World Journal of Agricultural Sciences 11 (1): 29-33, 2015
ISSN 1817-3047

DOI: 10.5829/idosi.wjas.2015.11.1.1841

Using of Effective Microorganism in Reducing Drip Emitters Clogging

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Abstract: Emitters clogging can caused a serious problem that affect drip irrigation performance. This study attempted to present a solution through investigation the impact of Effective Micro-Organism (EM) on mitigating clogging problems normally associated with drip irrigation DI systems. A field experiment was conducted during the period of July to September of 2012 in North Khartoum area, Sudan. In the concerned randomized complete block design (RCBD) was used, where four different concentrations treatments of EM were used; (0, 25, 50 and 100%). Sunflower was used as an indicator crop to study impact of EM as a fertilizing material promoting plant growth. The results elaborated that, there were significant differences ($P \leq 0.05$) among treatments. Whereas, 100% EM concentration gave the highest reduction (50%) of emitter clogging, followed by 50% EM concentration (37%) reduction, while 25% EM concentration gave the lowest (24%) reduction. Also crop growth parameters were improved in a similar trend as compared to the control. EM can be used as a technique for mitigating DI clogging as same as fertilizing material.

Key words: Effective Micro Organism · Emitters clogging · Drip irrigation

INTRODUCTION

The application of modern irrigation techniques has occupied large part in irrigation methods and received considerable attention in the world in recent years, particularly in developing countries. The importance of drip irrigation system (DI) lies in the fact that it can save more water as well as meet the same plant requirements as other methods of irrigation systems. In addition, the (DI) system decreases water contact with crop leaves, stem and fruit [1]. As such, the water can only wet a limited area that is close to the plant and directly to its root zone. This will save some serious problems such as rotting of plant parts. 1

Clogging of emitters has been a major problem in drip line systems because of the high levels of suspended solids and nutrients particularly those associated with treated wastewater effluents when used for irrigation. Biofilms that develop inside the drip lines accumulate as inorganic and organic materials.There can eventually block the small orifices of the emitters. Previous research indicates that the cause of clogging in (DI) systems fall into three main categories: (1) physical, caused by suspended solids; (2) chemical, caused by precipitation reactions; and (3) biological, caused by bacterial and algal growth [2]. Emitter clogging is usually the result of two or more of these processes working in concert [3]. Many researches have been performed to determine the causes and prevention of emitter clogging [4; 5].

Thin materials like silt, clay and organic matter suspending in quite narrowing emitter out let due to the precipitation, accelerate clogging by means of piling up easily. This kind of plugging can widely appear in DI systems in which ground water or surface water is rich in minerals used for irrigation purposes [6]. However, there has been few researches carried out to study the development and application of EM method for treatment of emitter clogging. Hence, the main objectives of this study were: (1) to investigate the potentiality of using an effective microorganism EM (primarily photothenthic eclectic acid bacteria yeasts, actenomycides fermenting fungi) in minimizing clogging problem of emitter in an

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in-line (built-in) out door drip irrigation system, (2) evaluate drip irrigation hydraulic characteristics performance and (3) crop growth parameters under EM when considered as fertilizer.

MATERIAL AND METHODS

Study Area and Experimental Layout: The experiment was conducted during the July to September of 2012 at North Khartoum area (15° 40'N and 32° 32'E, with an elevation 382 m a.m.s.l). The experiment was carried outwith an in-line surface drip irrigation system in an open field organized in a randomized complete block design (RCBD). Four treatments were used, control (EM_0) and three treatments of effective micro-organism (EM) were injected inside system in three concentration EM_1 (25%), EM_2 (50%) and EM_3 (100%) to study the effect of EM on emitter clogging and as a fertilizing material on crop sunflower (as indicator) growth parameters.

