Journal of AgriSearch 2(2): 100-104
Peer Reviewed Quarterly
ISSN : 2348-8808 (Print), 2348-8867 (Online)

Soil Acidification due to Point Application of Fertilizers through Drip Irrigation

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ARTICLE INFO

Received on	: 25.09.2014
Accepted on	: 01.05.2015
Published online	: 01.06.2015

ABSTARCT

An experiment was conducted to know about the effects of point application of fertilizers. Fertigation through drip irrigation was done to tomato and french bean grown under plastic house in two consecutive seasons. Fertilizers were applied at 100%, 75% and 50% of the recommended doses and compared with basal application. Fertigation was also done at three different intervals of application *i.e.* 2 days, 6 days and 10 days. Urea, Single Super Phosphate and KNO_3 was used as source of NPK. The soil pH of polyhouse was 6.51. The irrigation water had the pH of 5.89. Fertilizer applied at the interval of two days at 100% of recommended dose (RD) and 75% of RD to tomato and french beans gives highest yield. After the first crop season of tomato, the pH was found to reduce by 1-1.5 points over the base value from 6.51 to 4.92 in 100 % of RD application irrespective of interval of fertigation. The pH before the 2nd crop was found to be slightly reduced (6.34) over the base value of 6.51. However, after the 2nd crop, the soil pH was found to be reduced and the values were from 5.16 to 5.29. The reduction of soil pH was not as high as in the case of tomato. It indicated that though soil acidity increased due to point application of fertilizers, the increment might have linked to the types of crops and french bean being a leguminous crop had a positive effect against soil acidification.

Keywords: Drip irrigation, French bean, Point Fertilizer Application,_Soil acidification, Tomato

INTRODUCTION

Drip irrigation is gradually becoming popular in the hilly states of North Eastern Region. In areas where topography is undulated, drip irrigation is the only method of irrigation suitable for orchards and other horticultural crops. Vegetable cultivation is very common in Meghalaya during post-monsoon season. However, water scarcity is also acute during this season. Hence, efficient irrigation method for the vegetable crops and orchard is the only mean to improve water productivity, crop productivity even better quality crop produce due to better and efficient protection from soil and water borne insects pests and disease (Singh and Pandey, 2014; Pandey *et al.*, 2013). Presently, another dimension, i.e. fertigation, is added to drip irrigation system. Fertigation means application of fertilizer along with irrigation water. Nevertheless, only soluble fertilizers can be used through drip system (Pandey *et al.*, 2012). Nitrogenous fertilizers are most commonly used in fertigation due to its high solubility in water under ambient temperature, application of Nitrogenous fertilizers continuously through drip during the entire season helps in the increase of fertilizer use efficiency, nitrogen uptake, crop productivity, higher dry matter production and reduce leaching (Mahajan and Singh, 2006; Hebber *et al,.* 2004; Rajput and Patel, 2006; Bhat *et al.*, 2007; Zotarelli *et al.*, 2008 and Zotarelli *et al.*, 2009). A considerable amount of fertilizers can also be saved if applied through drip system (Singandhupe *et al.*, 2003). It was found to that if we applied nitrogenous fertilizers through fertigation more nitrogen uptake (8-11%) can be obtained as compared to what we get in furrow irrigation method (Mahajan and Singh, 2006). The application of fertilizers through drip is continuous process, hence a low dose of fertilizers per irrigation can be used which enhances the uptake. Therefore, daily or

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weekly application of fertilizers was found to be better than the application at the interval of 20 or 30 days (Bhat *et al.*, 2007; Bhat and Sujatha, 2009).

Fertilizer use efficiency is higher in fertigation as compare to normal soil application be it basal or top dressing (Singh and Kumar 2009). Greater economy is achieved in fertilizer due to fewer amounts of fertilizers required in drip based fertilizer management (Bhat *et al.*, 2007) used 75% of the recommended dose of fertilisers to achieve better crop productivity. Hanson *et al.* (2006) reported reduced nitrate leaching under drip fertigation due efficient control over watering. In spite of all the benefits of fertigation through drip irrigation, a flip side is seriously considered. Nitrogenous and phosphoric fertilizers are usually acidic in nature. Phosphoric acid has pH as low as 2.6. Point application of fertilizers, through drip irrigation may increase soil pH.

