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Evaluation of impact of chemical treatment on clogged drip irrigation system

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■ **ABSTRACT :** The experiment was conducted on farmer's field at Vivare, Tal-Raver, dist-Jalgaon to study the impact of chemical treatments on clogged drip irrigation system.Total 27 laterals of 12mm diameter having length 25 meters each, on which 20 clogged emitters of 4 l ph discharge were mounted at a spacing of 1.25 m. The discharge of 10 emitters from each lateral was measured at a pressure of 1 kg/cm^2 for 5 minutes before treatment. The three types of acid that is hydrochloric acid (35 % conc.), sulphuric acid (98% conc.) and nitric acid (60% conc.) were used for acid treatment. The acid treatment was given at different pH levels *viz.,* 3, 3.5 and 4 pH.It was found that when the pH of water was greater than 7.0, precipitation of salts occurred in the drippers. The water having electrical conductivity 1.45 mmhos/cm when passed through the drip system, most of emitters were clogged. The uniformity co-efficient of drip system before and after acid treatment was 84.03 per cent and 96.20 per cent, respectively. The average percentage reductions in discharge of clogged emitters were observed in between 42.5 per cent to 45 per cent. The average percentage increased in discharge was observed 68.18 per cent when clogged emitter was treated with HC1 (35% cone.) having 3 pH cone. The best chemical treatment of hydrochloric acid (35% cone.) having 3 pH was more effective to water having electrical conductivity 1.45 mmhos/cm for obtaining maximum discharge.

■ **KEY WORDS :** Drip irrigation, Clogging, Chemical treatment, Uniformity co-efficient

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Drip or trickle irrigation is one of the latest method of irrigation, which is becoming increasingly popular in areas with water scarcity and salt problem. Drip irrigation is defined as the precise, slow application of water in the form of discrete or continuous or tiny streams of miniature sprays through mechanical devices called emitters or applicator located at selected points along water delivery lines.

Drip irrigation is not only economical in water use but also gives higher yield with poor quality water. For this reason it is gaining rapid popularity in arid region throughout world. The drip irrigation method has an advantage of higher application efficiencies *i.e*. upto 90 per cent. Bresler (1977) stated that the system of drip irrigation is more advantageous for improving the soil water regime to obtain more crop yield, minimizing the salinity hazard to plants and restricting water supply to those parts of the field where the root system is more efficient.

The limitation of drip irrigation method includes high initial cost, salinity hazard, clogging of emitter and uneven water distribution in slope land. Just as every water is

not suitable for human being, in the same way it is not suitable for plant life. Water contains impurities and various types of salts, which are injurious to plant growth, is not satisfactory for irrigation and is called unsatisfactory water. If unsatisfactory water is applied to plant through drip system, there may be possibility of clogging of emitters, which affects the performance of drip irrigation system.

The major problem with drip irrigation is clogging of system components by particulate, chemical and biological material. Thate (2001) revealed that acidic nature of solid soluble fertilizers may have attributed to less reduction in discharge.

Drip irrigation system has low flow rates and extremely small passages for water. These passages are easily clogged by organic debris and mineral particles carried in irrigation water and by chemical precipitates and biological growth that develop within the system. Clogging adversely affects rate of water application and uniformity of water distribution and increases operating cost. Emitter clogging is directly related to quality of irrigation water *i.e.* suspended loads, chemical composition and microbial activity.

Considering the water quality, clogging of emitters can be classified a physical clogging, biological clogging and chemical clogging. Clogging effects on water application efficiency and hence crop yield. Specific concentration, water pH and temperature play an important role in chemical clogging. Gaikwad (2000) observed that the variation of emission uniformity with operating head was influenced by length, diameter and slope of lateral.

Chemical treatment of clogged emitter at the source of water or within the system is the most useful method of preventing chemical clogging. This treatment includes use of acid injection continuously. Hydrochloric acid (35% cone.) 0.2 to 0.5 per cent by volume introduced in the system for 10 min. is found effective for removing calcium carbonate salts (Meyer, 1985).

The water having electrical conductivity (EC) greater than 2.75 mmhos/cm is not recommended for drip irrigation method. But if the water having the electrical conductivity greater than 2.75 mmhos/cm is available on the farm and applied through drip system clogging may occur Bucks *et al.* (1980).

The study is undertaken to see the effect of acid treatments on clogged drip irrigation system. Emission uniformity co-efficient of clogged drip irrigation system, before and after acid treatment was evaluated.