System Installation: Electric centrifugal water pump with 50 mm diameter and 0.5 hp capacity, driven by an electric motor was used to draw irrigation water from the storage tank and diverts in the supplying system. The main pipeline is connected to sub-main pipelines of 30 and 12 m length, respectively and 25 mm in diameter in both and made of Polyvinyl Chloride (PVC). It was buried at a depth of 0.7 m. The lateral pipes each 15 m in length and 13 mm inside diameter and made of black Linear Low Density Polyethylene (LLDPE). In line (built in) emitters were used with spacing of 0.5 m that coincides with the plant spacing.

Component and Application of Effective Micro-organism (EM): Effective Microorganism is a mixture or group of organisms that has a reviving action on humans, animals and the natural environment and has also been described as a multi-culture of coexisting anaerobic and aerobic beneficial microorganisms (EM Trading 2000). The main species involved in EM include:

- Lactic acid bacteria - Lactobacillus plantarum, L. casei, Streptococcus lactic.
- Photosynthetic bacteria- Rhodopseudomonaspalustrus, Rhodobacterspaeroides.
- Yeasts – Saccharomyces cerevisiae, Candida utilize.
- Actinomycetes- Streptomyces albus, S. griseus.
- Fermenting fungi -Aspergillusoryzae, Mucorhiemalis.

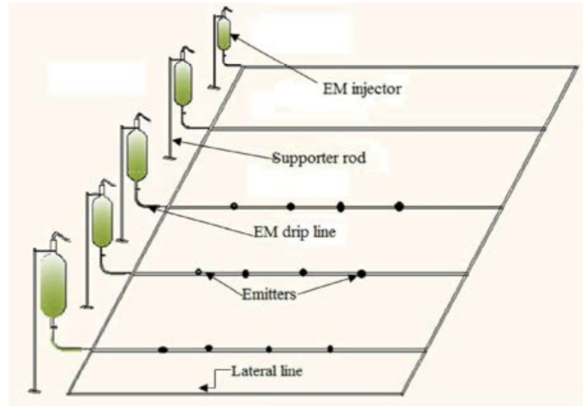

Fig. 1: EM application and injection point

Similar cans were used to collect water discharged from emitters, whereas four emitters were selected at random from each lateral. Plastic containers which are used for dripping glucose for patients were held on stick at constant head to inject EM of selected concentrations at points located after the connection of the laterals to the sub main lines (Fig. 1).

Drip Irrigation Hydraulic Characteristics: Coefficient of uniformity (CU) which indicates the variation of emitters flow in a drip system was calculated using Eq.1. The efficiency of drip irrigation system depends on the uniformity with which water is discharged from the emission devices determined as distribution uniformity (DU). So, in system with drip tubing on soil surface, the uniformity can be evaluated by direct measurement of emitter flow rate as follows Eq.2. Application efficiency (Ea %), this efficiency was calculated by dividing the average depth of water collected in the catch cans by the average depth of application as monitored by the system flow meter [7] Eq.3. Emission uniformity (EU) which depends mainly on water temperature and the manufacturer's coefficient of variation that has been developed for evaluating trickle lateral design and emission device selection. The emission uniformity is defined for point- and line source emitters by the equation of Keller and Biller, (1990) [8] Eq.4. Percentage of completely clogged emitters (P clog) calculated following method that suggested by Ravinia *et al* (1997) [5] Eq.5.

$$Cu = 100\left(1 - \frac{\Delta q}{q}\right) \quad (1)$$

$$Du = 100\left(1 - \frac{qn}{q_{ave}}\right) \quad (2)$$

$$Ea\% = \frac{Dc}{Ds} \times 100 \quad (3)$$

where, Ea: Application efficiency (%); Dc: Average depth of water in catch cans (mm); Ds: Average depth of application as recorded by the system flow meter (mm).

$$Eu\% = 100\left[1 - \frac{1.27}{\sqrt{Nnes}}\right]\frac{q_{min}}{q_{ave}} \quad (4)$$

where, Eu = The design emission uniformity in percent; Nes: Number of point source emitters per emission point; Cv = Manufactures coefficient of variation (0.05) = q_{min}: Minimum emitters flow along the lateral line; q_{ave}= Average discharge rate of all emitters (l/h).

$$Pc\ log = 100\left(\frac{N_{cog}}{N}\right) \quad (5)$$

Sunflower Growth Parameters: Sunflower (*Helianthus annus*) was used as an indicator plant to study the effect of EM as a fertilizing material. One plant was selected randomly from each lateral to measure the growth parameters consisting of plant height (m), number of leaves per plant and stem diameter (cm).