Drip irrigation is commonly used in arid and semi arid region, where water saving gets the priority. In general, arid and semi-arid regions have alkaline soil. Increased soil acidity through point application of fertilizer during the crop season, in fact, improves soil chemical properties and enhances crop productivity. In high rainfall areas, where soil is mostly acidic due to higher leaching of bases, drip irrigation has not become popular and hence the problems of enhanced acidity has not been reported so far. But it is found that nitrification causes soil acidification below trickle emitters. High rate of N-fertilizers particularly in ammonia form induce more acidity (Haynes, 1988). Hence, it is obvious that proper doses of fertilizers in acid soil of high exchangeable aluminium are necessary to avoid soil acidification. This may warrant soil amelioration in case of permanent installation of drip system. Nevertheless, sufficient information on soil acidification due to fertigation is not available to prepare any strategy for fertigation. As it is anticipated that fertigation is going to be introduced in North Easter Region's acid soil sooner or later, some basic information on soil acidification through drip fertigation may be generated to provide a future guideline. The present study was therefore planned to investigate the effect of fertigation of nitrogenous and potassic fertilizers at different intervals and doses on soil pH under covered conditions in two different crop seasons.

MATERIALS AND METHODS

The present experiment was conducted during the year 2010-11 at the experimental farm of College of Post-Graduate Studies, Umroi Road, Umiam. The experiment was planned under plastic house of dimensions of 6 m X 10 m. A low cost polyhouse was constructed with 200µ UV stabilized polythene cladding. The polyhouse was mainly used for the experiment to provide a semi-controlled environment for the growth and development of the crops. During summer the polyhouse was used as the rain-shelter by folding the side walls for proper aeration.

Drip Irrigation System

A gravity fed drip irrigation system was installed inside the polyhouse. Overhead water tank fitted at the height of 2 m so that water can be supplied to the system at a pressure of 0.2 kg/cm^2. Four numbers of overhead tanks were used to supply water to different treatments of fertilizer doses. 12 mm online drip laterals are used which were fitted with 2 liter per hour (lph) emitters at spacing of 45 cm considering the spacing of tomato as 45 cm X 60 cm. Since the length of laterals was only 10 m, NPC drippers were found to be sufficient for uniformity of application.

Experimental Layout

The experiment was carried out in randomized block design (RBD) with four fertilizer doses and three fertigation schedules. The four fertilizers doses were:

F1: 100% of recommended doses of fertilizers (NK) through drip

F2: 75% of recommended doses of fertilizers (NK) through drip

F3: 50% of recommended doses of fertilizers (NK) through drip

F4: 100% of recommended doses of fertilizers (NPK) as basal

Phosphorus was applied through basal application in case of the treatments with N and K through drip system. There were three fertigation schedules, *viz*.

S1: Fertigation at 2 days interval

S2: Fertigation at 6 days interval

S3: Fertigation at 10 days interval

Application of water was done at 2 days interval irrespective of the fertigation schedules and doses of fertilizers.

Basic Information of Soil

The soil inside the polyhouse was analysed for the base information about its fertility and soil pH, the result is given in the table 1.

Table 1: Basic information of soil within polyhouse

Parameters	Values
Available N (kg/ha)	221.61
Available P (kg/ha)	8.21
Available K (kg/ha)	61.23
Organic Carbon (%)	1.42
Soil pH	6.51
pH of irrigation water	5.89
Soil Bulk Density (g/cm^3)	1.41

Amount of irrigation water was determined based on the average daily evapo-transpiration of the crops. Two crops in two seasons were taken up for studies. These were Tomato (var. MT-3) and French Beans (var. Contender). Except fertilizers doses and method of application, all the cultural practices were followed as prescribed for mid hill regions of Meghalaya.

Fertilizers for Application

Phosphorus being insoluble in water at ambient temperature cannot be used in drip fertigation. Full dose of phosphorus in the form of Single Super Phosphate was applied as basal for all the treatments. Nitrogen and Potassium were applied through drip in the form of Urea and KNO_3. 100% Urea was dissolved in distilled water and the solution was kept under air tight condition for adding to the irrigation water as per doses. Laboratory grade KNO_3 was also diluted in kept separately in air tight situation and added to the system as per doses. Since in this experiment, drip irrigation system operated under low head conditions, hence ventury system was not applied for fertilizer injection, instead of that a separate bucket was used for adding fertilizer solution. The bucket was fitted in such a way that the head of the water in the tank was equal to the height of fertilizer bucket for uniform addition of fertilizer solution to the irrigation water.

Fertilizer doses

The type of fertilizer, source, doses and percent of recommended doses for both the crops *i.e.* tomato and french bean are summarized in the table 2.

