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Studies on efficiency of acids for unclogging of inline type emitters

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Abstract
The main hurdle in drip irrigation system management is emitter clogging. Emitter clogging greatly reduces the water distribution uniformity in the irrigated field and which negatively influence crop growth and yield. Acids which are selected for the study were DS-99, Nitric acid, sulfuric acid, Hydrochloric acid and phosphoric acid. No acid treatment was taken as a control.
Inline type of emitters (non-pc) was having less discharge (1.3 lph) and turbulent flow regime therefore these emitters were more susceptible to clogging though the drip irrigation system was six year old. Amongst the different acids used for unclogging of emitters, sulfuric acid -75% was found significantly superior over all other treatments followed by hydrochloric acid (37%), nitric acid (70%), DS-99 acid and phosphoric acid (85%) for inline drip irrigation systems. From study, it is revealed that three applications of acid at 15 days interval were required for satisfactory unclogging of inline (Non-PC) emitters. Crop response was found to be significantly superior for higher EU, UC values treatments.

Keywords: Inline emitter clogging, acid treatment

Introduction
Irrigation system is one of the most important components affecting the yield and quality of agricultural produce from greenhouse farming system. Hence it is vital and most important part of the greenhouse industry. In India, out of 172.6 million hectare of cropped area only 76.82 million hectare area is under irrigation. This means that 44.51% of the cropped area is under irrigation. In Maharashtra out of 30.8 million hectare geographical area 32.5 lakh hectare is under irrigation and 5.41 lakh hectare areas is under drip irrigation (Economic survey of Maharashtra 2010-2011).
In Maharashtra, in majority of the cases where drip has been adopted, the source of irrigation water is the groundwater. On an average the salt concentration level of well water in different parts of Maharashtra state ranges between 425 to 2135 ppm, EC in the range of 0.66 to 3.337 dS/m and pH in the range of 7.5 to 8.5. The predominant soluble salts are of sulphate, magnesium and sodium. Comparatively higher salt concentration of ground water has posed the problem of partial or total emitter clogging.
The main hurdle in drip irrigation system management is emitter clogging. The phenomenon of emitter clogging has been extensively studied. The reasons for emitter cogging can be classified into three types; physical clogging, chemical clogging and biological clogging (Bucks, 1979). Physical clogging is caused by suspended inorganic particles (such as sand, silt, clay, and plastics), organic materials (animal residues, snails etc) and micro biological debris (algae, protozoa etc): physical materials are often combined with bacterial slimes. Chemical problems are due to dissolved solids integrating with each other to form precipitates, such as the precipitation of calcium carbonate in waters rich in calcium and bicarbonates (Wu I.P., 2004). Biological clogging is due to algae, iron slimes and sulfur slimes.
To prevent emitter clogging, different methods are in use on both experimental and on field scales. Filtering and flushing drip lines are simple and useful method to prevent emitter clogging, particularly for physical clogging. Filtering can prevent inorganic particles and organic materials suspended in water from entering the drip irrigation system. Flushing drip lines can clear the inorganic and organic materials precipitated in emitter orifices and on the inside wall of drip hoses out of the system. Chemical clogging can be controlled with acid injection, which can lower the pH value of irrigation water and thus prevent chemical precipitation. Biological clogging is quite difficult to control,

chlorination is one of the most common and efficient ways used to prevent and treat emitter clogging caused by algae and bacteria (Ravina, 1992, Dehghanisanij, 2005) [4]. The injection of acid into drip irrigation system is primarily carried out to lower the pH of the irrigation water and prevent the precipitations of salts.
Precipitation of salts such as calcium carbonate, magnesium carbonate or ferric (iron) oxide can cause either partial or complete blockage of the drip system. Acid may also be effective in cleaning systems which are already partially blocked with precipitates of salts. The most reliable step for deciding an acid treatment is a water analysis. Water samples are collected during the survey and then analyzed to recommend acid treatments as per the water quality. Generally hydrochloric, nitric acid, sulfuric acid, phosphoric acid etc. are used for acid treatment (Anonymous, 2002). Emitter clogging greatly reduces the water distribution uniformity in the irrigated field and which negatively influence crop growth and yield. Clogging can be controlled with acid injection, which can lower the pH value of irrigation water and thus to prevent clogging of emitters different acids treatment can be used.

Materials and Methods

The field experiment entitled "Studies on Efficiency of Acids for Unclogging of Inline Type Emitters" was conducted at Hi-Tech floriculture project, Fruit research station, Aurangabad.

Experimental details

The experiment was planned in polyhouse with inline type non-pc emitters (long path). The inline type non- pressure compensating dripper having the discharge of 1.3 lph spaced at 20 cm were used. Polyhouse was of 20 R i.e. 2088 m2 (58 x 36 m) areas with two irrigation hydraulic valves. Area under one valve was considered as a sector, totally two sectors and each sector divided into three plots for treatments. There were six treatments with six plots in polyhouse. In polyhouse having soil cultivation (Red soil mix) Jain make inline non-pressure compensating drip irrigation system was installed. These two valve controlled by Fertigation unit make Talgil, imported from Israel was used.