METHODOLOGY

Experimental site:

The experiment was conducted on farmers field at Vivare, Tal. Raver, dist. Jalgaon which is 60 km away from Jalgaon.

Location and climate:

Jalgaon district is situated in the Khandesh region of Maharashtra and lies in 22.1° North-South latitude and 15.34° longitude. The average rainfall of the region is 750 mm. The temperature ranges between 40°C to 46°C.

Soil of the region is medium to deep black soil. On an average the salt concentration level of well water ranges from 400 to 1200 ppm. The pH of well water in the region ranges from 6.2 to 7.6. The prominent soluble salts are sulphates; calcium, magnesium and sodium comparatively high salt concentration of ground water has posed the problem of partial or total clogging of emitter.

Experimental set-up:

The experimental set upto collect the data required to study consists of pump, filter, pressure gauge, mainline, sub main line, laterals, emitters, grommet takeoff and end plugs and other accessories such as flow control valve, tee, elbow, couplings and end caps.

Laterals and emitters:

The 27 lateral pipes made of linear low-density poly-ethylene (LLDPE) of 12 mm diameter having lengths of each lateral 25 m were connected to sub main through grommet take off. The spacing of each lateral was 1.25 m. On each lateral 20 clogged drippers of 4 l phdischarge rate, at an operating pressure of 1kg/cm^2 were mounted at a spacing of 1.25 meter along the lateral length.

Discharge measurement:

The ten emitters of each lateral were selected for discharge measurement. The total 30 emitters were tested for 3 replications. The flow rate of emitter was measured by collecting water for 5 minutes in measuring cylinder. The flow rate of emitters was measured before and after acid treatment.

Table A: Volume of acid required

Sr. No.	Acid treatment	Name of acid	pH level	Vol. of acid required per lit (ml)	Vol. of acid required per lateral (ml)
1.	X_1		3.0	4.0	20.00
2.	X_2	HCL (35 % conc)	3.5	3.0	15.00
3.	X_3		4.0	2.5	12.50
4.	Y_1		3.0	2.8	14.00
5.	Y_2	H_2SO_4 (98 % conc)	3.5	2.4	12.00
6.	Y_3		4.0	2.0	10.00
7.	Z_1		3.0	3.5	17.50
8.	Z_2	HNO_3 (60 % conc)	3.5	3.0	15.00
9.	Z_3		4.0	2.8	14.00

Chemical treatment:

The solution of the required concentration was prepared in large container using pH indicator paper. The chemical solution was passed through system till the solution of same concentration was emitted out from last emitters, which was tested by pH paper at that point. The total volume of water required per lateral including losses was 5 liters. Table A shows volume of acid required per lateral of 25 m lengths. The drip set thus, treated, was flushed after 24 hours by taking out the end plugs of each laterals and allowing water to discharge outside for about 15 minutes till the clear water was discharge out.

Computation of uniformity co-efficient (C.U.):

It is expressed by Christiansen (1942).

$CU = 100 \times (1- \Sigma x / m.n)$

where,

x = Deviation from mean

m = Average of all observations

n = Number of observations.

■ RESULTS AND DISCUSSION

The main problem in drip irrigation system is the clogging of emitters due to salt accumulation. To analyze the problems like salt accumulation in laterals as well as in emitters, which is resulted in partial clogging of the system and to asses the quality of water, which is directly affected the operation of the unit. It was observed that the salt was accumulated at the water emitting point and on the surface of the emitters. Thus, the discharge obtained from each emitter was below the capacity. Hence, the acids were used for flush out the drippers. Thus, the discharge obtained from each emitter was approximately equal to the rated discharge.

Effect of clogged emitters on discharge:

The clogged emitters were studied visually, it was observed that salt were accumulated at water emitting point on the surface of emitter and swirl plate.

The emitters from each lateral were selected alternately and measured the discharge of emitters for five minutes. The values for uniformity co-efficient are presented in Table 2. The uniformity co-efficient of the clogged system was found out to be 84.03 per cent. The discharge variation was about 2 to 2.6 Iph before treatment.