Statistical Analysis: Analysis of data was performed using the statistical package Minitab statistical program. One factor-Analysis of Variance (ANOVA) was conducted to find the significant differences among the means [9]. The level of significant was calculated at (p<0.05) using the least Significant Differences (LSD) test [10].

RESULTS AND DISCUSSIONS

System Performance Parameters: The treatments showed positive effect on coefficient of uniformity (Cu %) (Fig. 2) whereas 100% of EM_3 recorded highest significant values ($P \leq 0.05$), while 25% of EM_1, control EM_0 and 50% of EM_2 revealed lowest values, respectively. These results may be attributed to the high viscosity of high EM concentration hence slower flow rate [6, 11]. Also, Roan, (2004) [12] stated that the Emitters with higher discharge rates clogged less than similar ones with lower discharge rates.

As reported in Fig. 2 thedistribution uniformity (Du%), emission uniformity (Eu%) and application efficiency (Ea %) values were in similar trend to the values of Cu %, however EM_1 (25%) obtained heights values of Du%, Eu% and Ea% but they don't lie under the acceptable range which as specified by Michael, (1978) [7]. This results may be due to the partial clogging of some emitters [13, 12] who stated that the partial clogging of emitters was more common than complete plugging.

Clogging Before and after Treatments: Figure. 3 revealed the reduction percentage obtained by treatments. While EM_3 (100%) which had concentration of 100% effective micro-organism recorded highest reduction (50%) of emitter clogging. Whereas EM_2 (50%) with 50% effective micro-organism concentration recorded 37% of emitter clogging reduction. And EM_1 (25%) with 25% EM recorded 24% emitter clogging reduction. This result illustrated the fact that effective micro-organisms have high potential ability in reducing clogging in emitters, due to its content of photothenthic eclectic acid and reduction

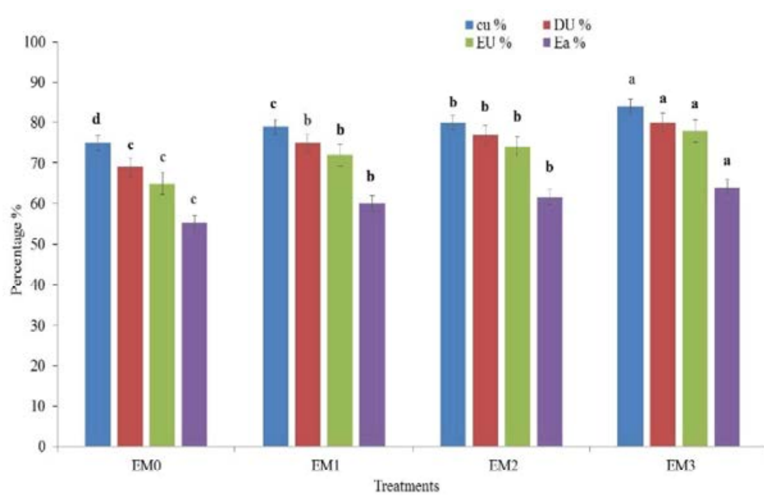

Fig. 2: Effect of EM on Coefficient of Uniformity (Cu %), Distribution Uniformity (Du %), emission uniformity (Eu %) and application efficiency (Ea %). *Means in the same letter are not significantly different at 5%.

