RESEARCH PAPER | International Journal of Agricultural Engineering | Volume 5 | Issue 1 | April, 2012 | 58 – 61

Study of hydraulic performance of drip irrigation systems in Banana fields of Guntur district

CH MURALI KRISHNA, H.V. HEMA KUMAR AND D. SAI GANGADHARA RAO

Received : 23.11.2011; Revised : 25.12.2012; Accepted : 13.02.2012

See end of the Paper for authors' affiliations

Correspondence to:

H.V. HEMA KUMAR
Department of Soil and Water Engineering, College of Agricultural Engineering, BAPATLA (A.P.) INDIA
Email : muraliagengg@gmail.com

Abstract **:** Andhra Pradesh state in India has pioneered in installing drip irrigation systems in farmers' fields through government subsidy schemes. State government, though established centers for certifying the efficiencies of systems installed for payment to the micro irrigation companies,farmers face many maintenance functional problems in their field while irrigating through drip. The authors strongly feel that the system design accuracy play a vital role in terms of energy saving, long life of pipe material and equipment. Farmers' satisfaction is also of paramount importance and the system performance and post maintenance aspects should be felt as research component too. Hence, 40 farmers growing banana crop were identified from Guntur district of Andhra Pradesh state, whose fields were installed with drip system by various micro irrigation companies. The hydraulic parameters selected for the study are back calculation of HP requirement of pump set, pressure and discharge variations. Around 31 installations show that the pumps need to be upgraded for the discharge and pressure. If the same applied at national scale one can easily comprehend the loss of huge government investments allocated to benefit the farming community, importance of accurate design and installations for the drip irrigation systems.

Key words **:** Drip irrigation system, Total head loss, Discharge variation

How to cite this paper **:** Murali Krishna, CH, Hema Kumar, H.V. and Rao, D. Sai Gangadhara (2012). Study of hydraulic performance of drip irrigation systems in banana fields of Guntur district. *Internat. J. Agric. Engg.*, **5**(1) : 58-61.

Water is the precious natural resource, a basic human need and a prime national asset. The extent to which the water is plentiful or scarce, clean or polluted, beneficial or destructive, profoundly influence the extent and quality of human life. The relentless increase in population and the resulting spurt in the demand for water require careful planning and management of the limited water resources. The available water resources are to be optimally harnessed and beneficially utilized with appropriate priorities of use. Drip irrigation is also known as trickle irrigation or micro irrigation, which minimizes the use of water and fertilizer by delivering water slowly near the root zone or directly in to the root zone of plants, through a net work system of prime movers, filters, valves, pipes, tubing and emitters. The major crop cultivated in the study area is as it is an acclimatized one and also has market in the region with high returns.

The procedure to evaluate head losses in drip laterals, based on constant outlet, discharge has been proposed (Domienico *et al.,* 2006). It is also demonstrated that in India drip irrigation is found performing better than basin irrigation in all aspects of growth, yields of banana, and in water use efficiency (Srinivas and Hedge, 1989). The results of his work stated that the productivity has increased by 51 per cent and water saving is about 44.8 per cent. Losses in drip irrigation lines. Total head losses values are measured on 15 commercially available co–extruded laterals were compared with those obtained by using the newly proposed methodology. Relative errors on the pressure head estimation for the examined cases were always $\pm$ 2.4 per cent. It was found that the pressure requires to operate the farthest dripper ranges between 3 to 7m with respect to length of lateral

METHODOLOGY

Study area:

As part of this study and performance evaluation of drip irrigation systems in some of the villages in Mangalagiri and Thulluru mandals of Guntur district, the data collected from various organizations like Andhra Pradesh Micro Irrigation Project (APMIP) office, Micro Irrigation(MI)

companies etc., and the methodology adopted is presented in the subsequent sections of this chapter. As many farms are installed with drip systems under Andhra Pradesh Micro Irrigation Project (APMIP) in Mangalagiri and Thulluru mandals, some of the villages namely Mandadam, Venkatapalem, Lingaya palem, Rayapudi, Nuthakki, Kaza, Needamarru were selected for the present study for the sake of operational convenience. The important technical parameters like discharge variation, pressure variation between the inlet and end plug positions of the selected laterals of certain fields of the villages have been found out.

Fig. A : AP Micro irrigation project implemented area

Evaluation of pressure variation:

As per the standard practice of drip irrigation system a pressure variation of 20 per cent is allowed in Indian conditions for the better performance of the systems. To ascertain the same in the farmer's fields of the selected villages, Mandadam of Thulluru mandal, about forty farmer's fields covered with drip system were chosen according to the extent of the land *viz.*, one acre owner and so on and one lateral was randomly chosen in each of the field and the pressure at the inlet and at the end plug of the lateral pipe were measured with the help of a pressure gauge as presented through plates 4. The data are reported in the next chapter.

