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Analysis of the Behavior of Drippers Fed by Pond Water Treated with Meal Powder and Almond Seeds of Moringa Oleifera

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Abstract*— *The main objective of this study is to analyze the behavior of drippers fed by pond water treated with almond powder from Moringa Oleifera seeds in a drip irrigation system. The method adopted is to carry out the clogging test of these drippers. Through an experiment at the Faculty of Agronomy of Niamey.

This test will consist of measuring the flow rates delivered by the drippers at each ramp and the pressures. The results obtained through the uniformity coefficient and the statistical analyzes of the flow rates delivered by the drippers show a homogeneity of the water distribution at the level of the different ramps and networks supplied by the treated water and the water of the Waters of Niger (NDE). The results obtained show that the flow rates measured at the drippers and ramps are homogeneous compared to those of references. The same applies to the volumes of water delivered to the drippers, various ramps and networks. The pressures at the drippers decrease as we move away from ground level. The chemical characteristics of the irrigation water were taken into account.

This study is carried out on the experimental site of the Faculty of Agronomy of the Abdou Moumouni University of Niamey. In this research work, the aim is to assess the suitability for irrigation of pond water treated with natural coagulants derived from Moringa oleifera seeds and raw water from the same pond by highlighting the a possible physical clogging of the drippers supplied by these different waters.

The methodology consists of measuring the water coming from the drippers after each irrigation. Indeed, currently, the main methods for evaluating the performance of drip irrigation systems consist of measuring the flow rate of the drippers and counting the total number of blocked drippers (Duran-Ros et al., 2009, Li et al., 2009, Puig-Bargués et al., 2010).

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I. INTRODUCTION

In arid or semi-arid regions like Niger, rain-fed agriculture, which is the driving force of the economy, remains insufficient to meet the needs of the population. Thus, partial or total control of water for irrigation purposes is an absolute necessity, to stimulate agriculture dependent on climatic hazards and improve food production through the diversification of production (BATIEBO, 2006).

Irrigation consists of supplying crops with water by artificial means, in order to enable agriculture in arid zones and to compensate for the effects of drought in semi-arid zones (FAO, 2006).

Agriculture is the largest consumer of fresh water on the planet, responsible for around 70% of all withdrawals (FAO, 2006). The gravity irrigation system is the most widely used in the world. However, this type of irrigation presents enormous disadvantages, in particular, the losses of water by evaporation and percolation which result in the reduction of the concentration of oxygen at the roots, the migration of fertilizing elements in depth constitute a probable source of pollution and salinization of the water table (BATIEBO, 2006).

With climates where the rainfall has been one year at a time for three decades, we must replace this water-wasting irrigation system with new water-saving irrigation systems which make it possible to intensify and diversify agricultural production. The drip irrigation system seems best suited to these listed constraints. Drip irrigation or localized irrigation or micro irrigation consists of applying water at a low flow rate and at frequent intervals in the vicinity of plants only by means of a dense network of pipes (MERMOUD, 2004). In Israel, drip irrigation compared to sprinkling and furrowing can increase yields by 30% with the same volumes of irrigation water (KETTAB, 2003). In drip irrigation, the quality of irrigation water is of major importance.

Indeed, drippers are particularly sensitive to clogging which substantially increases the maintenance cost of this irrigation system (Oron et al, 1991).

Also, in drip irrigation systems, the clogging of these orifices is one of the most recurring problems and therefore the most difficult to manage. According to Pitts et al (2003), this phenomenon of clogging of drippers or emitters can seriously hamper the uniformity of water application to cultivated plants. The drip irrigation emitter is a small

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mechanical device designed to dissipate pressure and constantly release a small, even flow of water.

This study is carried out in the research laboratory of the soil sciences department of the Faculty of Agronomy of the University of Abdou Moumouni in Niamey. More precisely, this will involve testing the clogging of the drippers by comparing three water sources:

- The first, called raw water, comes from the Kongou Gorou Zarmagandey (KGZ) pond;
- The second comes from the treatment of Moringa Oleifera seeds in water with almond powder;
- Finally, the third is tap water (i.e. SEEN water).

