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Research Article

EFFECT OF DRIP IRRIGATION AND MULCHING METHODS ON SOIL PROPERTIES IN AONLA (*Emblica officinalis* Gaerth) ORCHARD ESTABLISHED ON SODIC LAND

MOHD SUHAIL*, VISHWAKARMA S.K. AND BISEN P.K.
ICAR-Krishi Vigyan Kendra, Lakhimpur Kheri, 262802, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, 208 002 Uttar Pradesh India
*Corresponding Author: Email-drsuhail.lmp@gmail.com

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Abstract: A field experiment was conducted with view to find out of the influence of four irrigation regimes and three mulches on soil properties, microbial and earthworm population in anole (*cv*. NA-10) orchard. The most important physical property *i.e*., bulk density (1.45) and chemical properties pH (8.18), ESP (24.29), ECe (3.01) were significantly reduced in paddy straw mulching and increased the hydraulic conductivity (0.28), available nitrogen (237.90) kg/ha, organic carbon (0.35), C:N ratio (25.22), fungal (136.94), bacterial (8.72) and earthworm (22.57) population drip irrigation at I_1 (IW/CPE=1.0) regime significantly improved the hydraulic conductivity (0.22), available nitrogen (225.09) and number of bacteria(8.13) and earthworm (22.43). Application of water at I_1 (IW/CPE=1.0) significantly decreased the soil pH (7.98), ESP (24.98), ECe (3.15). The fungal colonies were recorded maximum (210.27) in I_3 (IW/CPE=0.6) irrigation treatment. Significantly highest available nitrogen was recorded in I_1 irrigation regime coupled with paddy straw (M_2) mulch. Interactive effect of I_3 M_2 and I_2 M_2 treatment combination proved beneficial improving the soil fungal and bacterial population.

Keywords: Aonal, Drip, Mulches, Soil, Fungi, Bacteria, Earthworm

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Introduction

Aonla or Indian gooseberry (*Emblica officinalis* Gaerth) thrives well in the varied climate and soil conditions in the country. In recent years, its cultivation is increasing rapidly particularly in salts affected soils (sodic, saline) and also in the ravines areas in the country. Poor organic matter content and moisture stress are the major limiting factors on problem soil [1]. Drip irrigation couple with mulching can play an important role in conserving soil moisture, reducing soil erosion, improving soil structure, regulating soil temperature and controlling weed population. Continuous uses of organic mulches are also helpful in improving physico chemical and soil biological properties. Few attempts on water economy and soil properties through drip irrigation and mulching have been attempted in aonla orchards. The present investigation was desired to find out the effect of drip irrigation and mulching on physico chemical and biological properties of the soil [2].

Material and Methods

The present investigation was conducted on 72 plants of aonla cultivar NA-10 was planted at a distance of 8x8 meter. The two-year observation has been period and analyzed by factorial Random Block Design with having three replications. The detail of treatment and their combination are given in Table (1). The soil of the experimental site was sodic with low fertility and poor water holding capacity. The initial soil character is given in Table-2. The soil samples for analysis were collected from basin of the plant at 0-25 cm depth with the help of screw auger.

Moisture regime

Water was applied by drip method, scheduling based on pan evaporation. The evaporation was daily recorded from the Department of Metrology with the help of class "A" Pan evapo-meter. The amount of water was computed at the ratio of IW/CPE at third day interval as per the following formula:

$$\text{Quantity of water (liter)} = \frac{\text{Size of basin (m2)} \times \text{depth of irrigation (cm)} \times \text{pan evaporation (mm)}}{100}$$

Mulching: Black polythene sheet of 400 gauge of 4x4 m2 size was unrolled on the surface of tree basin with their corners and site stitched. Paddy straw @ 20 kg per plant basin (app. 10 cm thick) was spread uniformly and there was no mulching in control treatment. Mulches were placed after weeding, fertilizer application and irrigation.

Observation: Observation pertaining with physical and chemical properties was recorded as per established procedure shown in Table (2). The earth warm populations were counted on soil surface to 15 depths.

Isolation of microorganisms was performed in all treatments separately by dilution plate technique. The fungal populations were counted with one ml of finally diluted soil sample plated on Mortine agar medium. After inoculation, the part dishes were incubated in BOD incubator at 25+2^{0}C for a period of one week to allow fungal growth (colonies). The number of genera of darkly pigmented and none pigmented colonies were counted with the help of colony counter daily from the first appearance of the colony after a week of incubation. The bacteria population were recorded by potassium orthophosphate (0.2 g) + $CaCO_3$ (0.5g) + Glucose (1.0 g) + Agar (20.0g). All the procedures like dilution etc. done under aseptic condition of laminar flow with UV lamp. After inoculation, the plate kept in BOD incubator at 25+ 2^{0}C for a period of one week to allow development of bacterial colony and counted manually daily. The number of bacteria per gram of dry over soil was calculated by following formula:

Bacteria per g of dry soil= Average count x dilution / Dry weight of one g of moist soil

Table-1 *Detail of treatments and their combination*

SN	Factors	Treatments	Notation	S.No.	Treatment Combinations	Notation
1	Irrigation regime	IW/CPE=1.0	I_1	1.	IW/CPE=1.0+BP	I_1M_1
		IW/CPE=0.8	I_2	2.	IW/CPE=1.0+PS	I_1M_2
		IW/CPE=0.6	I_3	3.	IW/CPE=1.0+Control	I_1M_3
		IW/CPE=0.4	I_4	4.	IW/CPE=0.8+BP	I_2M_1
2	Mulching method	Black polythene (B.P.)	M_1	5.	IW/CPE=0.8+PS	1_2M_2
		Paddy straw (P.S.)	M_2	6.	IW/CPE=0.8 Control	1_2M_3
		Control (no mulching)	M_3	7.	IW/CPE=0.6 BP	1_3M_1
				8.	IW/CPE=0.6+PS	1_3M_2
				9.	IW/CPE=0.6 Control	1_3M_3
				10.	IW/CPE=0.4 BP	1_4M_1
				11.	IW/CPE=0.4+PS	1_4M_2
				12.	IW/CPE=0.4 Control	1_4M_3

Table-2 Soil characters before the experimentation

Particular	Experimental value	Method of analysis
Physical properties		
Mechanical analysis		Black, (1965) [1]
Sand (%)	38.25	
Silt (%)	41.90	
Clay (%)	16.55	
Texture class	Silty loam	
Field capacity (%)	20.40	Pressure plate
Bulk density (g cc^{-1})		Richard, (1954) [12]
0-30 cm	1.42	
30-60	1.49	
Hydraulic conductivity (cm hr^{-1})	0.16	Method no. 30(b) USDA HBK No-6
Chemical properties		
Organic carbon (%)	0.21	Jackson, (1973) [9]
Soil reaction(P_H)	8.86	Jackson, (1973) [9]
Electrical conductivity (m mhos. / cm at 25°C)	3.7	Richard, (1954) [12]
Exchangeable sodium percentage	30.49	Bower *et al*, (1952) [3]
Soluble ions (me l^{-1}) (me L^{-1})		Richard, (1954) [12]
Carbonate (Co_3^{--})	16.89	
Bicarbonate (Hco_3)	9.70	
Available Nitrogen (Kg/ha.)	169.65	Jackson, (1973) [9]

Table-3 *Effect of drip irrigation regimes and mulching methods on physical and chemical properties of soil on aonla c.v.NA-10*

S.No.	Treatment	Physical		Chemical properties					
		Bulk Density (gcc^{-1})	Hydraulic Conductivity (cm hr^{-1})	pH	ECe (%)	ESP	Organic carbon (%)	Nitrogen ($kgha^{-1}$)	C:N ratio
a).	Irrigation Regimes								
i)	I_1(IW/CPE= 1.0)	1.53	0.22	7.98	3.15	24.98	0.28	225.09	20.95
ii)	I_2(IW/CPE=0.8)	1.53	0.21	8.31	3.57	25.21	0.27	218.90	21.09
iii)	1_3 (1W/CPE=0.6)	1.54	0.21	8.34	3.24	25.83	0.26	212.34	21.20
iv)	1_4 (IW/CPE=0.4)	1.54	0.20	8.36	3.32	26.36	0.25	204.29	21.54
	CD at 5%	0.015	0.005	0.048	0.111	0.844	NS	5.747	NS
b).	Mulching								
i)	B.P.(M_1)	1.58	0.18	8.27	3.15	25.45	0.22	211.02	17.98
ii)	P.S. (M_2)	1.45	0.28	8.18	3.01	24.9	0.35	237.92	25.22
iii)	Control (M_3)	1.58	0.18	8.29	3.53	26.43	0.23	196.54	20.39
	CD at 5%	0.013	0.004	0.070	0.096	0.731	0.033	4.977	2.02
c).	Interaction I X M	NS	NS	NS	NS	NS	NS	NS	NS

Results and Discussion

Data presented in Table (3 & 4) showed interesting responses with respect to physio – chemical and biological properties. Mulching with paddy straw significantly decreased the bulk density (1.45 g cc-1) and increased the hydraulic conductivity (M2=0.28) followed by black polyethylene and control. The interaction effect of mulching and irrigation regimes showed non-significant variations.

Decrease in bulk density with organic mulches in banana has been observed by Obiefuna, (1991) [1]; and in apple and grape by Pianmonti, *et al*., 1995) [3]. It is evident from Table (3) that drip irrigation at I_1 (IW/CPE=1.0) regime significantly reduced the soil pH (7.98), ESP (24.98), ECc (3.15). This is because of high moisture regime, which might have help in leaching of soluble exchangeable ions. There result in accordance with the Singh, *et al*., (1990) [4].

