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STUDY OF THE MOVEMENT OF MOISTURE AND NITROGEN CONCENTRATION IN SOIL WITH DRIP IRRIGATION SYSTEM IN OKRA CROP

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Abstract

For producing healthy and fresh vegetables typically calls for utilization of irrigation water and fertilizer (N) in large quantity. Joined utilization of high rates of water and N prompts intemperate draining of nitrogen, making the majority of it inaccessible to plants. The study is accomplished in the experimental fields of Punjab Agricultural University, Ludhiana with sandy loam textured soil. Three different irrigation treatments (60, 80 and 100 percent of evapotranspiration in okra crop) and fertigation schedule (60, 80, and 100 percent of recommended dose of fertilizer (92 kg N ha^{-1})) are provided using drip irrigation. The depths used for study included 0-15cm, 15-30cm and 30-45cm for estimating the moisture and nitrogen pattern. The outcomes of the experiment showed that the maximum soil moisture is retained the 15-30 cm layer and was observed for a combination of 60% ETc and 60% RDF for 30, 60, 90 and 120 days after sowing. Similarly combination of 60% ETc and 60% RDF had maximum nitrogen percentage after 2 and 4 hours of fertilizer application. Concluding that drip irrigation causes the maximum retention of soil moisture in the root zone of okra.

Key words: soil moisture, irrigation, nitrogen leaching and okra

Introduction

Limited water resources and pollution of soil due to excess use of agricultural chemicals and fertilizers are the main concerning issues of agriculture in India (Serpil 2012). The per unit availability of consumable water seems lessening every year subsequently causing more prominent pressure on accessible water assets. With the gross developed region of 172 Mha in India, just 37percent (65 Million hectare) is irrigated using water irrigation systems (Tiwari *et al.,* 2010). The sum total of yearly utilizable volume of water asset is evaluated to be 112.23 Million hectare meter, out of which just 70.05Million hectare meter is being used for irrigation purposes. Regardless of whether the whole accessible water is used for irrigation utilizing present techniques, about half of developed territory will remain rain sustained, as gigantic amount of water is squandered due to evaporation and seepage, having a low count on efficiency ranging between 40 - 55% only.

The conventional surface water system strategies incite issues identified with water, soil and ecological imbalance. These strategies are driven by supply as opposed to crop requirement, which cause ambiguity within the requirement of crop and amount which is provided. A more noteworthy bit of inundated range with application on the surface techniques, follows a low water application efficiency. On the other hand drip irrigation is able to achieve higher field level application efficiency of about 80-90%, as losses which include minimizing percolation to the deeper layers of soil and runoff from the soil surface to a greater extent (Postel, 2000 and Heerman *et al*., 1990). Therefore irrigation with the help of drip system helps in greater crop production with unit water application, and aids growing of crops in areas with scares water available for irrigation.

Admist various different elements required for the development and growth of plant, nitrogen (N) is believed to be the essential fertilizer element provided to the soils as the demands for N are greater in comparison to the demands of potassium (K), phosphorous (P), and other necessary nutrients required by the plant. However, dissolving power of nitrate (NO_3) fertilizers are high in water and causes speedy movement within soil. Within the different N losses in agricultural fields, leaching is counted as an important source of NO_3-N loss within standard agricultural practices (Allison 1966). The depths of the roots, its densities, requirements of water, and efficiencies of plant to uptake nutrients differ with the crop. (Peterson and Power 1991). The downward movement of NO_3-N into higher depth of soil profile relies upon the cropping pattern. Along with the supply of N composts and water provided through water irrigation or by rainfall, kind of water application system and physical properties of soil assume an imperative part in NO_3-N leaching to under groundwater.

Drip irrigation along with fertigation ensures an efficaciously in manner and cost for application of nutrients and water to plant (Bar Yosef, 1999). Application of fertilizer with irrigation helps in delivering of readily dissolvable chemicals and different fertilizers accompanied by irrigation water, in a uniform manner and in a more efficient way (Narda and Chawla 2002, Patel and Rajput 2000). The mainstream fertilizers like urea also has easy application with the help of drip irrigation. Dribble water system with fertigation offers the likelihood of definitely setting water system water and supplements to the crop within the plant root zone to upgrade the agrarian generation, proficiency of water use along with supplement use effectiveness. Wetting design close to the yield within the soil and the movement of water in the soil, matric possibilities and manure focuses are reliant basically on soil pressure driven properties, producer discharge rate, distribution, water system sum and recurrence, root dispersion structure and plant water up-take rate (Gardenas *et al.,* 2005). Superior data of interdependencies of water application methodologies, type of soil, plant roots appropriation, take-up examples, application rates of water and composts gives better comprehension of smaller scale water system and water the management practices (Hopmans and Bristow 2002). An effectively structured dribble fertigation framework give water and supplements at a rate and recurrence, that advances edit water and supplement take-up, likewise lessening filtering of supplements and synthetic concoctions within the root area in agrarian lands(Gardenas *et al.,* 2005).