Chemical treatment to clogged emitters:

The clogged emitters were treated by three types of acids, *viz.*, hydrochloric acid (35% conc), sulphuric acid (98% conc) and nitric acid (60% conc.). Table 1 shows the

Table 1 : Volume of acid required for 10 cubic meter of water

Sr. No.	Name of acid	Acid for 10 meter^3 pH levels (liters)		
		4	3.5	3
1.	HCL (35% cone.)	25	30	40
2.	H_2SO_4 (98% cone.)	20	24	28
3.	HNO_3 (60% cone.)	28	30	35

total quantity of acids required for 10 cubic meter of water to reduce pH of water to 4, 3.5 and 3 pH.

Water analysis:

The analysis of water was done in laboratory, from the analysis, it was found that the sample contents mostly natural salts like calcium carbonate, magnesium carbonate, sodium chloride etc Also it was concluded that when the pH of water is greater than 7, calcium can precipitates and make sedimentation on emitter, which results in emitter clogging. From the above discussion, it can be concluded that the reduction in dischargebefore treatment was due to salt accumulation.

Effect of acid treatment on discharge of emitter:

Chemical treatment was given to clogged drip system to reduce pH of water to 4, 3.5 and 3 pH and discharge of 10 emitters from each lateral was measured for five minutes. An average discharge is given in Table 2. Table 2 revealed that the average discharge of emitters after chemical treatment of hydrochloric acid was 3.7, 3.6 and 3.7 lph for 4, 3.5 and 3 pH levels, respectively. The percentage increase in discharge was found out to be 68.18, 63.63 and 60.86 for 3, 3.5 and 4 pH levels, respectively.

Similarly the average discharge of emitters after chemical treatment by sulphuric acid was 3.6, 3.7 and 3.6 Iph for 3, 3.5 and 4 pH levels, respectively. The percentage increase in discharge was 63.63, 60.86 and 63.63 for 3, 3.5 and 4 pH levels, respectively.

Also the average discharge of emitters after chemical treatment by nitric acid was 3.6, 3.6 and 3.6 Iph for 3, 3.5 and 4 pH levels, respectively. The percentage increase in discharge was 63.63, 63.63 and 63.63 for 3, 3.5 and 4 pH levels, respectively

From the above discussion, it can be concluded that one can choose any acid out of hydrochloric acid, sulphuric acid and nitric acid. But hydrochloric acid (35% cone.) is easy to handle and cheap in cost. Hence, hydrochloric acid (35% cone.) can be preferred for acid treatment. When the irrigation water having EC 1.45 mmhos/cm, then give the acid treatment of hydrochloric acid (35% cone.) having 3 pH level of concentration (Gorantiwar *et al.*, 1998 and Wu and Gitlin, 1974).

Summary and conclusion:

Tests were conducted to study the impact of acid treatment on discharge of emitters at different pH levels *viz.*, 3, 3.5, 4 pH. The three types of acid that is hydrochloric acid (35 % cone.), sulphuric acid (98% cone.) and nitric acid (60% cone.) were used for a acid treatment. The solution of required concentration was prepared in a large container using pH indicator paper and passing through laterals till the solution of same concentration was emitted out from last emitter, which was tested by pH indicator paper at that point.

Thus, it is concluded that the uniformity co-efficient of drip system before and after acid treatment was 84.03 per cent and 96.20 per cent, respectively.The average percentage reductions in discharge of clogged emitters were observed in between 42.5 per cent to 45 per cent. The average percentage increased in discharge was observed 68.18 per cent when clogged emitter was

Table 2: Unifarmity co-efficient before treatment and after treatment

Acid	Treatments	pH level	Avg. discharge rate (LPH)			% decrease in discharge	% increase in discharge	CU after clogging	CU after acid treatment
			Before clogging (Rated)	After clogging	After treatment				
HCL	X_1	3.0	4	2.3	3.7	45	68.18	84.74	96.74
(35%	X_2	3.5	4	2.2	3.6	45	63.63	84.32	96.40
cone.)	X_3	4.0	4	2.3	3.7	42.5	60.86	85.18	96.30
H_2SO_4	Y_1	3.0	4	2.2	3.6	45	63.63	83.78	96.00
(98%	Y_2	3.5	4	2.3	3.7	42.5	60.86	83.85	96.10
cone.)	Y_3	4.0	4	2.2	3.6	45	63.63	83.75	96.00
HNO_3	Z_1	3.0	4	2.2	3.6	45	63.63	83.80	96.10
(60%	Z_2	3.5	4	2.2	3.6	45	63.63	83.66	96.00
cone.)	Z_3	4.0	4	2.2	3.6	45	63.63	83.08	96.20

treated with HC1 (35% cone.) having 3 pH cone.

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