II. MATERIAL AND METHODS

Dripper clogging and/or clogging test Choice of drippers

In a drip irrigation system, the drippers must have a very minimal flow section at the outlet, the diameter of which varies between 0.25 to 1 min, therefore sensitive to blockage according to Keller et al., (1983). In this study, the dripper chosen is a simple NETAFIM dripper (see appendix 9) at very low pressure (0.15 to 0.20 bar) delivering a flow rate of 1l/h and has a low hydraulic exponent equal to 0.6. According to Filali (2010), in a drip irrigation system, it is recognized that the dripper having a low hydraulic exponent (< to 1) is not very sensitive to temperature, so our dripper meets this condition.

In this dripper clogging test, we chose a dripper with a flow rate of 1l/h for 3 reasons:

- For good diffusion of water in the ground, it is recommended to choose drippers with low flow rates of 1l/h to 2l/h;
- The dripper clogging test requires a low flow rate so that the dripper orifices are blocked within a period of time, especially with charged water such as surface water (Filali., 2010);
- High flow drippers reduce the risk of clogging and/or blockage and increase the risk of water percolation into the soil and leaching of nutrients. (Filali., 2010)

III. EXPERIMENTAL DEVICE

The test on the study of clogging of drippers in a drip irrigation system consists of testing the drippers for distributing irrigation water using an experimental device. The emitter (dripper) clogging test consists of measuring the nominal flow rate of 72 drippers. Three (3) irrigation water sources supplying three drip irrigation networks, namely: R1, irrigation network receiving raw water from the Kongou Gorou pond (EB), R2, network supplied by the water resulting from the treatment with almond meal (EPA) and R3 the water resulting from the treatment of raw water with almond meal powder (EPT) watering the network.

At the level of each ramp holder, 4 ramps, each 7m long, are connected to it. These booms are each equipped with 6 drippers spaced 0.5m apart with a nominal flow rate of 1l/h and numbered from 1 to 6. The spacings between booms are also spaced 0.5m apart. Given that the soil of the study site has a sandy texture, the recommended spacings in a drip irrigation system are 15 to 50 cm (Boswell., 1985). The drippers are integrated into the booms to deliver a nominal flow rate of 1l/h under a pressure of 0.12 bar.

At each dripper, a cylindrical hole 10 cm in diameter and 42 cm deep was dug. In each hole, there is a 1.5l bottle fitted with a funnel to collect the water coming from the dripper during irrigation. As irrigation management takes place during the rainy season, each network is covered with a 24 m2 black plastic sheet to prevent disruption during possible rain.

For water treatment tanks with natural coagulants derived from Moringa oleifera, they are also protected by this 1 m2 black plastic. The feed water for networks R2 and R3 comes from the treatment tanks. 20cm from the bottom of each of them is placed a tap (valve) to transfer the treated water into the supply tanks (EBR1, ETR2 and ETR3).

The raw water treatment tanks are placed 2m from the ground. A 1.5m high platform is set up to facilitate stirring of the water-flocculant mixture. 20cm from the bottom of the treatment tank, a tap is placed to transfer the treated water into the irrigation water supply tank. The implementation of the experimental device was carried out in accordance with the art:

The entire land has been well leveled using a level, the irrigation water supply tanks are positioned at the same level in relation to the natural land and are all placed at 0.32 m from ground level. well planned. The essential components of the experimental setup are summarized in Table 1.

Table I: Summary of the components of a network of the experimental device

Repetition	Reservoir	Valve	Ramp holder	Ramp	Dripper
1	1	1	1	1 to 4	1 to 6
2	2	2	2	1 to 4	1 to 6
3	3	3	3	1 to 4	1 to 6

The dripper clogging and/or clogging test will be carried out in two (2) main stages:

- The first step consists of triggering a series of 5 successive irrigations of 1 hour at respective water heights h1, h2, h3, h4 and h5 in the tank with water treated with almond powder and Moringa almond cake oleifera and raw water from the Kongou Gorou Zarmagandey pond, this constitutes a repetition and we repeat these irrigations 4 times giving a total of 20 irrigations for each network. These four repetitions and the irrigations to compare are summarized in table2:

Table II: Summary of irrigations according to height and

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repetition

`	Water height in the tank				
	h1	h2	h3	h4	h5
	Irrigation				
Rep1	1	2	3	4	5
Rep2	6	7	8	9	10
Rep3	11	12	13	14	15
Rep4	16	17	18	19	20

An irrigation rehearsal lasts approximately 2.5 hours, including 1 hour of irrigation itself and 1.5 hours dedicated to the different measures at the level of 3 irrigations networks.