Table 2: Doses of fertilizers for different crops

Fertilizer (kg/ha)	Tomato			French Beans		
	100%	75%	50%	100%	75%	50%
Urea	261	196	131	224	168	112
SSP	500	375	250	500	375	250
KNO_3	154	116	77	154	116	77

RESULTS AND DISCUSSIONS

The results obtained due to experimentation conducted at research farm during two years, were statistical analysed and results data were presented in suitable tables. The treatment wise yield, soil pH after the crops and Water Use Efficiency (WUE) are given in the table 3.

Table 3: Yield, soil pH after the crop and WUE after the two crop seasons

Treatment	Tomato			French Bean		
	Yield (t/ha)	Soil pH	WUE (t/ha/cm)	Yield (t/ha)	Soil pH	WUE (t/ha/cm)
F1S1	62.06	4.92	7.60	15.22	5.23	2.17
F1S2	55.91	4.96	6.84	14.57	5.16	2.08
F1S3	51.82	4.88	6.34	12.74	5.29	1.82
F2S1	53.24	4.95	6.52	17.59	5.22	2.51
F2S2	48.85	4.91	5.98	12.80	5.20	1.82
F2S3	47.11	5.10	5.77	11.48	5.19	1.63
F3S1	41.78	5.09	5.11	11.24	5.21	1.60
F3S2	47.27	4.87	5.79	9.06	5.20	1.29
F3S3	58.56	4.86	7.20	6.21	5.20	0.88
F4S1	59.81	5.53	7.32	10.71	5.20	1.53
F4S2	55.82	5.40	6.83	8.14	5.22	1.16
F4S3	43.71	5.52	5.35	3.66	5.20	0.52
CD (P=0.05)	3.42	0.72	0.47	1.71	0.63	0.13

Yield of Crop

In the first season, the crop under drip irrigation with 100% recommended dose fertilizer and application of fertilizers at two days interval was found to perform better over all the treatments. Frequent application of fertilizers even daily gave better yield (Rajput and Patel, 2006; Mahajan and Singh, 2006) (Table 3 & Fig 1a). It was obviously due to slow application of fertilizer to crop root zone which led to better utilization of applied fertilizers. However, the higher yield in F4S1 and F3S3 were considered to be aberration than the rule. The experiment was conducted in a small area (60 m^2) within a polyhouse, the environment of which was considered to be uniform. It was possible that rainfall occurred during the later part of crop affected overall moisture availability at the boundary of the polyhouse. Experiment conducted by Singandhupe *et al.* (2003) indicated that application of N @120 kg/ha produced highest yield under drip irrigation. The results of present experiment further strengthened the earlier findings. In the 2nd season of crop, French Beans, highest yield was obtained in the treatment with 75% of recommended dose of fertilizers applied at the interval of 2 days followed by 100% of recommended dose of fertilizers

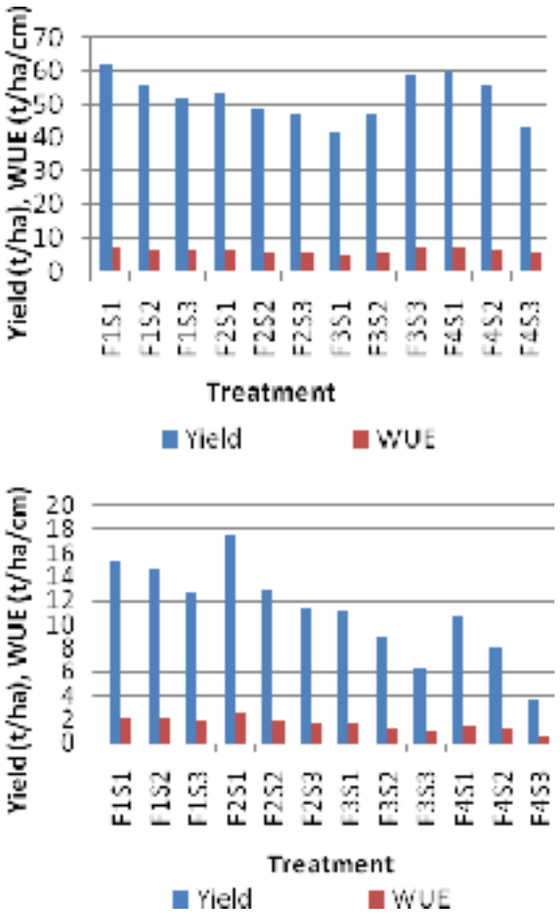

Fig. 1 a & b: Yield of Tomato and French Beans and WUEs

applied at the interval of 2 days. It was found that application of fertilizers at the interval of 2 days gave the highest returns in terms of crop yield (Table 3 & Fig. 1b). This is supported by the results of the experiment conducted by Rajput and Patel (2006). As French bean is a leguminous crop, the yield advantage at 75% of RD of fertilizers was due to better utilization of nitrogenous fertilizers under drip situation. It is also reported that alternate day irrigation with 96% of recommended dose of fertilizer gave up to 27% better yield with 21% of water savings.