Evaluation of discharge variation:

As per the standard practice, a variation of 8-10 per cent may be allowed in the discharge from the inlet to the end plug of the lateral. To ascertain the same, the discharge of the emitters of a randomly selected lateral at three locations. *i.e.* at the inlet, middle, and near the end plug were measured. The average discharge of the emitters was also calculated. The discharge of the emitters was measured accurately by volumetric method with help of a one litre measuring cylinder and a stop watch used for the measurement of time.

Calculation of HP requirement of the pump of the some of the drip systems:

The readings of emitter discharge and submain discharge were calculated to find the required HP of the system. To calculate the size of the motor, the frictional head loss in the laterals, submains and mains has to be observed. To estimate the friction head of drip system laterals, the Darcy-Weishbach equation for smooth pipes in micro-irrigation can be combined with the Blassius equation as follows

$$H_{fl} = K \times L \times Q^{1.75} \times D^{-4.75} \times F \quad \text{.....(1)}$$

where,

H_{fl} = Friction loss in lateral pipe, m

K = A constant whose value is 7.89 x 10^5 for SI units of water at 20^0C

L = Length of the pipe in, m

Q = Rate of flow in pipe, lit/sec

D = Diameter of the pipe, mm

F= Factor for multiple outlet flow.

The value of F is generally 0.376 for laterals and for sub main 0.389 and the value for main is 1 as the main is not a multiple outlet pipe because it has only a few sub main connections. F values are calculated based on christiansen's formula.

The discharge of the lateral is obtained by dividing the design discharge of the pump (generally 8-12 lps) by number of laterals on the submain. The number of laterals on the sub-main can be calculated by dividing the length of the sub main with the spacing between laterals. The generally adopted spacing between laterals ranges from 1.2 m to 1.5m for banana crop and the spacing between the dripper (inline) is 0.6m, 0.8m and 1m for banana crop. The friction head in sub-main and main are denoted as H_{fs} and H_{fm}, respectively. The length and diameter of the sub-main and main and laterals are measured in the field with the help of measuring tape and digital calipers, respectively. The pressure head required to operate the farthest emitter ranges between 6 to 12m. In general the pressure head required to operate the farthest emitter is regarded as the operating pressure of the system and is taken as 10m or 1kg / cm^2. The head loss due to bends, filters etc. is taken as 1.5m for the whole drip irrigation system. The maximum pressure drop of the screen filter is specified as 0.3 to 0.5m and the pressure drop in the fertigation tank generally depends upon the capacity of the fertigation tank and also on the type of the fertilizer used for fertigation. Then the total head requirement of the system is calculated as follows:

H_{sys} = Head for operation + friction loss + bend losses + filter loss

$H_{sys} = H_o + H_{fl} + H_{fs} + H_{fm} + H$, where,

H_0 = head required to operate the system, m
H_{fl} = Total head loss due to friction in the lateral, m
H_{fs} = total head loss in the submain, m
H_{fm} = total head loss in the main line, m
H = Head loss due to bends, filter losses etc.,

The friction losses in the suction pipes are generally taken as 6m per 100m pipe as proposed by Al-Ghobari (2005). Therefore, the head required for the pump is

$H_{total} = H_{sys} + H_s + H_{fs} + H_d + H_V + H_{fd}$. where,
H_{sys} = Total head requirement of the system, m
H_s = Total suction head ,m
H_{fs} = Frection losses in suction pipe,m
H_d = Delivery head, m
H_V = Velocity head, m

The delivery head and the friction losses due to delivery head in drip irrigation system are zero as there is no tank constructed to deliver water.

Then, the size of the pumping unit can be estimated using the equation

$$HP = \frac{Q \times H}{75 \times \eta_p \times \eta_m} \quad (2)$$

where,
H.P= Horse power of the electric motor driving the pump,
H = Total head requirement of the pump, m
Q = Capacity of the drip irrigation system l/s.
ηp = efficiency of the pump, fraction,
ηm = efficiency of the motor fraction.

The combined efficiency of the pump and motor is assumed as 95 per cent as all the pumps used are centrifugal mono block directly coupled to the motor drive. The HP required by the pump is calculated as per the above equation for all the selected forty farmers of villages of Mangalagiri and Thulluru Mandals. This is done to analyze the size of the installed pump sets matches whether the requirements exact fit for the system.