From the 1st to the 20th irrigations, we will always determine the volume of irrigation water for:

- The 3 networks (24 drippers).
- The second step consists of detecting possible clogging and/or blockage at the level of the drippers.

At the level of the drippers: given the number of drippers on all the networks (72) and that of irrigations (20 in total), we chose to follow drippers 1, 3 and 6 of ramps 1 and 3 of each network. Remember that dripper 1 is at the head of the boom, dripper 3 in the middle and 6 at the end of the boom. In addition, 3 heights were considered for the measurements, these are h1, h3 and h5.

If clogging of the drippers is identified, this clogging will need to be checked at two (2) successive levels:

Checking clogging at the ramps: in each network, 2 ramps out of 4 will be the subject of study in this test: these are ramps 2 and 4. Regarding the height of water in the tank, 3 heights out of 5 were taken, these are h1, h3 and h5. The methodology adopted is for a given water height and a given ramp, it involves comparing the volumes of water obtained during irrigation with treated water and raw water to the reference volume of the ramp considered.

After comparison, there is clogging and/or blockage if during irrigation with treated water or raw pond water, the volumes of irrigation water obtained at the level of the ramps differ significantly from the reference volumes of the ramps where irrigations were carried out beforehand with water from the NDE network.

IV. RESULTS AND DISCUSSION

This involves comparing the data obtained during irrigations carried out with treated water and raw water with the data from reference irrigations with water very suitable for drip irrigation, namely that of the network of the SEEN.

Evaluation of water volumes from network drippers according to the height of water in the reservoir.

The table 3 gives the average water volumes obtained from drippers 1, 3 and 6 of booms 2 and 4 depending on the treatments at heights h1, h3 and h5. According to this table and for a given water height, we see that the average water volumes of the drippers are identical for the treatments with almonds (Amd), almond cake (Trt) and SEEN which differ significantly from the average volume obtained with raw water. This difference ranges from 601.875ml (EB) to 722.50ml (Trt) for water height h5; from 775.417ml (EB) to 855.292ml (Amd) for the water height h3 and from 766.250ml (EB) to 910.292ml (Amd) for h1. On the other hand, the average volumes of these drippers as a function of water height in the tank are not identical and vary by decreasing from one height to another. These averages are 688.146ml, 828.431ml and 866.240ml respectively for heights h1, h3 and h5 (Table 3).

Table III: Results of the statistical analysis of average water volumes obtained from drippers 1, 3 and 6 of booms 2 and 4 depending on the treatments at heights h1, h3 and h5

Modality	Estimated average	Groups				
H0,155*EB	601,875	A				
H0,155*Amd	713,750		B			
H0,155*NDE	714,458		B			
H0,155*Trt	722,500		B			
H0,53*EB	766,250			C		
H0,336*EB	775,417			C		
H0,336*Trt	830,417				D	
H0,336*NDE	852,597				D	
H0,336*Amd	855,292				D	
H0,53*Trt	890,417					E
H0,53*NDE	898,000					E
H0,53*Amd	910,292					E

NB EB: Raw Water; Amd: Almonds; NDE: Niger Society of

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Water and Trt: Oilcakes

The table 4 illustrates the statistical analysis of average water volumes of drippers 1, 3 and 6 of booms 2 and 4 as a function of water height in the tank.

Table IV: Statistical analysis of average water volumes of drippers 1, 3 and 6 of booms 2 and 4 as a function of water height in the tank

Modality	Estimated average	Groups		
H0,155	688,146	A		
H0,336	828,431		B	
H0,53	866,240			C

The volumes of irrigation water delivered depend on the height of the water in the reservoir. In fact, the greater the height, the greater the volume. In descending order of height, the volume decreases from one height to another. And the pressure that can be deduced from the water levels in the reservoir does not play a direct role in the physical clogging of the drippers.

