AU Res. J. 1990. 15 (2) : 28-31

Effect of Precision Field Levelling on Irrigation Efficiency and Yield of Wheat

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ABSTRACT

An experiment was carried out to find suitable levelling index for growing wheat under border method f irrigation at the research farm of Gujarat Agricultural University Campus, Navsari. The study was onducted for three years with two lengths of border (75 m and 90 m) and three magnitudes of levelling ndex (0 to 1 cm, 2 to 3 cm and 4 to 5 cm). Experimental results revealed that field levelling index should ot be greater than 1 cm and length of border should be between 75 m and 90 m for growing wheat and imilar type of crops in heavy black soils.

(Received on 3rd Aug. 1987)

INTRODUCTION

Irrigation usually plays an important role in gricultural production. Irrigated area benefits reatly from proper levelling since the field in its atural state is seldom suited for the efficient pplication of water by surface method of irrigation. n unlevelled plot, the distribution of water by rface method of irrigation is non-uniform as high pots are watered too little and the low spots too uch. Among the surface methods, border method f irrigation is most prevalent in the command reas. Layout of border is based on conventional ractices which require over-irrigation due to heavy ater losses. Excess irrigation increases the loss of utrients and helps to build up salinity and lkalinity resulting in lower crop production per nit of land and water.

The importance of land levelling for judicious ater management in the canal command areas has een emphasized by Hauston (1966) and Tyagi *et al.* 1979). Johnson *et al.* (1976) have reported that ain yield of wheat improved by 26 per cent in recision levelled fields as compared to traditionally velled field. Kumbhare and Tyagi (1977) in their udy in alkali soils of CSSRI have found that uniform sloping borders resulted in higher grain yield of rice by 10,000 kg/ha and saved 13 per cent water. Agarwal (1981) carried out a study in the sandy loam soil of Hissar research farm and found that wheat grain yield reduced significantly for levelling index value of higher than 2.5 cm. The results also showed that irrigation application, distribution and water use efficiencies were appreciably reduced with increase in levelling index i.e. deterioration in levelling quality.

Admitting the importance of uniform water application, it is necessary to find the optimum magnitude of precision land levelling to economise the cost of this operation which may vary from a few hundred rupees to several thousand rupees per hectare (Pillai and Rege, 1974). The yield is also greatly influenced by uniformity of water application. This happens of variation of available moisture for nutrient uptake and evapotranspiration requirement.

MATERIALS AND METHODS

Land levelling index quantitatively reflects the precision of the field levelling. It may be defined as the average variation (cm) between designed and

existing field level either before or after the completion of levelling work. Mathematically it is expressed as :

$$\text{Field levelling index (cm)} \quad U = \frac{\text{Differences between the designed and existing grid level (cm)}}{\text{Number of grid points}}$$

A zero value of levelling index indicates that the field is having designed uniform level of slope with no high or low spots throughout the length.

The study was undertaken at the research farm of Gujarat Agricultural University Campus, Navsari for three years in a heavy black soil having pH 7.95, EC 0.37 mmhos/cm, field capacity 32.4%, permanent wilting point 17.2%, clay content 62% and bulk density 1.42 g/cm^3 with wheat as test crop. The experiment on levelling index and length of border was laid out with three replications in a randomised block design with two lengths of border (L) namely 75 m and 90 m and three magnitudes of levelling indices (U) namely 0 to 1 cm, 2 to 3 cm and 4 to 5 cm respectively. The plots were irrigated by recommended inflow rate of 1.5 l/s/m width and irrigation interval. Since the general slope of the plot was about 0.3 per cent, only secondary levelling was done by terracing blade and levelling float. The designed magnitude of levelling index in each border was established artificially by repeated earth movement and taking level along the length of border at one metre interval. Inflow rate in each border was measured by Parshall Measuring Flume and flow was continued till it reached the downstream end of the border. The values of advance and recession time at 10 m interval for each irrigation were recorded for different treatments and replications. Soil samples were taken from 15 cm, 30 cm, 45 cm, 60 cm, 75 cm and 90 cm depths at upstream, middle and down stream end of borders just before and after 24 hours of each irrigation. The crop yield and yield attributing characters were recorded and data were analysed statistically.

RESULTS AND DISCUSSION

Effect of levelling index on water requirement

After the establishment of desired levelling indices, crop was sown. Two common irrigations each of 6 cm were given at the time of sowing for germination and after 10 days of sowing for establishment. Then the values of levelling indices rechecked but found within the range of treatments level. A little variation of levelling indices might be due to recommended non-erosive inflow rate and limited disturbance of soil for secondary levelling. In addition to two common irrigations, four treatment irrigations (Table 1) were given to each plot at 15 days irrigation interval as per the recommendation of the centre for wheat crop.