■ RESULTS AND DISCUSSION

Two of the important design parameters pressure and rated discharge of the emitters were measured for different laterals in drip systems of about forty farmer's fields. The name of the land owner, extent of land and the name of the company which installed the drip system are given in. The evaluation of technical parameters was taken up to check whether the operation of the drip systems was under the limits of the standards or not. The literature provides the information that a pressure drop 20 per cent in the lateral indicates the best range for the performance of the system and a variation of 20 per cent to 40 per cent is acceptable for the operation of the system. The variation of 10 per cent in the rated discharge is acceptable for a drip system (AI-Ghobari, 2005). The observations of the pressure and rated discharge at different locations of the lateral are presented through Fig. 1, 2, 3, 4.

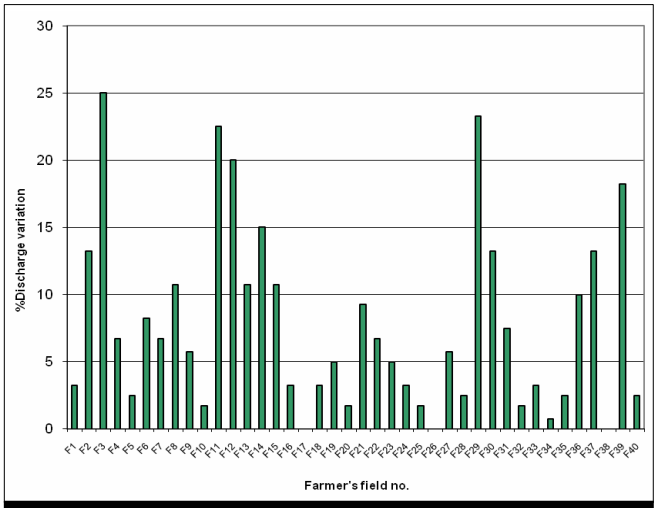

Fig. 1 : Discharge variation in farmer's fields surveyed

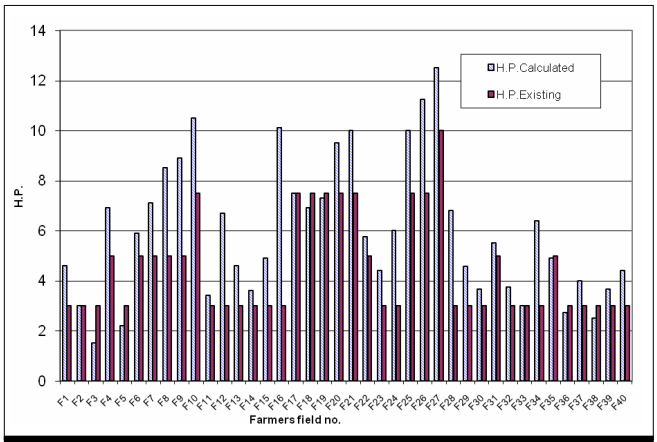

Fig. 2 : Calculated and existing HP of motor pumpsets

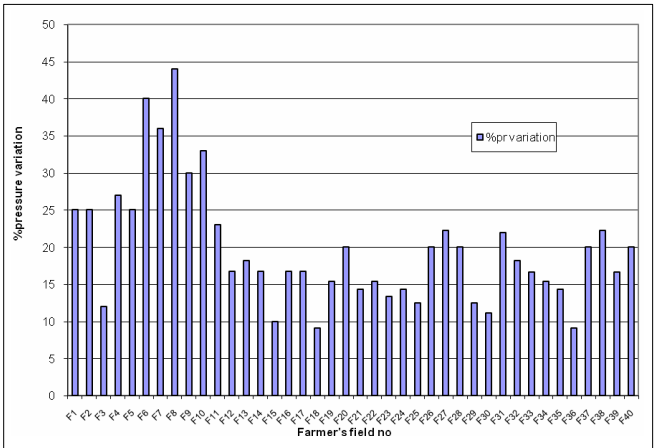

Fig. 3 : Pressure variation (%) different farmers fields

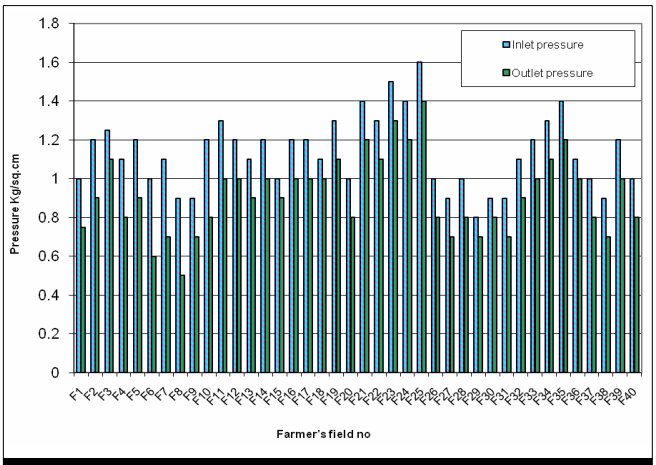

Fig. 4 : Inlet and outlet pressures in various fields

The results of the study reveal that out of forty fields inspected, twenty one fields are proved best with pressure drop between 10 per cent and 20 per cent. Fourteen fields were showing the acceptable range with the pressure drop of 20 per cent and 30 per cent. The other five fields, the pressure drop was above 30 per cent which is beyond the standards with poor performance having a low pressure of 0.9 kg / cm^2 at the inlet and 0.5 kg / cm^2 at the end plug position. Fig. 2 describes the variation of pressure in lateral pipe. The per cent variation ranged between 1 to 44 in the forty fields surveyed.

The results of study reveal that out of forty fields inspected, the discharge of drippers of twenty one fields showed a little variation from the rated discharge proved the best with discharge variation between 1 per cent to 10 per cent and in nine fields the variation was found between10 per cent to 20 per cent which is considered to normal. Three fields were not in acceptable range of discharge variation between 20 per cent to 30 per cent, but three fields have shown excess discharge than rated. The other three fields showed exact the rated discharge *i.e.* 4lph.The discharge variation ranged between 0 to 23.25 per cent. it can be considered that the systems are performing better by considering the above data.

The results of the study reveal that out of forty fields inspected, twenty one fields were proved best with pressure variation between 10 per cent and 20 per cent. Fourteen fields were showing the acceptable range with the pressure drop of 20 per cent and 30 per cent. The other five fields, the pressure drop of 30 per cent was found which was beyond the standards with poor performance having a low pressure of 0.9 kg / cm^2 at the end plug position. The percentage of pressure variation ranged between 1 to 44 per cent in the forty fields surveyed.

