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RESEARCH ARTICLE

PERFORMANCE EVALUATION OF A LOW HEAD DRIP IRRIGATION SYSTEM FOR SMALL FARMERS

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ABSTRACT

Low head drip system was evaluated for its appropriateness for small fields. Drip irrigation systems were laid out in different areas starting from 12m X 12m to 48m X 48m plots and were operated at low heads (using water storage tanks placed at heights of 1.5m, 3.0m and 4.5m). Water distribution uniformity decreased with increasing area irrigated by drip system operated at any given operating head. Largest areas that could be irrigated with at least 85 % coefficient of uniformity were found to be 12m X 12m, 24m X 24m and 36m X 36m at operating heads of 1.5m, 3.0m and 4.5m, respectively.

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INTRODUCTION

The dominant method of irrigation practiced in large parts of the country consists of diverting a stream at the head of the field into furrow or border and allowing it to flow down the grade by gravity. Generally under such surface irrigation methods, a good part of the applied water is lost in conveyance, application, runoff and evaporation and the crop utilizes only less than one half of the water released. Rising demand of water for rapid urbanization, large-scale industrialization and environmental demands necessitate that the available water is efficiently utilized. Adaptation of drip irrigation system, particularly for orchard and vegetable crops, may help in saving significant amounts of water. Besides savings in water drip irrigation system helps in increasing the quality and amount of produce. Drip irrigation is very well suited for water scarce areas and for areas where adequate land leveling is either undesirable, owing to less soil depth, or is uneconomical. A typical small farmer in India cultivates four to five plots ranging in size from one fifth of an acre to half an acre. Unlike other biological techniques such as seeds and fertilizers, the existing drip irrigation technology is not "divisible" i.e. it cannot be divided into very small functional units. Low cost drip irrigation systems developed by different research workers including pitcher irrigation, sip irrigation, siphon irrigation (Dadgi, 1993) and bucket kit (Naik, 2000) are too small to be adopted for commercial cultivation. The development of reliable low cost drip system that fits the needs of small farmers in developing countries has long been recognized as a critical need (Hillel, 1985; Saksena, 1995 and Nir, 1995). The efficacies of small drip irrigation system operated at low heads (1.5 to 4.5 m) were explored. The areas irrigated and their resulting uniformity of water distribution under these low head drip irrigation systems was studied. The results of the performance evaluation of different low head drip systems are presented and discussed in this paper.

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MATERIALS AND METHODS

Different drip irrigation systems (with laterals and drippers spacing of 1.0m X 0.50m) were laid in 12m X 12m, 12m X 24m, 12m X 36m, 12m X 48m, 24m X 24m, 24m X 36m, 24m X 48m, 36m X 36m, 36m X 48m and 48m X 48m areas were laid out for the study. Each drip irrigation system consisted of a main pipe (40mm Diameter, HDPE) was connected to the water storage tank. The water storage tank was fixed at the heights of 1.5m, 3.0m and 4.5m from the ground for each drip irrigation systems. Laterals were connected directly with the main pipe at an interval of 1m each. Laterals with inbuilt emitters (located at 50cm interval) were used in all cases. The expensive filtration system of standard drip system was replaced with a nylon cloth tied around the inlet of the main pipe. Uniformity of water distribution in different drip irrigation systems under different operating head conditions was evaluated. In a micro irrigation system water is discharged to the field through the drippers. Ideally, all drippers in a micro irrigation system should deliver equal flow rate during different irrigation events (Wu and Gitlin, 1973). Bralts *et al.* (1981) reported that, in reality, unit to unit dripper discharge varies. The actual dripper flow rates along a lateral line may vary considerably depending on several factors including pressure variation, land slope and dripper clogging. The concept of emission uniformity (Equation 1) as developed and documented by Meriam and Keller (1978) was used in this study. :

$$CU = 100\left[1 - \frac{\sum_{i=1}^{n}\left|q_i - q_{ave}\right|}{\sum_{i=1}^{n} q_i}\right] \qquad \text{…………………… (1)}$$

Where,

q_i = individual dripper flow rate, Lph
q_{ave} = mean dripper discharge rate, Lph and
$[q_i - q_{ave}]$ = the absolute deviation from the mean.