Water Use Efficiency

Water applied to the crops in the first season was @ 817 m^3/ha (8.17 cm) and in the 2nd season it was @ 702 m^3/ha (7.02 cm). The amount of water applied to crop was the same across all the treatments and irrigation was done to all the treatments at the interval of 2 days. Hence, water input was a uniform parameter. The Water Use Efficiency (WUE) was therefore influenced by the fertigation alone. Further, water applied to the crop was equal to the ET on daily basis as calculated by ET calculator. The highest WUE was found in case of F1S1 in the first season (7.596 t/ha/cm) followed by the treatments F4S1 (7.321 t/ha/cm) and F3S3 (7.204 t/ha/cm). In the 2nd season, WUE was the highest in F2S1 (2.505 t/ha/cm) followed by the treatments F1S1 (2.168 t/ha/cm) and F1S2 (2.076 t/ha/cm). These followed the same trend as in case of yield of the respective crops. The results conformed to the findings of Zotarelli *et al*., 2008 & Zotarelli *et al*., 2009.

Soil Acidification

Apart from Haynes (1988) no previous report was found about the performance of drip fertigation in Al toxicity induced acidic soil, which is pre-dominant in North East region. Soil in the experiment site was slightly acidic to near normal (pH 6.51). The water in the pond used for irrigation was having a pH of 5.89. Hence, it was natural that soil pH would come down after irrigation. After the 1st season of crop, the pH was found to decrease considerably to a range from 4.86 to 5.53, higher being in the plot with basal application of fertilizers. From the table 3 and Fig.2, it is quite evident that fertigation affected the soil pH.

In the 2nd season, the necessary soil management

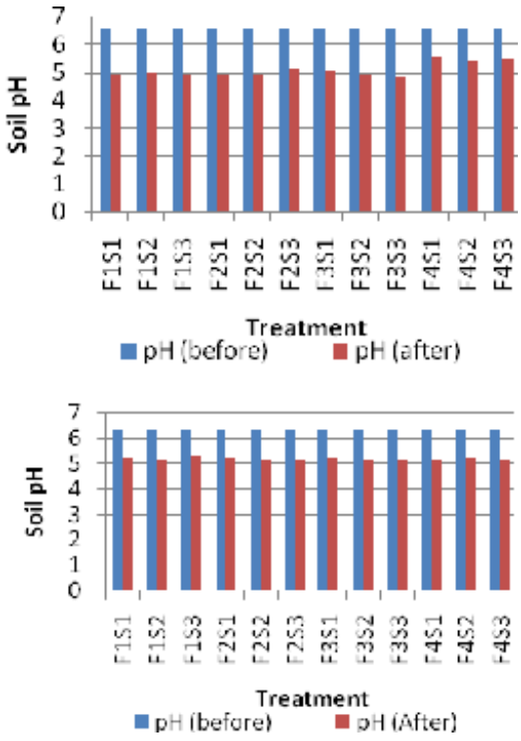

Fig 2 a & b: Soil pH after each season of Crop

practices were carried out apart from this the soils from the point of application of fertilizers in the previous year were thoroughly mixed with the plot soils to make it uniform soil with respect to fertility and off course pH of soil too. Results revealed that the pH before the 2nd crop was found to be slightly reduced (6.34) over the base value of 6.51. However, after the 2nd crop, the soil pH was found to be reduced and the values were from 5.16 to 5.29. The reduction of soil pH was not as high as in the case of tomato. It indicated that though soil acidity increased due to point application of fertilizers, the increment might have linked to the types of crops and French bean being a leguminous crop had a positive effect against soil acidification

CONCLUSION

The present study was primarily conducted to understand the effect of fertigation through drip on the soil acidity in the inherently acidic soils of NE region. It provided the vital clue that the fertigation led to further soil acidification, however, the study remained inconclusive due to the scale of experiment. A detailed study on acidic soil's reaction with fertigated chemicals is necessary for understanding the problem. Crop yield, Water Use Efficiencies under different fertilizers doses and interval of application followed the same trend as reported by various previous works. This further strengthens the need of fertigation for increasing water productivity and better utilization of agricultural inputs

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Citation:
Bora P K and Ray LIP. 2015.Soil Acidification due to Point Application of Fertilizers through Drip Irrigation. *Journal of AgriSearch* **2**(2): 100-104