The results of the pump HP calculations shows that for the 31 fields out of forty fields inspected, the size of the pump was not sufficient to operate the system as the calculated pump HP is greater than the existing HP, which proves the design of the drip system is inadequate to operate. But these farmers are operating their drip systems section wise with help of control valves according to available discharge of the pump set. For the six fields, the existing HP was slightly more than the required HP, which is sufficient to operate the drip system in single operation. The other three fields, the calculated HP was matching with HP of the existing pump set. But in the case of seven fields of the drip systems, the actually required pump size was more than the presently installed pump size by about 50 per cent, which resulted in the poor performance of the system with low pressure head build up, large variation of pressure was observed between the lateral inlet and end plug position of the lateral.

Conclusion:

The following conclusions can be drawn from the present study out of 40 drip installation.

– It was found that 53 per cent fell in acceptable range and 22 per cent not acceptable. However, the exact was discharge was shown by only 10 per cent of the total installations.
– The pressure variation was best in 53 per cent (10 to 20%) of total installations. Acceptable was in 35 per cent (20 to 30%) installations and 12 per cent (>30%) were not in acceptable range
– The size of the pump set (HP) was not sufficient for 77 per cent of the systems to operate the drip system. More size than required capacity was in 15 per cent and suitable size of pumps were 8 per cent only.

Therefore, from above conclusions it is noticed that, there is a lot of design lacunas in most of the drip installation in entire country as well as Andhra Pradesh state. Hence, special attention is required on the drip irrigation hydraulic design before installing in the farmers' fields.

Authors' affiliations:
CH. MURALI KRISHNA AND D. SAI GANGADHARA RAO, Department of Soil and Water Engineering, College of Agricultural Engineering, BAPATLA (A.P.) INDIA

REFERENCES

AlGobhari (2005). Trickle irrigation application uniformity from simple emitters, *Trasn. ASAE*, **16** (6) : 1108-1111.

Domenico, P., Giuseppe, P., and Pietro, D. (2006). Simplified procedure to evaluate head losses in drip irrigation laterals. *J. Irrigation & Drainage Engg.*, **131** : 525-532.

Srinivas, K., and Hedge, D.M. (1989). Growth, yield, nutrient uptake and water use of banana crops under drip and basin irrigation with N and K fertilization. *Tropical Agric. (Trinidad),* **68**: 331-334.

***