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BORDER IRRIGATION FOR GUAR IN SEMI-ARID ZONE OF RAJASTHAN

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ABSTRACT

This paper deals with the water front advance studies and studies on application, distribution and water use efficiencies in level border irrigation for guar (*Cyamopsis tetragonoloba* Taub.) in semi-arid zone of Rajasthan. A study on border irrigation with different border widths and cut-off ratios was conducted with the stream size of 2.01 second/m width of border. 8 x 50 m^2 border gave the higher application and distribution efficiency. This size with 80% cut-off ratio may be adopted in the arid zone of Rajasthan. The regres sion equa tions developed in the paper may be used for the efficient design of border in the region, when the stream size is in the range of 8 1/sec to 20 1/sec.

INTRODUCTION

Border irrigation is the most common irrigation method used by farmers in the command area of Gang Canal, Bhakhra Canal and Indira Gandhi Canal of arid and semi-arid zones of Rajasthan. Lay out of border is based on conventional practices with under irrigation or heavy water losses resulting in lower crop production per unit of land. Therefore, a study on design of level border irrigation was undertaken at the Research Farm of Agricultural Research Station, Sriganganagar. The Gang Canal is the only source of irrigation for the farm which has a designedcarrying capacity of 77 cumec, C.C.A. of 0.308 m ha and water allowance of 0.18 cumec for 1000 ha (Anon., 1983).

MATERIAL AND METHODS

The experiment was conducted for 2 years on level border of 4 m, 6 m, 8 m and 10 m width, each having 50 m length with cut-off ratios 70%, 80%, and 90% (cut-off ratio is the ratio of the length at which stream was cut-off to the total length of the border). Since all the cultivation is done by farmers on the level border, the study was

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also conducted on such borders. The stream size was kept 2.0 l/sec/m width of border. The physical and chemical properties of the experimental soil were: pH 8.34, EC 0.21 millimhos/cm, bulk density 1.577 g/cm^3, particle density 2.61 g/cm^3, field capacity 11.61%, wilting point 5.15%; and 75.58%, silt 9.10% and clay 13.00% (Anon., 1982).

The basic infiltration rate of soil at the time of sowing of crop and before each irrigation was measured with the double cylinder infiltrometer. An equation to predict the accumulated infiltration (y) with time (t) was developed using least square method (Michael, 1978):

$$y = 0.3895\ t^{0.4588}$$

The crop grown was guar, *Cyomopsis tetragonoloba* Taub. The total number of irrigations applied was 2; the first was applied at active vegetative stage and the second at pod stage when the moisture content was in the range of of 4 - 5%. The moisture content at the time of sowing was in the range of 10 - 12%. The data on water front advance with time were recorded and the equations to predict water front advance with time were developed to predict the relationship of water front advance with elapsed time using regression analysis (Panse and Sukhatme, 1978).

The soil samples were taken in each border before and after each irrigation. Soil samples after each irrigation were taken at 5 different locations at the interval of 10 m from head end of border upto the root zone depth of crop. The moisture content of the samples was determined by gravimetric method. The depth of water percolated along the run of water in the border was calculated. The application efficiency and distribution efficiency was calculated by finding average depth of water percolated in the root zone using the standard formulae (Michael, 1978). The crop yield of each plot was recorded and mean water use efficiency was calculated.

RESULTS AND DISCUSSION

The flow in border strip is a case of specially varied unsteady flow with decreasing discharge. The decrease in discharge is due to infiltration. The dominant variables which influence the border irrigation are size of irrigation stream, slope of land surface, infiltration characteristics of soil and the resistance to flow offered by the soil surface and vegetative cover. Thus, the advance of water front in the border is a function of the infiltration characteristics of the soil, elapsed time, hydraulic resistance and land slope. The study was conducted at level border and the slope was kept the same throughout the course of study. Thus, the elapsed time would be a function of the resistance offered to flow and infiltration. So, an equation of $X = at^b$ form was developed to correlate the water front advance (x) with elapsed time (t). The equations for different border size and cut-off ratios are given in table 1. The equations had fairly good index of correlation and average error of prediction was less than 5%. The generalised equations for different border size developed from these equations are recorded in table 2. These could be used to predict the distance travelled by water front with a stream of 2.0 l/s/m width of border.