Performance evaluation of drip irrigation system

In order to evaluate the performance of drip irrigation system installed at two selected sector of polyhouse in Aurangabad, emission uniformity of the drippers were recorded.

- **Emission uniformity**

The emission uniformity is determined by using Capra (1995) equation as

$$EU = \frac{q_n}{q_a} \times 100$$

Where,
EU = Field test emission uniformity, per cent
q_n = Average of the lowest 1/4th of the field data emitter discharge, lit/h
q_a = Average of all the field data emitter discharge, lit/h.

- **Uniformity Coefficient**

The uniformity coefficient is determined by using Bralts (1983) equation as

$$Uc = \left(1 - \frac{Sq}{q_a}\right) \times 100$$

Where,
Uc = Uniformity coefficient, per cent
Sq = Standard deviation of emitter discharge, lit/h
q_a = Average emitter discharge, lit/h

- **Coefficient of variation**

The coefficient of variation is determined by using ASAE (2002) equation as

$$C_v = \frac{Sq}{q_a} \times 100$$

Where,
C_v = Coefficient of variation, per cent
Sq = Standard deviation of emitter discharge, lit/h
q_a = Average discharge of emitters, lit/h.

Determination of acid treatment

The acid required for the known volume of water sample determined by following procedure.
For acid treatment water sample of 1 litre is collected from existing water source of the project. Simple titration method is followed by adding acid drop by drop in water sample of 1 liter at the time of titration glass rod is used frequently for stirring and pH of the solution was calculated. The quantity of acid required to maintain pH value to 4 was calculated. pH meter was used for observing the pH value. To carry on the said treatment installed Talgil make fertigation unit imported from Israel was used at the time of operated and concentration of acid were mixed along with water and discharged at their final end. The machine was kept 24 hours unoperated so that action of acid on clogged laterals were observed, generally acid action will be effective after 6 to 8 hours of discharge. After 24 hours the machine was reported to flush the sub mains, laterals so that the remaining residues of the salt will be driven out of the system and the emission uniformity can be effectively observed.
Acid injection rate –
The acid injection rate is determined by following equation,

$$Q_a = \frac{(3.6 \times Q \times A)}{V}$$

Where,
Q_a = Acid injection rate, l/h
Q = System flow rate, l/h
A = Acid quantity in ml to achieve the required pH in a water test sample V litres
V = Volume of test sample

Results and Discussion

Performance evaluation of drip irrigation system

Table 1: Average of emission uniformity, uniformity coefficient and coefficient of variation before & after first application (inline type emitter non- pc)

Treatments	EU(%) for First Application		UC (%) for First Application		CV (%) for First Application	
	Before	After	Before	After	Before	After
LT_1	34.69	53.24	52.32	62.49	47.68	37.51
LT_2	34.29	59.82	54.34	70.48	45.66	29.52
LT_3	34.31	55.57	54.25	68.72	45.75	31.28
LT_4	35.95	56.65	55.85	68.70	44.15	31.30
LT_5	34.20	51.96	56.02	61.60	43.98	38.40
LT_6	34.69	37.74	55.20	56.52	44.80	43.48
S.E. ±	0.652	0.505	-	-	-	-
CD at 5%	NS	1.591	-	-	-	-

It was observed from the Table 1, average emission uniformity before first application for inline type emitter (non-pc) was in the range of 34.20% to 35.95%. This limit of emission uniformity was unacceptable for drip irrigation system. This indicates that the system was under severe clogging condition. It was mainly due to deposition of salts, salt present in water i.e. dominant salt were chlorides, calcium, magnesium and sodium. The carbonate & bicarbonate were also present. Clogging also due to type of emitter, flow regime and energy dissipation pattern in the emitter. This result was non-significant for drip irrigation system. The average emission uniformity after first application of acid treatments for inline type emitter (non-pc) was in the range of 51.96% to 59.82%. This limit of emission uniformity was poor for drip irrigation system. It was mainly due to dissolution of salts in acids.

Average uniformity coefficient before first application for inline type emitter (non-pc) was in the range of 54.25% to 56.02%. This limit of uniformity coefficient was poor for drip irrigation system and after first application of acid treatments for inline type emitter (non-pc) was in the range of 61.60% to 70.48%. This limit of uniformity coefficient was marginal for drip irrigation system and flushing treatment (control) for inline type emitter (non-pc) was found 56.52%. This limit of uniformity coefficient was unaccepted for drip irrigation system.

Average coefficient of variation before first application for inline type emitter (non-pc) was in the range of 43.98% to 47.68%. This limit of coefficient of variation was unaccepted for drip irrigation system and after first application of acid treatments for inline type emitter (non-pc) was in the range of 29.52 to 43.48. This limit of uniformity coefficient was unacceptable for drip irrigation system.