Table 5 gives the comparison of the water volumes of ramps 2 and 4 as a function of the height of water in the tank. It appears that whatever the height considered, the p value is less than 0.0001 indicating a very significant difference in the volumes of water obtained with the heights considered.

Table V: Comparison of the water volumes of ramps 2 and 4 depending on the heights

Contrast	Pr > Diff	Significant
H0,155 vs H0,53	< 0,0001	Yes
H0,155 vs H0,336	< 0,0001	Yes
H0,336 vs H0,53	< 0,0001	Yes

The table 6 illustrates the average water volumes of drippers 1, 3 and 6 recorded at booms 2 and 4. The latter experienced a significant variation ranging from 775.77ml (G3) to 823.767ml (G6). It should be noted that there is no significant difference between drippers 1 and 3 but the water volumes of these drippers differ from that of dripper 6.

Table VI: Statistical analysis of average water volumes delivered by drippers 1,3 and 6 all heights combined confondues

Modality	Estimated average	Groups	
G3	775,771	A	
G1	783,278	A	
G6	823,767		B

From this table 6, we see that dripper 6 delivers more water compared to drippers 1 and 3.

This difference in water volumes recorded at these drippers would be due to their position on the ramp. In fact, drippers which are at the end of a ramp hydraulically deliver more water compared to others.

The table 7 gives the 2 to 2 comparison of the volumes of water delivered between booms 1, 3 and 4. It appears that the p values are less than 0.05 because all equal to 0.0001 for drippers 3 and 6, then drippers 1 and 6. Which means statistically that there is a very significant difference in the volumes of water obtained with these drippers. On the other hand, considering drippers 1 and 3, the p value is equal to 0.298 and is greater than 0.05. So the two drippers delivered approximately the same volumes of water.

Table VII: Comparison 2 to 2 of the volumes delivered by drippers 1,3 and 6

Parameters	Difference	Pr > Diff	Significant
G3 vs G6	-47,997	< 0,0001	Yes
G3 vs G1	-7,507	0,298	No
G1 vs G6	-40,490	< 0,0001	Yes

The table 8 gives the average water volumes from drippers 1, 2 and 3 recorded at booms 2 and 4 depending on the treatments. It appears from this table that there is no significant difference in the volumes of water obtained from the tasters of the almond cake (Trt) and almond (Amd) treatments which are equal to the reference water volumes. NDE. However, the three volumes differ from the volumes obtained during irrigation with raw water (EB). They vary significantly from 714.51ml (raw water) to 826.44ml (NDE).

Table VIII: Average volumes of water delivered by drippers according to treatments, all heights combined

Modality	Estimated average	Groups	
EB	714,514	A	
Trt	814,444		B
NDE	821,685		B
Amd	826,444		B

The table 9 gives the 2 to 2 comparison of the volumes of water obtained from drippers 1, 3 and 6 in relation to the treatments.

From this table, it is remarkable, when comparing the EB-NDE, EB-Trt and EB-Amd treatments, that the p values are without exception less than 0.0001 therefore less than 0.05 thus showing a very significant difference between these treatments. This indicates that the average water volumes of three (3) treatments (Trt, NDE and Amd) compared 2 to 2 with that of raw water (EB) are not identical. From the results of the multiple comparisons, it is noted that the average obtained for the EB treatment is the only one to be significantly lower than that of three other treatments.

On the other hand, considering the Amd-NDE, Amd-Trt and Trt-NDE treatments, the respective p values are 0.523; 0.189 and 0.331 therefore all greater than 0.05. Which means that there is not a significant difference between the volumes

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obtained with these treatments, in other words, their volumes are statistically identical.

Table IX: Comparison 2 to 2 of the volumes of water obtained from drippers 1, 3 and 6 in relation to the treatments

Contrast	Pr > Diff	Significant
EB vs Amd	< 0,0001	Yes
EB vs NDE	< 0,0001	Yes
EB vs Trt	< 0,0001	Yes
Trt vs Amd	0,189	No
Trt vs NDE	0,331	No
NDE vs Amd	0,523	No

These various statistical results confirm the physical clogging of the drippers fed by raw water and the non-clogging of the latter by using pond water treated with almond powder and *Moringa oleifera* cake during irrigation.