Toble 1. Water front advance *Vs.* elapsed time relationships for different border size

Border size (m^2)	Irrigation number	Year	Models		Index of correlation	Average error (%)
50 x 4	I	I	x = 6.7193t	0.7325	99.61	4.53
,,	II	I	x = 5.1830t	0.7734	99.94	1.48
50 x 6	I	I	x = 6.5399t	0.6805	99.51	4.53
,,	II	I	x = 5.5357t	0.7182	99.78	3.65
50 x 8	I	I	x = 5.4695t	0.7882	99.78	4.58
,,	II	I	x = 5.5784t	0.7344	99.91	3.20
50 x 10	I	I	x = 6.1890t	0.6781	99.33	8.95
,,	II	I	x = 5.7639t	0.6784	99.59	5.59
50 x 4	I	II	x = 7.155 t	0.5448	99.28	5.75
,,	II	II	x = 5.2053t	0.6493	99.70	4.35
50 x 6	I	II	x = 4.6707t	0.6444	99.81	1.50
,,	II	II	x = 3.7754t	0.7523	99.32	4.16
50 x 8	I	II	x = 3.6462t	0.7501	99.91	3.34
,,	II	II	x = 4.8853t	0.6380	99.95	2.41
50 x 10	I	II	x = 3.4377t	0.7269	99.59	5.75
,,	II	II	x = 4.6200t	0.6391	99.87	3.11

Table 2. Generalised equations for water front advance *vs.* elapsed time

Border size (m^2)	Models
50 x 4	$x = 5.9950t.^{\circ}6150$
50 x 6	$x = 5.0269t^{\circ}.6990$
50 x 8	$x = 4.8280t^{\circ}.7299$
50 x 10	$x = 4.8801t^{\circ}.6886$

IRRIGATION EFFICIENCIES

Application Efficiency :

The higher irrigation application efficiency is achieved in 50 x 4 m^2 size border. There is a decrease in the efficiency when cut-off ratio is increased from 70% to 90%. It means that there is more percolation loss at head - end when cut-off ratio is 90% but there is under irrigation at tail - end of border when cut-off ratio is 70%. In this case the water is hardly able to reach the tail - end of the border. Thus 80% cut-off ratio seems to have a balance between under irrigation at tail-end and percolation losses at head - end. The variation in application efficiency for 80% cut-off ratio is from 75.42% to 82.4% (Table 3).

Distribution Efficiency :

The distribution efficiency had an increasing trend as the cut - off ratio increased from 70% to 90%. The water could simply moisten the surface in case of 70% cut-off ratio. The irrigation water was not enough even for survival of plants in the last 2 m of border. There was a case of under irrigation at tail-end when cut-off ratio was 80%. The root-zone depth was completely irrrigated when cut-off ratio was 90%. The water distribution was better in 8 m border resulting in better distribution efficiency. The results are given in table 3.

Water Use Efficiency :

The water use efficiency was highest in 4 m wide border and there was decrease in the efficiency as the border size increased. The results are given in table 3. The highest water use efficiency was 1.30 q/ha cm in 4 m wide border and lowest is 1.17 q/ha cm in 10 m wide border. The selection of a 4 m border would mean more land wasted by a larger number of bunds per hectare and also the labour requirement would be more. So, for a compromise between border size and water use efficiency, 8 m wide border is recommended for higher irrigation efficiencies.

CONCLUSIONS

An 8 m wide border with 80% cut-off ratio with 2.0 l-s m width of border should be made for efficient irrigation during kharif season in sandy loam soil.

The prediction equations developed in this paper could be used for efficient design of border irrigation in the zone.

Table 3. Irrigation efficiencies and crop yield

Border size (m^2)	Cut-off ratio (%)	Distribution efficiency (%)	Application efficiency (%)	Mean Water use Efficiency, (q/ha-cm)	Mean Grain Yield (q)
50 x 4	70	67.10	92.51		
,,	80	74.31	82.40	1.38	9.08
,,	90	78.86	76.89		
50 x 6	70	72.87	81.39		
,,	60	70.40	75.42	1.21	10.18
,,	90	75.31	74.86		
50 x 8	70	79.60	82.25		
,,	80	85.50	79.10	1.18	9.33
,,	90	85.50	74.29		
58 x 10	70	85.25	88.31		
,,	80	76.41	77.81		
,,	90	78.95	69,78	1.17	9.60

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