International Journal of Agricultural Sciences
Volume 8 |Issue 2| June, 2012 | 535-537

RESEARCH PAPER

Effect of drip irrigation system on water and fertilizer use efficiency for okra cultivation

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Abstract : A comparative study was conducted to evaluate the performance of drip and check basin irrigation system in okra. Okra yield was found significantly higher in drip irrigation treatment (double drip line between three plants rows). It was found that drip irrigation gave 34.60 per cent higher yield than the yield obtained with check basin irrigation system. Drip irrigation saved 44.65 per cent water and 46.66 per cent fertilizer consumption. The water and fertilizer use efficiencies were undoubtly higher in the drip irrigation than that of traditional method of irrigation.

Key Words : Drip irrigation, Check basin irrigation, Water use efficiency

View Point Article : Yadav, S.S. (2012). Effect of drip irrigation system on water and fertilizer use efficiency for okra cultivation. *Internat. J. agric. Sci.*, **8**(2): 535-537.

Article History : Received : 09.05.2012**; Revised :** 24.05.2012**; Accepted :** 10.06.2012

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. India ranks first in the world with 5.784 million tons (70% of the total world production) of okra produced from over 0.49 million ha land (Indian Horticulture Data Base- 2011). Adjustment of climatic factors helps in taking at least one (summer) crop in hills, 2 or even 3 (summer, *Kharif* and late *Kharif*) crops in the east, west and north Indian plains and almost year-round cultivation under moderate climate in south India. The production and productivity of okra is quite low. Therefore, it is imperative to adopt improved varieties, improved method of water and fertilizer application to boost okra production. Water and fertilizer application at right time with quantity are main important factor plays a vital role in productivity of okra. This can be achieved only by introducing advance irrigation method like drip or fertigation.

Generally, check basin method of irrigation is used for irrigating the vegetable crops in arid and semi arid region, where about 40 per cent of water is lost in storage and conveyance (Srinivas, 2006). In other hand drip irrigation is an efficient method in which water is supplied directly to root zone of the plant so as to maintain near the field capacity of soil for most of the time. Water is applied frequently to the soil through drippers attached to water delivery lateral lines placed near the plants row. The principal of drip irrigation is to irrigate the root zone of the plants to get minimal wetted soil surface. Very high water application efficiency (90-95%) can be obtained through drip irrigation method (Hasan *et al*., 2008).

The drip irrigation system becomes more efficient and effective when fertilizer is applied through irrigation system known as fertigation and become a common technique in irrigated agriculture. In conventional method of fertilizer application fertilizers are normally used as a basal and top dressing and the whole quality is applied in one to three doses, because these fertilizers are applied in bulk. Major quantity of applied fertilizer go waste due to leaching, denitification, volatilization and its fixation in the soil. Moreover these fertilizers also get transmitted to reason beyond the active and thereby remain no longer useful to the plants. The effective utilization by the plants in many cases is less than 50 per cent of the fertilizer application (Yadav *et al*., 2009). In fertigation application is made directly to the plants roots, in split form, uniformly matching the plant water use to avoid leaching and

other application losses.

Keeping this in view the present investigation was carried out in sandy loam soil in okra crop to evaluate water and fertilizer use efficiencies requirement and cost benefit analysis of drip irrigation as compared to traditional practices of irrigation *i.e.* check basin irrigation system.

MATERIALS AND METHODS

In order to compare the performance of drip and check basin irrigation systems for irrigating okra crop verity Parabhani Kranti was shown on raised bed in drip irrigation and in check basin irrigation treatment sowing was done in flat bed (bed size 3.5 m x 3.0 m) in the first week of March for two consecutive years. The plat to plant and row to row spacing was 30 cm and 40 cm, respectively. The plants population per unit area was maintained equal in all treatments. Three treatments of drip irrigation *i.e.* $T_{1=}$ single drip line on bed between two rows, T_2 = double drip line on the bed between two rows and T_3 = single drip line on each row were taken to vary the quantity of water and study the installation system of laterals. The trial was laid out in randomized block design with four replications. Soil status was measured before conducting the trail. The soil was low in organic carbons (0.2%), P (25 kg/ha) and available K (150 kg/ha) with pH 7.7. The field capacity and permanent wilting point in 45 cm root zone soil profile were 10.22 and 3.82 per cent with the bulk density of 1490 kg/m^3. Irrigation application efficiency of surface method was 85 per cent. Net irrigation requirement volume of water required in the check basin and required duration of irrigation was obtained as,

$$N_i = F_c - M_c \quad (1)$$

where, N_i = Net irrigation requiremen
F_c = Field capacity
M_c = Available soil moisture content