Material and Methods

Location Details

The research farm of Soil and Water Engineering department, PAU, Ludhiana, India was chosen for conducting experiment (Longitude 75° 52’ E, Latitude 30° 56’ N and height above mean sea level is 274 m). The mean yearly rainfall of Ludhiana is 680 mm majority of which is experienced in the season of monsoon. The mean annual precipitation for the previous five years was nearly 434.1 mm. The climate of this region is typically monsoon

Soil Texture

Table 1: Soil textural details of the site

Depth of soil (cm)	Percentage (%)			Texture
	Sand	Silt	Clay	
0-15	70.74	18.21	11.04	Sandy loam
15-30	70.03	18.17	11.80	Sandy loam
30-45	70.36	18.24	11.40	Sandy loam

Experimental Design / Layout

Layout of the experiment choosen is Randomized Block Design (RBD) consisting of nine treatments with three replications mainly. Standard culture pattern for okra crop cultivation were adopted according to the recommendations (Singh *et al,* 2007).

Treatments for Irrigation

Irrigation regime was scheduled on the basis of crop evapotranspiration values. The evapotranspirational requirements of okra crop was derived by the multiplication of the crop coefficient with potential evapotranspiration. The Penman Montheith Method was used for the calculation of potential evapotranspiration. Irrigation treatments used in this experiment include

60 percent of crop evapotranspiration (I_1)
80 percent of crop evapotranspiration (I_2)
100 percent of crop evapotranspiration (I_3)

Treatments for Fertigation

The fertigation regime used for the experiment comprised of different fertilizer treatments derived on the basis of suggested fertilizer dosage (92.4 Kg/ha) and different irrigation degrees computed by crop evapotranspiration. The application of fertilizer was done in 17 splits. The different fertigation treatments used for this experiment included

60 percent of recommended dosage of N fertilizer (F_1)
80 percent of recommended dosage of N fertilizer (F_2)
100 percent of recommended dosage of N fertilizer (F_3)

Determination of Moisture in the Soil

Test samples used for this experiment were gathered from various plots at three continuous profundities for example 0-15, 15-30 and 30-45 cm for I_1 F_1, I_2 F_2 and I_3 F_3. Gravimetric soil moisture determination method was utilized to decide the soil moisture values at various spots. The samples gathered were weighed using a standard weighing scale and dried in the oven at a temperature of 105°C for around 1 day. The oven dried examples were gauged again. The dampness of soil was derived using the weight deduction in soil before oven drying and the weight of the oven dried soil.

$$\text{Moisture content of soil (by weight)} = \frac{\text{(weight of soil in wet condition)} - \text{(weight of oven dried soil)}}{\text{(Weight of oven dried soil)}} \qquad (3.1)$$

Soil moisture readings on volume basis can be computed by multiplication of soil moisture content by bulk density of the soil.

Determination of Nitrogen Content in the Soil

Test samples which were gathered following two and four hours after fertilizer application for I_1 F_1, I_2 F_2 and I_3 F_3 treatments from various profundities (0-15 cm, 15-30 cm and 30-45 cm) for extraction of nitrogen within the soil. The examples were prepared before nitrogen determination process by air drying them in shade. The samples were then pounding by mortar and pestel followed by sieving using 2mm standard sieve and put away keeping the samples in polythene sheets labelling with the of explicit treatment used. Diverse chemical reactions included are presented underneath

$$2KMnO_4 + H_2O \xrightarrow{\text{Alkaline medium}} 2MnO_4 + 2KOH + 3O^- \quad \text{(Nascent oxygen)} \tag{3.2}$$

$$\underset{\text{(Organic-N fraction)}}{R.CHNH_2COOH} + O^- \xrightarrow{\text{Oxidation}} R.CO.COOH + \underset{\text{(Ammonia)}}{NH_3} \tag{3.3}$$

$$NH_3 + H_2O \xrightarrow{\text{Distillation}} NH_4OH \tag{3.4}$$

$$3NH_4OH + H_3BO_3 \xrightarrow{\text{Absorption}} \underset{\text{(Green colour)}}{(NH_4)_3BO_3} + 3H_2O \tag{3.5}$$