V. DISCUSSION

Irrigations with water treated with almond cake powders and with raw water from the Kongou Gorou Zarmagandey pond were carried out in the present study to analyze the behavior of drippers supplied with water treated with natural coagulants. The latter are almond powders and almond cakes from Moringa olifera seeds.

As for the booms, it appears that booms 2 and 4 supplied by water treated with almond cake and almonds gave volumes of irrigation water identical to those of the reference booms. This indicates the good quality of this irrigation water used in the different networks. This required good water quality through the treatments undergone is manifested by the proper functioning of the networks showing no physical clogging of the drippers due to the volumes obtained during irrigation.

On the other hand, we note a clear malfunction of ramps 2 and 4 supplied by raw water from the pond which results in a significant reduction in the volumes of irrigation water compared to the reference volumes of the respective ramps of the NDE. However, according to Capra et al., (2005), the clogging of the drippers leads to a significant reduction in the average flow rate as well as a reduction in the uniformity of flow rates along the ramp.

In the present study, the clogging of the drippers observed cannot have a chemical origin because no fertigation was carried out during irrigation and the percentage of NaCl is very low (0.1%). It cannot, either, be due to the characteristics of the drippers, to the geometric parameters of the flow path, less to the frequency of irrigation or the biological aspect of the water used, otherwise we would have noticed it with the others networks supplied by water treated with products based on *Moringa oleifera*. This clogging would probably be due to the presence of suspended or dissolved matter in the raw water of the pond.

Turning now to the networks, it appears that the networks supplied by water treated with almond cake and almonds are statistically identical to the NDE reference networks and differ from the network supplied by raw water. Considering for example the height of water in the reservoir h5 = 0.155m and the 15th irrigation, the difference in terms of quantity of water between the almond cake network and the reference network (supplied by water from the NDE) is 0.11 to 0.22%. On the other hand, this difference is 15.55% between the reference network and raw water network. For the 20th irrigation and at the same water height, the difference between networks with water treated with moringa-based products and the reference network still remains very low (0.16 to 0.19%).

Considering the height h3= 0.336m and the 18th irrigation, the differences recorded between the water volumes of the networks supplied by treated water (Trt and Amd) and the reference network on the one hand and between the reference network and the raw water network on the other hand are respectively from 0.04% to 0.14% and 15.52%; but the relative difference in water volume between the reference networks and raw water increases to reach 26.53%. It clearly appears that the differences in water volume between the reference networks and raw water are observable whatever the pressure considered.

The absence of physical clogging of the networks supplied by treated water testifies to the effectiveness of Moringa oleifera seed derivatives in the treatment of surface water as highlighted by Mougli et al., (2005). The results of our work also match those obtained by Diallo in Guinea Conakry (2008), Siddo (2018) in Niger, Koto-té-Nyiwa (2015) in the Democratic Republic of Congo (DRC), Fatombi (2007) in Benin and of Emilie et al., (2007) in Mozambique.

VI. CONCLUSION

The aim of the present study was to investigate the feasibility of drip irrigation with water treated with coagulants derived from Moringa oleifera seeds. Tests on irrigation with this water and raw water from the Kongou Gorou Zarmagandey pond were carried out under different pressures. Irrigation carried out with networks supplied by water treated with almond cake powders does not show any physical clogging or blockage of the drippers. Indeed, drippers 1, 3 and 6 chosen at ramps 2 and 4 of each network delivered flow rates identical to the respective reference flow rates obtained during irrigation with NDE water whatever the water height. in the reservoir considered. This demonstrates the good quality of this treated water and illustrates the effectiveness of two natural coagulants from Moringa oleifera seeds in the treatment of generally cloudy surface water. On

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the other hand, the irrigations carried out at the level of the network supplied by raw water from the pond, show a clear dysfunction of the latter by recording a significant reduction of the order of 15.52 to 26.53% volumes of irrigation water at the level of 3 drippers for all water heights in the tank considered. The use of raw water from the Kongou Gorou pond in drip irrigation in such a short time causes the drippers to clog and is also verifiable at the level of the ramps and the network made up of 24 drippers.

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