficients for sunflower

Crop production function	Regression constant and coefficient at different crop growth periods				Multiple correlation coefficient (r)
	A	λ1	λ2	λ3	
Linear model	1.008	-0.0082	-0.0106	-0.0103	0.9926
Logarithmic model	1.009	-0.0927	0.0223	-0.0101	0.9861
Power model	1.019	-0.1124	0.0332	-0.0132	0.9815

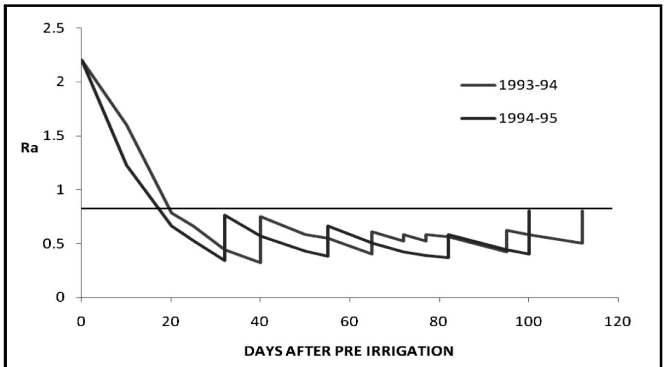

Fig. 3 : Variation of Ra during crop growth period of sunflower for I_3 (0.4) irrigation level

Logarithmic model

$$\frac{Y}{Ym} = A + \Sigma \lambda i \, (\ln SDi)$$

Power model

$$\frac{Y}{Ym} = A + \Sigma \lambda i \, (\ln SDi)$$

in witch,

λi = regression coefficient which reflects sensitivity of the crop to water stress in crop growth period i,

SDi = stress day for crop growth period i, degree day

n = number of crop growth periods

The value of A and λi was obtained from the regression analysis of the data for different models. The models were tested on the basis of correlation coefficient (r). The model yielding highest absolute value of correlation coefficient (r) was considered best model. The logarithmic and power models are valid for SDi > 0.

RESULTS AND DISCUSSION

The solution of mathematical models along with multiple correlation coefficients is given in Table 3.

The absolute values of the sensitivity factor (λi) can be considered as a measure of crop sensitivity to water stress, which varied during different crop growth periods. The negative values of λi indicated reduction in crop yield per unit stress factor, whereas the positive values indicated increase toward crop yield per unit stress factor.

The value, of correlation coefficient for the models considered indicate that the linear model was the best and superior to logarithmic and power models. The linear model showed greater absolute value of λ at crop growth period IInd than crop growth period III rd and Ist. The crop growth period IInd, spanning from vegetative to seed development of sunflower stated to be the most critical for water supply. In order to decreasing crop sensitivity to water stress, the crop growth periods can be ranked as crop growth period IInd, IIIrd and Ist.

Conclusion:

The linear model yielded best result relating YR and SD. From the result it was found that the IInd stage (vegetative to seed development) was most sensitive to water stress for sunflower.

Authors' affiliations:

SUDARSHAN PRASAD, Department of Irrigation and Drainage Engineering, College of Agricultural Engineering, Rajendra Agricultural University, PUSA (BIHAR) INDIA

S.P. NIKAM, Department of Soil and Water Conservation Engineeing, College of Technology and Agricultural Engineering, Maharana Pratap University of Agriculture and Technology, UDAIPUR (RAJASTHAN) INDIA

REFERENCES

Dabral , P.P. (1986). Optimal resource allocation and production function for irrigated paddy. M.Tech. thesis, I.I.T. Kharagpur, India.

Gupta, P., Khepar, S.D. and Kaushal, M.P. (1987). Conjective use approach for management of irrigated agriculture. *Indian J. Agric. Engg. ISAE,* **24** (3) : 307-322.

Harboversky, J.P., Gautam, O.P. and Khare, B.G. (1968). Production function for specifying economic optima in fertilizer use. *Indian J. agric. Sci.*, **38** (4) : 587-596.

Hossain, M.M. (1999). Response of rapeseed (*Brassica napus*) to irrigation at different growth stage. *J. agric. Res.*, **33** (3) : 214-220.

Prabhudeva,T.V., Chalapthi,M.V., Thimmegowda,S., Devakumar, N., Rao,G.G. and Mallikarjuna, K. (1998). Soil moisture stress and drought susceptibility index in sunflower. *Indian Agriculturist*, **42** (4) : 287-299.

Tripathy, P.K. (1988). Maximization of tea production by Judicious resource management. Ph.D. Thesis, Department of Agricultural Engineering, I.I.T., Kharagpur, W.B. (India).

***