It is also apparent from the perusal of Table (3) that mulching with paddy straw (M_2) recorded higher organic carbon content and resulted significantly in reducing of the soil pH (8.18), ESP (24.92), ECe (3.01), by polythene mulch (M_1) and control (M_3). Organic carbon is an important component of the soil, because it influences cation exchange capacity, water retention, soil structure and ecology of the soil. Reduction in soil pH by paddy straw (M_2) was because of its acidic effect after decomposition of straw. This is accordance of observation with Borthakur and Bhattacharya, (1992) [5]. Irrigation and interaction with mulches could not significantly affect the soil organic carbon, while paddy straw mulch exhibited significant increase in the organic carbon (0.35), due to addition of organic matter in the soil. Borthakhur and Bhattacharya, (1992) [5], Salau, *et al*., (1992) [6] also reported that increasing in organic carbon with organic mulching. From the observations it is clear that irrigation regime, mulching and their interaction significantly influenced the nitrogen content in the soil. Available nitrogen (225.09kg/ha) was maximum in I_1 (IW/CPE=1.0) treatment. Elfving, (1982) [7] reported that trickle irrigation increased the nutrient up take of soil because nutrients move into the wetted volume in manner consistent with the flux of water in the soil. Among the mulching treatments, paddy straw (M_2) showed significant in soil nitrogen (237.92 kg/ha) organic mulches improved nitrogen availability due to addition of organic matter. Similar effect of organic mulches on soil nitrogen content was reported in mandarin [8] banana, [1] apple and grape [3]. The two favorable conditions, irrigation regime I_1 (IW/CPE=1.0) and paddy straw (M_2) mulching showed maximum available soil nitrogen (257.74kg/ha) followed by I_2M_2, I_3M_3, I_1 M_1 treatment combinations. Paddy straw mulching significantly affected the C: N ratio. The effect of mulching on the soil with paddy straw increased humus content and reduced combustion losses.

Table-4 *Effect of drip irrigation and mulching on fungal, bacterial and earthworm population*

S. No.	Treatments	Fungal ($000g^{-1}$ of soil)	Bacteria (Mg-1 of soil)	Earthworm (Per 0.15 m^3)
a).	Irrigation regime			
i)	I_1 (IW/CPE=1.0)	70.39	8.13	22.43
ii)	I_2 (IW/CPE=0.8)	80.06	6016	20.35
iii)	I_3 (IW/CPE=0.6)	210.27	5.35	19.09
iv)	I_4 (IW/CPE=0.4)	128.67	3.99	17.83
	CD at 5%	11.352	0.538	1.652
b).	Mulching			
i)	Black polyethylene(M_1)	122.78	5.83	17.31
ii)	Straw (M_2)	136.94	8.72	22.57
iii)	Control (M_3)	100.58	3.18	19.91
	CD at 5%	9.832	0.470	1.429
c).	Interaction I X M	19.662	0.937	NS

Data presented in Table (4) suggest that the soil fungal and bacterial population were significantly affected by irrigation regimes and mulching method and their interaction. Maximum fungal (210.27) and bacterial (8.13) colonies were found in 13(IW/CPE=0.6) and I_1 (IW/CPE=1.0) irrigation level, respectively. Maximum fungal colony was occurred at 15-20% moisture holding capacity and is decreased with increase in moisture content [9]. The bacterial population was maximum (I_1) treatment. It is attributed to soil moisture at IW/CPE= I_1 would be appropriate for bacterial growth [10]. Total number of fungal (136.94) and bacterial (8.72) colonies were positively affected by paddy Straw (M_2) mulching, with increased level of organic content and helped in water retention on as well as maintained favorable temperature throughout the period. Among the different treatment combinations, the fungal and bacterial population was recorded in 1_3M_2 and I_2M_2 treatment combination, respectively. The earthworm population was significantly affected by irrigation regimes and mulches (Table-4). The earthworm population tends to increased (22.43) significantly at higher moisture regime (I_1). It might be major environment variable like temperature and moisture which affects the earthworms [2]. Mulching with paddy straw (M_2) significantly increased the earthworm population (22.57) followed by control (M_3) and polyethylene (M_3) mulching. Paddy straw (M_2) mulching maintains proper moisture, temperature, provides ample food sources and reduced tillage throughout the experimentation [11-15].

Application of research: Drip irrigation effect to regulate supply of water through period, which effect regular availability of soluble nutrient nearby root zone. Mulching of organic or inorganic substance effect on conversing moisture, increasing microbial population, suppress weed population etc. conservation natural resources.

Research Category: Drip Irrigation and Mulching

Abbreviations:
IW: Depth of Irrigation Water (cm), CPE: Cumulative Pan Evaporation (mm),
BP: Black Polythene, PS: Paddy Straw

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***Research Guide or Chairperson of research: Dr R. K. Pathak**
University: Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, 208 002 Uttar Pradesh
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