Kelplus named programmed nitrogen determination device was utilized in assurance of accessible nitrogen. A 20gm soil sample which is prepared above is weighed and added to the digestortube of the apparatus. The digestor tube with the soil is inserted to the distillation section. 2% of boric acid (20 ml) including indicator automatically gets released in digestor tube along the first pipe, with the help of hose pipe entering it. 0.32% of each potassium permanganate (25 ml) and 2.5% sodium hydroxide is also added into the distillation chamber. Heat is generated in the sample by introducing steam at a uniform speed and absorbing liberated ammonia in 2% boric acid of 20 ml of containing indicator. As the absorption of ammonia takes place the pink colour changes to green. The distillate which appears greenish in colour is t titrated then using 0.02N sulphuric acid. The colour of the extract again changes to pinkish colour back. On the other hand the evaluation of a blank sample is also carried out. The samples are analyzed and the total available nitrogen is determined.

Results and Discussion

Soil moisture content for various treatments

Irrigation was carried out under different irrigation regimes i.e. I_1, I_2 and $I_3$with the help of drip irrigation system. Initially approximately 4 millimeter depth of irrigation water was provided in March and increased to 6 millimeter by April and June owing to increase in temperature in these months. The given table 2 for here provides an insight about the observed soil moisture content at consecutive levels. The figures clearly depict that soil moisture values along the depth has a decreasing trend. Concentration of moisture is higher in the above layers of soil which can be due to the reason that the soil which is directly below the emitters in a drip irrigation system (surface) receives continuous supply of irrigation water within most of the growing period of crop.

Table 2: Observed values of moisture content in soil

Treatments of Irrigation	Depth (cm)	Moisture Content in Soil (cm^3/cm^3) Days after sowing (DAS) 30	60	90	120
I_1F_1	15	0.478	0.291	0.37	0.342
	30	0.391	0.252	0.362	0.39
	45	0.354	0.259	0.398	0.326
I_2F_2	15	0.269	0.262	0.304	0.306
	30	0.225	0.243	0.285	0.247
	45	0.210	0.235	0.231	0.24
I_3F_3	15	0.299	0.272	0.229	0.282
	30	0.268	0.264	0.236	0.263
	45	0.273	0.254	0.223	0.251

Available Nitrogen

The observed values of nitrogen present in the soil after 2 and 4 hours of fertilizer application is depicted by the table 3. It is evident from the tabulated values that nitrogen concentration has an increasing trend with the depth within the soil. The top layer experiences a lower nitrogen concentration which is due to the reason that nitrogen being mobile has a quick movement with saturated soil volume present directly below the emitters of drip irrigation system. Also the rate of nitrification in high moisture content zone is anticipated to be in a decreasing trend, owing to higher level of sensitivity involved in the process with lower oxygen conditions.

Table 3: Observed values of available soil nitrogen

Treatments of Fertigation	Depth (cm)	Available nitrogen in Soil (mg/ml) Time after fertigation (hours) 2 hours	4 hours
I_1F_1	15	0.18	0.092
	30	0.25	0.099
	45	0.43	0.112
I_2F_2	15	0.182	0.098
	30	0.254	0.096
	45	0.363	0.102
I_3F_3	15	0.225	0.075
	30	0.24	0.0992
	45	0.31	0.091

Conclusion

The concentration of moisture contentwas more eminent in top layer of soil in comparison with subsequent layers during the growing period of the okra crop. Initially i.e. 30 DAS as depicted by the figures that there is greater moisture value in 15 – 30 cm depth of the soil for observed as well as for simulated water levels. An alike pattern was also observed after60 days of sowing as well. The greater values of moisture content can be reasoned as in drip irrigation the upper soil layers receives continuous irrigation water. The rate of irrigation water supply is greater than that of percolation. Therefore higher moisture is found in the top few centimeters.

The nitrogen concentration on other hand was in increasing trend along with depth. The lower values of soil available nitrogen concentration in the above soil was reasoned as in drip irrigation, the soil mass directly below emitter remains saturated within the water application period. The rate of nitrification in this saturated zone is anticipated to be on the lower side, as there is higher degree of sensitivity involved in the procedure related to anaerobic conditions. Nitrogen is also considered as highly mobile and moves rapidly along with the wetting front (Kadale, 2002).

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