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Efficiency of different acids for unclogging of online 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. Considering problem of clogging in drip irrigation system, a field experiment "Studies on Efficiency of Acids for Unclogging of Online Type Emitters" was conducted in two polyhouses of 20R each at Hi-Tech floriculture project, Fruit Research Station, Aurangabad. Acids selected for the study were DS-99, Nitric acid, sulfuric acid, Hydrochloric acid and phosphoric acid. No acid treatment was taken as a control.
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 online drip irrigation systems. From study, it is revealed that two applications of acid at 15 days interval were required for satisfactory unclogging of online (PC) emitters. Crop response was found to be significantly superior for higher EU, UC values treatments.

Keywords: Acid treatment, on-line emitters, emitter clogging

Introduction
Irrigation system is one of the most important components affecting the yield and quality of agricultural produce from greenhouse farming system (Harmanto, 2002). 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 (Mundada, 1990). 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 (Taylor, 1995: Capra and Scicolone, 1998, 2007: Puig Bargues *et al.*, 2005: Zhang, 2007). 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 (Nakayama and Bucks, 1991). 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) [5]. 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 Acid for Unclogging of Online Type Emitters" was conducted at Hi-Tech Floriculture Project, Fruit Research Station, Aurangabad.

Experimental Details

The experiment was planned in polyhouse with online type pc emitters (orifice). The Online type pressure compensating dripper having the discharge of 8 lph with four way manifold spaced at 30cm, the Arrow dripper connected to the four way manifold of main dripper with micro tube of 4 mm diameter were 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\ 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) [1] 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 (online type emitter - pc)

Treatments	EU(%) for First Application		UC (%) for First Application		CV (%) for First Application	
	Before	After	Before	After	Before	After
OT_1	74.98	82.21	80.84	87.69	19.16	12.31
OT_2	74.30	87.71	80.45	90.91	19.55	9.09
OT_3	74.50	84.12	80.70	89.09	19.30	10.91
OT_4	73.57	85.58	80.28	89.64	19.72	10.36
OT_5	73.74	81.60	80.54	87.48	19.46	12.52

OT_6	72.83	75.21	79.89	81.30	20.11	18.70
S.E. ±	0.557	0.451	-	-	-	-
CD at 5%	NS	1.42	-	-	-	-

The observed data on average emission uniformity at before & after first application was presented in Table 1 reveled that, average emission uniformity before first application for online type emitter (pc) was in the range of 72.83% to 74.98%. This limit of emission uniformity was poor for drip irrigation system. This indicates that the system was under 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 was also caused by type of emitter, flow regime and energy dissipation pattern in the emitter. This result was non-significant for drip irrigation system. After acid treatments and flushing treatment there was slightly changed in emission uniformity of drip system. It was observed from the Table 6 that average emission uniformity at after first application of acid treatments for online type emitter (pc) was in the range of 81.60% to 87.71%. This limit of emission uniformity was good for drip irrigation system. It was mainly due to Dissolution of salts in acids. From Table 6 that average emission uniformity after first application of flushing treatment (control) for online type emitter (pc) was found 75.21%.

Average uniformity coefficient before first application for online type emitter (pc) was in the range of 79.89% to 80.84%. This limit of uniformity coefficient was marginal for drip irrigation system and after first application of acid treatments for online type emitter (pc) was in the range of 87.48% to 90.91%. This limit of uniformity coefficient was good for drip irrigation system. Average uniformity coefficient after first application of flushing treatment (control) for online type emitter (pc) was found 81.30%.

Average coefficient of variation before first application for online type emitter (pc) was in the range of 20.11% to 19.16%. This limit of coefficient of variation is unaccepted for drip irrigation system and after first application of acid treatments for online type emitter (pc) was of 9.09%, 10.91 & 10.36 for OT_1, OT_2 & OT_3 respectively. Table 3.3 shows that this limit of coefficient of variation was marginal for drip irrigation system. Also treatments OT_1 & OT_5 for 12.31 & 12.52 respectively. This limit of coefficient of variation was poor for drip irrigation system. From Table 6, average coefficient of variation after first application of flushing treatment (control) for online type emitter (pc) was found 18.70%. This limit of uniformity coefficient was unacceptable for drip irrigation system. The similar observations were recorded by Rienders F. B. (2005) [6] the average discharge variation CVq was a poor 8.2% with a variation of 2.7% up to 22.2% for the individual drip lines. The similar observations were recorded by Sah D.N. *et al* (2010) and category wise performance evaluation was presented.

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

Treatments	EU(%) for First Application		UC (%) for First Application		CV (%) for First Application	
	Before	**After**	**Before**	**After**	**Before**	**After**
OT_1	82.09	92.92	87.63	95.26	12.37	4.74
OT_2	87.45	98.11	90.82	98.31	9.18	1.69
OT_3	83.85	94.22	88.96	96.07	11.04	3.93
OT_4	85.23	95.70	89.49	96.76	10.51	3.24
OT_5	81.28	92.18	87.34	94.91	12.66	5.09
OT_6	74.76	75.33	81.13	81.41	18.87	18.59
S.E. ±	0.424	0.46	-	-	-	-
CD at 5%	1.335	1.448	-	-	-	-

It was observed from the Table 2, average emission uniformity at before second application for online type emitter (pc) was in the range of 81.28% to 74.76%. This limit of emission uniformity was marginal for drip irrigation system. This was mainly due to continuous flow of water inside the laterals and emitters for the period of 15 days. This result was significant 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 98.11 % was found for OT_2 treatment treated with sulfuric acid, which shows that effect of sulfuric acid treatment was dominant compared to all other treatment. The emission uniformity was excellent for drip irrigation system. From Table 7 found that, average emission uniformity after second application of flushing treatment (control) for online type emitter (pc) was 75.33%. The similar observations were recorded by Anonymous (1997) for emission uniformity. This limit of emission uniformity was marginal for drip irrigation system. This result was significant for drip irrigation system. This limit of uniformity coefficient was good for drip irrigation system.

Average uniformity coefficient after second application of acid treatments for online type emitter (pc) was in the range of 94.91% to 98.31%. This limit of uniformity coefficient was excellent for drip irrigation system. Average uniformity coefficient after second application of flushing treatment (control) for online type emitter (pc) was found 81.41%. This limit of uniformity coefficient was marginal for drip irrigation system.

The highest coefficient of variation of 9.18% was found for OT_2 treatment treated with sulfuric acid. The Coefficient of variation was marginal for drip irrigation system. The lower coefficient of variation of 18.87 % was found for OT_6 treatment treated with flushing (control). This limit of coefficient of variation was unacceptable for drip irrigation system.

Online type pressure compensating emitter (orifice) was having high discharged i.e. 8 lph and turbulent flow regime that's why it was less susceptible to clogging though the drip irrigation system was seven year old. Also it has given good response to acid treatments and reclaimed after second application to the highest level. Flushing treatment (control) was also given less response.

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 online drip irrigation systems. From study, it is revealed that two applications of acid at 15 days interval were required for satisfactory unclogging of online (PC) emitters.

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