Under each treatment, 36 catch cans were placed below the drippers in a square grid pattern spread over the entire irrigated area. The drip system was operated and the discharges received by different catch cans in 10 minutes duration were recorded. On the basis of discharges received by catch cans the coefficient of uniformity of drip system was estimated with the help of Equation 1. Cauliflower was grown in an area of 12m X 24m with an operating head of 4.5 m (tank hight 4.5m) during winter season of 2001-2002 at Water Technology Centre, IARI, New Delhi (Fig 2). Operation schedule of drip system was developed for cauliflower based on its estimated water requirement under Delhi climatic conditions.

RESULTS AND DISCUSSION

Coefficients of uniformity of water distribution in drip irrigation systems under different operating heads (tank heights) are presented in Table 1.

Table 1. Coefficient of uniformity of water distribution

Size of drip irrigation system, (Field size), m x m	Operating head (height of water supply tank), m		
	1.5	3.0	4.5
12 x 12	89.45	92.62	97.76
12 x 24	83.76	91.40	95.60
12 x 36	76.52	90.36	92.60
12 x 48	65.24	89.20	91.52
24 x 24	66.32	88.45	91.27
24 x 36	51.27	83.10	90.53
24 x 48	47.70	79.52	88.64
36 x 36	46.54	77.46	85.25
36 x 48	41.20	71.00	82.20
48 x 48	39.75	65.24	76.61

At a tank height of 1.5m, coefficient of uniformity of water distribution was highest (i.e. 89.45 %) for the field size of 12m X 12m. Coefficient of uniformity of water distribution decreased with increasing field size to as low as 39.75 % for a field size of 48m X 48m. At a tank height of 3.0m the highest coefficient of uniformity (92.62 %) was observed for a field size of 12m X 12m, which decreased up to 65.24 % for a field size of 48m X 48m. The value of uniformity coefficient ranged from 97.96 % to 76.61 % for field sizes of 12m X 12m to 48m X 48m at a tank height of 4.5m (Table 1). Uniformity coefficient was found to be 89.45 % with a tank height of 1.5m, which increased to 97.76 % with increased tank height of 4.5m. It may also be noted from Table 1 that for all other field sizes too the coefficient of uniformity was highest with tank heights of 4.5m and lowest with tank heights of 1.5m. Largest areas that can be irrigated with different levels of achievable uniformity of water application of 80%, 85 %, 90% and 95% with tank heights of 1.5m, 3.0m and 4.5m are presented in Fig. 1.

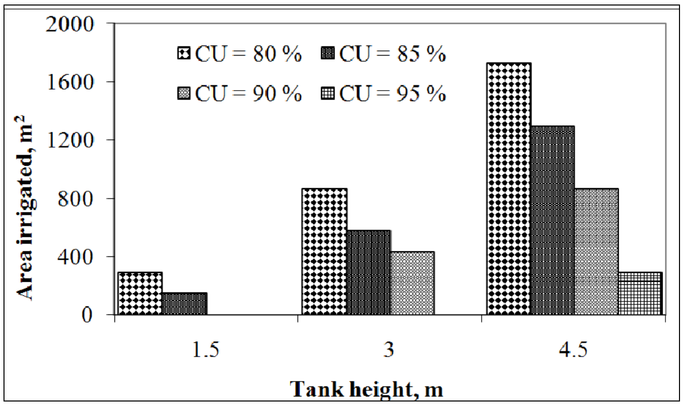

Fig. 1. Distribution uniformity with irrigated area and tank height

Fig. 2. Low head drip system in cauliflower

It may be noted from Fig. 1 that with a tank height of 1.5m coefficients of uniformity of 90% or higher are not achievable even for the smallest field size considered i.e. 12m X 12m. It may also be noted from Fig. 1 that 95% or higher levels of coefficient of uniformity was achieved only in case of the tank height of 4.5m. The largest area irrigated with 95 % uniformity of water distribution was 12m X 24m. Yield of cauliflower grown under low head drip irrigation system was found to be 52 t/ha, which was significantly higher than those realized under surface methods of irrigation and was comparable to the yields realized under conventional drip irrigation system. This suggests that low head drip system could be followed in small fields without compromising on the quality and quantity of the produce.

Conclusion

Low head drip irrigation systems offer an economical solution for efficiently utilizing the available limited amounts of water**.** Such low head drip systems will be very much suitable under hilly conditions where its required operating head may be available naturally.

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