Table 2: Average of emission uniformity, uniformity coefficient and coefficient of variation before & after second application (inline type emitter non- pc)

Treatments	EU(%) for First Application		UC (%) for First Application		CV (%) for First Application	
	Before	After	Before	After	Before	After
LT_1	53.08	71.93	62.78	81.31	37.22	18.69
LT_2	59.82	81.05	70.48	84.90	29.52	15.10
LT_3	54.90	74.29	68.01	82.65	31.99	17.35
LT_4	55.56	77.00	68.42	82.50	31.58	17.50
LT_5	51.42	71.15	61.32	81.50	38.68	18.50
LT_6	37.21	38.98	56.02	56.22	43.98	43.78
S.E. ±	0.472	0.709	-	-	-	-
CD at 5%	1.485	2.231	-	-	-	-

It was observed from the Table 2 that average emission uniformity after first application of acid treatments for inline type emitter (non-pc) was in the range of 51.42% to 59.82%. This limit of emission uniformity was poor for drip irrigation system. It was mainly due to dissolution of salts in acids and average emission uniformity after first application of LT6 treatment (control) for inline type emitter (non-pc) was found 37.21%. This limit of emission uniformity was unacceptable for drip irrigation system and after acid treatments the highest emission uniformity of 81.05 % was found for LT2 treatment treated with sulfuric acid, which shows that effect of sulfuric acid treatment was dominant compared to all other treatment. This limit of emission uniformity is marginal for drip irrigation system.

The highest uniformity coefficient of 70.48 % was found for LT2 treatment treated with sulfuric acid, which shows that effect of sulfuric acid treatment was dominant compared to all other treatment. This limit of uniformity coefficient was marginal for drip irrigation system. Average uniformity coefficient after second application of acid treatments for inline type emitter (non-pc) was in the range of 81.31% to 84.90%. This limit of uniformity coefficient was good for drip irrigation system and flushing treatment (control) for inline type emitter (non-pc) was found 56.22%. This limit of uniformity coefficient was unacceptable for drip irrigation system.

From the Table 7, average coefficient of variation before first application for inline type emitter (non-pc) was in the range of 29.52% to 43.98%. This limit of coefficient of variation was unaccepted for drip irrigation system and average coefficient of variation after second application of acid treatments for inline type emitter (non-pc) was in the range of 15.10% to 43.78%. This limit of coefficient of variation was unacceptable for drip irrigation system.

Table 3: Average of emission uniformity, uniformity coefficient and coefficient of variation before & after Third application (inline type emitter non- pc)

Treatments	EU(%) for First Application		UC (%) for First Application		CV (%) for First Application	
	Before	After	Before	After	Before	After
LT_1	71.28	92.60	80.96	93.71	19.04	6.29
LT_2	80.57	97.84	84.77	97.29	15.23	2.71
LT_3	73.72	94.90	82.11	95.19	17.89	4.81
LT_4	76.66	95.55	82.52	95.43	17.48	4.57
LT_5	70.73	91.81	81.36	93.15	18.64	6.85
LT_6	38.54	39.78	51.76	51.45	48.24	48.55
S.E. ±	0.711	0.395	-	-	-	-
CD at 5%	2.238	1.244	-	-	-	-

It was observed from the Table 3 that average emission uniformity after first application of acids treatments for inline type emitter (non-pc) was in the range of 70.73% to 80.57%. This limit of emission uniformity was marginal for drip irrigation system. After acid treatments and flushing treatment there was slightly changed in emission uniformity of drip system. The highest emission uniformity of 97.84 % was found for LT2 treatment treated with sulfuric acid, which shows that effect of sulfuric acid treatment was dominant compared to all other treatment and after third application of flushing treatment (control) for inline type emitter (non-pc) was found 39.78%. This limit of emission uniformity is unaccepted for drip irrigation system. This result was significant for drip irrigation system.

From the Table 8, average emission uniformity after third application of acid treatments for inline type emitter (non-pc) was in the range of 80.96% to 84.77%. This limit of emission uniformity was marginal for drip irrigation system. The average uniformity coefficient after third application of acid treatments for inline type emitter was in the range of 93.15% to 97.21%. This limit of uniformity coefficient was excellent for drip irrigation system.

Average coefficient of variation after third application of treatments for inline type emitter (non-pc) was in the range of 17.48% to 48.24%. This limit of coefficient of variation was unacceptable for drip irrigation system. The coefficient of variation of 2.71 % was found for LT2 treatment treated with sulfuric acid, which shows that effect of sulfuric acid treatment was dominant compared to all other treatment. This limit of coefficient of variation was excellent for drip irrigation system. The lower coefficient of variation of 48.55 % was found for LT6 treatment treated with flushing (control). This limit of coefficient of variation was unacceptable for drip irrigation system. Inline type non-pressure compensating (long path) emitter was of low discharge of 1.3 lph and though it was in turbulent flow regime, the drip irrigation system has more susceptible for clogging. It has given response to acid treatments and reclaimed after three applications to the higher level. Flushing treatment was not found suitable.

Conclusion

Amongst the different acids used for unclogging of emitters, sulfuric acid -75% was found significantly superior over all other treatments followed by hydrochloric acid (37%), nitric acid (70%), DS-99 acid and phosphoric acid (85%) for inline drip irrigation systems. From study, it is revealed that three applications of acid at 15 days interval were required for satisfactory unclogging of inline (Non-PC) emitters. Crop response was found to be significantly superior for higher EU, UC values treatments.

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