It is revealed from the Table 1 that the maximum and minimum depths of total treatment irrigations are 40.61 cm and 27.49 cm respectively. Irrigation requirements increased with higher value of levelling index and border length. There was also some variation of irrigation requirements with years. It might be due to some variation of land preparation and climatic factors. The average irrigation requirements for the treatments of 90 m and 75 m border length with 0 to 1 cm levelling index (L_2U_1 and L_1U_1) were 28.73 and 28.00 cm respectively. Both the treatments were statistically at par and significantly superior to rest of the treatments. Hence, it is evident that by minor levelling within the plot, about 6 to 14 per cent water can be saved.

Water application, storage and distribution efficiency

The values of efficiencies for different treatments are given in Table 2. The highest and second highest water application efficiencies of 95 and 92 per cent were for the treatments of 90 m and 75 m border lengths with 0 to 1 cm levelling index respectively. These two treatments gave water storage efficiencies of 82 and 73 per cent respectively. The same two treatments (L_2U_1 and L_1U_1) also gave highest and second highest water

istribution efficiencies of 84 and 83 per cent espectively. It is also revealed from the table that fficiencies reduced remarkably when the levelling ndex increased from 2 to 3 cm to 4 to 5 cm. This uggests that the values of levelling index should be naintained below 2 to 3 cm for efficient utilization f irrigation water.

Yield and water use efficiency

Treatmentwise yields for three years and verage values of water use efficiencies are presented in Table 3. The variation of wheat yields (Table 3) for different treatments in three consecutive years were 37.26 to 27.79 q/ha, 27.08 to 22.38 q/ha and 31.32 to 25.93 q/ha respectively. The variation of yields in different years might be due to yearwise variation of climatic factors.

Yearwise and pooled analysis of data (Table 3) revealed that the treatments of 90 m and 75 m border lengths with 0 to 1 cm levelling index ($(L_2U_1$ and $L_1U_1)$ were statistically at par and significantly superior to the rest of the treatments. These two treatments gave highest and second highest average

TABLE 1

Treatmentwise irrigation requirement of wheat for three years and average.

Treatment	*Irrigation requirement in cm (excluding two common irrigations)*			
	1st year	*2nd year*	*3rd year*	*Average*
(L_1U_1)	27.49	28.42	28.11	28.00
(L_1U_2)	27.95	29.04	31.53	29.50
(L_1U_3)	32.54	29.44	36.68	32.88
(L_2U_1)	27.66	28.80	29.73	28.73
(L_2U_2)	28.07	31.47	35.76	31.76
(L_2U_3)	33.17	33.43	40.61	35.73

	S. Em.± (cm)	C. D. at 5% (cm)	C. V. (%)
Treatment	0.18	0.53	1.75
Treatment × year	0.31	0.91	

a. Length of border, L_1 = 75 m and L_2 = 90 m

b. Levelling indices, L_1 = 0 to 1 cm, U_2 = 2 to 3 cm and U_3 = 4 to 5 cm

TABLE 2

Average water application, water storage and water distribution efficiencies for different treatments.

Treatment	*Water application efficiency, %*	*Water storage efficiency, %*	*Water distribution efficiency, %*
L_1U_1	92	73	83
L_1U_2	82	65	80
L_1U_3	81	87	81
L_2U_1	95	82	84
L_2U_2	91	68	84
L_2U_3	75	84	81

TABLE 3

Wheat grain yield, total irrigation requirement and water use efficiency for different treatments.

Treatment	*Wheat grain yield, q/ha*				*Total irrigation requirement, cm*	*Wateruse efficiency, kg/ha cm of water*
	1st year	*2nd year*	*3rd year*	*Average*		
L_1U_1	37.26	25.37	30.71	31.12	40.00	78
L_1U_2	34.13	23.18	27.76	28.35	41.50	68
L_1U_3	33.47	22.38	25.93	27.27	44.88	61
L_2U_1	36.57	27.08	31.32	31.65	40.73	78
L_2U_2	30.06	24.28	29.98	27.77	43.76	63
L_2U_3	27.79	22.93	25.98	25.58	47.73	54
S.Em.±	0.31	0.62	1.27	0.18		
C.D. at 5%	0.98	1.95	4.01	0.53		
C.V.%	1.63	4.43	6.54	1.75		

* Total irrigation requirement is inclusive of two common irrigations each of 6 cm.

wheat yields of 31.65 and 31.12 q/ha respectively. The same two treatments of 90 m and 75 m border length with 0 to 1 cm levelling index (Table 3) also gave equal but highest wateruse efficiency of 78 kg/ha cm of water.

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