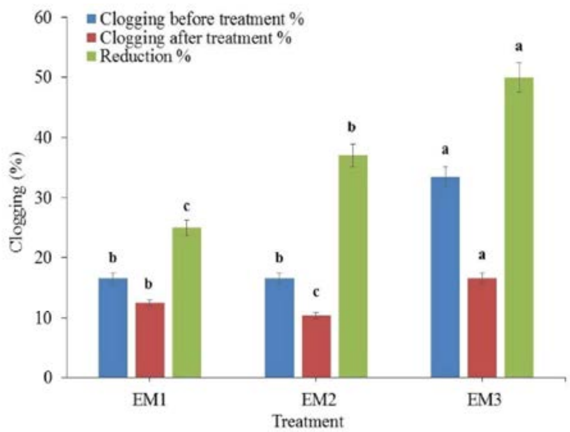

Fig. 3: Effect of EM on Clogging before and after treatment; Means in the same letter are not significantly different at 5 %.

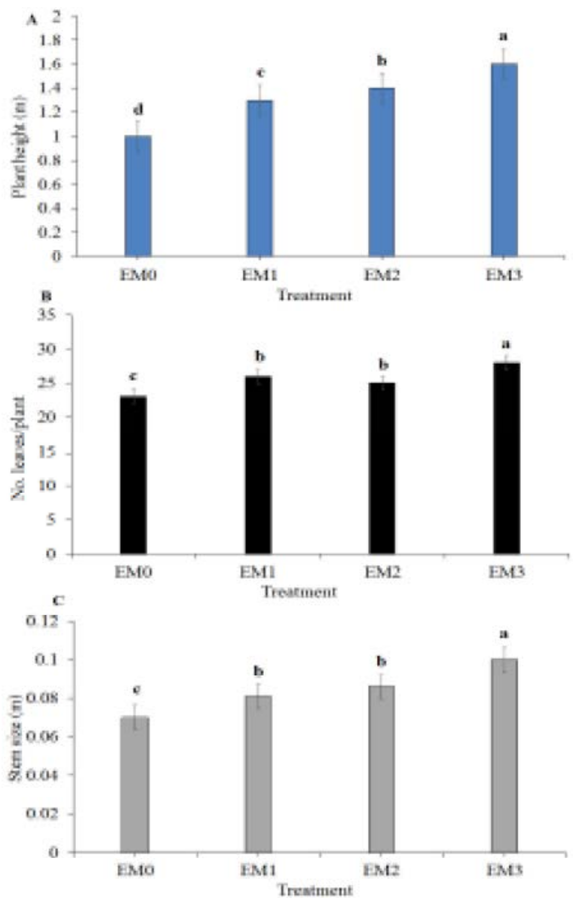

Fig. 4: Effect of EM on plant height, number of leaves per plant and stem diameter, the same letter in the same column are not significantly different at 5 %.

of emitters clogging increase with increasing eclectic acid concentration level. These resultsagreed with previous results reported by Şahin *et al* (2005) [14].

Plant Growth Parameters: Figure. 4 A shows that there were significant differences ($P \leq 0.05$) among treatments on plant height. Plant height resulted in an increased with EM_3 (100%) and giving the higher value (1.6 m). This results may be refer to that EM can be used as a fertilizer. The highest values on number of leaves per plant were produced by addition of EM_1 (25%) and EM_2 (50%) were recorded highest values (26 and 26 leaves per plant). As for EM_0 (0%) treatment (control) recorded the lowest ones (23 leaves per plant). Whereas, EM_3 (100%) had significant increasing in NLP 27 As shown in Fig. 4B. Data in Fig. 4C showed that EM_3 (100%) had significant effect on increased stem size. Neither EM_0 (0%) treatment had any significant effect on stem size. Meanwhile, EM_2 (50%) and EM_1 (25%) tended to increase stem size and being significant. The results above illustrated that EM has photothenthic eclectic acid bacteria yeasts, actenomycides fermenting fungi) that can be applied as fertilizer to increase the microbial diversity of soils this in turn can improve the soil quality and health which enhances the growth parameters.

CONCLUSIONS

Clogging of drip emitters is a common problem with significant production and cost consequences. The using of EM plays a major role in reducing and prevention emitters clogging and this reduction increases with increase in its concentration. In the same time EM has positive fertility effect for plant growth. The study recommended that, EM can be used safely in reducing emitters clogging without causing environmental problems such as water or soil pollution.

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