Total volume of water required in check basin (V_w)

$$V_W = A_b \times N_i \quad (2)$$

where, A_b = Area of basin
N_i = Net depth of irrigation

Required duration of irrigation (D_i)

$$D_i = \frac{V_W}{D} \quad (3)$$

where, D = discharge of stream

The drip irrigation system was operated with 7.5 hp centrifugal pump fitted in open well, maintaining operating pressure of 1.5 kg/ cm^2. Inline lateral having discharge of 2.0 l/ dripper/h were used. Soil samples were collected from three successive layers (0-15, 15-30 and 30 - 45 cm) to determine the soil moisture content by gravimetric method before each irrigation and 24 hours after applying the irrigation such as consumptive use and water use efficiency were computed following the method by Dastane (1972). The average irrigation frequency in check basin method of irrigation was 5 and 4 days whereas in drip irrigation system it was 3 and 2 days in March to April and May to June, respectively. The frequency and duration of water application in drip irrigation treatment was determined by soil water depletion, evapotranspiration and soil infiltration rate. The fertigation in drip irrigation treatments was done through by pass tank.

RESULTS AND DISCUSSION

Comparative performance of drip and check basin irrigation system is presented in Table 1. Two years yield data and polled data revealed that highest yield (61.50 q/ha) was obtained in treatment (T_3) *i.e.* single drip line on each bed per row. It was at par with okra yield (59.70 q /ha) obtained in treatment (T_2) *i.e.* double drip line on the bed between two rows. In conventional check basin irrigation system (T_4) the okra yield was found 44.50 q/ha. It was significantly lower than the drip irrigation treatments (T_2 and T_3). It was obseserved that by application of drip irrigation system 34.60 per cent higher yield can be obtained in comparison to the check basin irrigation system. In drip irrigation treatment, (T_2) 99.69 ha-cm water was applied whereas in check basin irrigation treatment (T_4) 179.80.0 ha-cm water was applied. Thus, by applying drip irrigation treatment (T_2) 44.11 per cent water saving can be obtained. It can be also observed (Table 1) that in drip irrigation treatment (T_2) water use efficiency (WUE) was 0.60 q/ha-cm whereas in check basin irrigation treatment (T_4) it

Table 1 : Yield obtained, water applied, water saving and water use efficiency in different treatments

Treatments	Yield (q/ha)			Total water applied (ha-cm)	Water saving (%)	Water use efficiency (q/ha-cm)
	2007	2008	Pooled			
T_1	51.0	50.2	50.60	60.01	56.76	0.84
T_2	60.0	59.4	59.70	99.69	44.55	0.60
T_3	62.0	61.0	61.50	150.40	16.35	0.41
T_4	45.0	44.0	44.50	179.80	-	0.25
S.E.±	2.16	1.83	2.98			
C.D. (P=0.05)	6.65	5.64	8.65			
CV, %	8.86	7.84	-			

Table 2 : Comparative fertilizers use efficiency and cost benefit ratio in drip and check basin irrigation system

Treatments	Fertilizer applied (kg)	Fertiliser use efficiency (q/kg)	Fertilizer saving (%)	Labour engaged (man-h/ha)	Labour saving (%)	B : C ratio
$T_{1=}$ Single drip line on bed between two rows	40	1.26	46.66	1848	33.04	2.58
T_2 = Double drip line on the bed between two rows	40	1.49	46.66	1848	33.04	3.12
T_3 = Single drip line on each bed per row	40	1.54	46.66	1848	33.04	3.27
T_4 = Check basin irrigation system	75	0.59	-	2760	-	2.20

was 0.41 q/ha-cm. Thus, WUE in check basin irrigation was quite lower than the drip irrigation treatment. It clearly indicates that vegetable contains large amount of water (80 -85 %), thus their yield and quality suffer rapidly under water stress. A short period of 2-3 days of moisture depletion can reduce their yield drastically. This was in agreement with the finding of Bahdur and Rai (2006). Drip irrigation system always maintains crop rhizosphere almost at field capacity, so crop never experience water stress at any stage.

The comparative fertilizer use efficiency and cost benefit ratio of both irrigation systems are given in Table 2. The fertilizer use efficiency in drip irrigation treatment was 1.49 q/kg wherein check basin irrigation treatment it was 0.59 q/kg. It was quite higher than that of check basin irrigation treatment. Besides enhancing the okra yield and WUE the drip irrigation system also saves fertilizer (46.66 %). It is clearly indicated in Table 2 that there is considerable saving (33.04%) in labor as the drip irrigation system needs labour only to start and stop the system. Drip irrigation system was found cost effective (B: C ratio 3.12) than the conventional irrigation method (B: C ratio 2.20) in spite of high installation cost.

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