Research Article

Influence of Drip fertigation on Soil NPK status of aonla ((*Emblica officinalis*) Gaertn.) cv. NA-7

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Abstract

A field experiment to study the influence of drip fertigation levels on soil NPK in aonla was carried out during 2011 to 2013. The experiment was laid out in randomized block design with eight treatments of fertigation levels, namely 75, 100 and 125% recommended dose of water soluble fertilizers including, soil application (control) and replicated three times, to test various soil NPK content of 8 years aonla cv. NA.7 grown under drip fertigation. The investigation indicated that 125 % recommended dose of water soluble fertilizers (T_8) applied through fertigation resulted in maximum soil N, P and K during 2011-2012 and 2012-2013 vegetative, flowering and harvesting stages respectively. Therefore (T_8) 125 % recommended doses of NPK in the form of water soluble fertilizers can be suggested for increasing the yield of eight years old aonla cv. NA.7 significantly.

Keywords: Aonla, Drip fertigation, Soil NPK, Vegetative, Flowering and Harvesting

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Introduction

Aonla (*Emblica officinalis* Gaertn.), belonging to the family Euphorbiaceae, is said to be indigenous to tropical south eastern Asia, particularly in central and southern India and has been cultivated since ancient times. Aonla is known as 'the mother of herbs. It is one of the richest sources of vitamin C (ascorbic acid) and also a rare example of an edible material, rich in phenols and tannins. Aonla is commercially cultivated in Mayanmar, Bangladesh, SriLanka, Iran and Iraq. India leads in the world in area and production. The area under aonla cultivation in India is about 1, 08,060 hectares with an annual production 12, 66,460 MT (NHB, 2014). The average productivity of aonla in Tamil Nadu is 19 tonnes per hectare with traditional way of cultivation against the Indian average productivity of 11.71 tonnes per hectare (NHB, 2014). NA.7 variety is the most precocious and heavy yielder, selected from chance seedling of Francis (Hathijhool). It is a prolific bearer with more percentage of female flowers. Fruits are medium to bold in size (44.50 g), flattened oblong with greenish-white in colour, smooth skin surface, semi translucent and free from necrosis, less fiber content, more juice and Vitamin C content. The variety is ideal for preparation of preserve, candy and beverages. It has wider adaptability to grow successfully all over the country. Since the natural ground water potential is diminishing, many farmers in India have opted drip irrigation. Through drip irrigation, fertigation is easier with high nutrient use efficiency, saving in labour, less weed infestation besides enhancing the productivity (Thiyagarajan, 2006).

Aonla responds to applied fertilizers to meet its nutrient requirements. Through fertigation methods, nutrients are added to the soil in adequate doses and interval through which qualitative improvement of produce can also be attained to a larger extent. Production of quality fruits in aonla will enable the farmers to earn more income. In Tamil Nadu, a dose of 200:500:200 g NPKtree^{-1}year^{-1} is generally recommended (TNAU) for aonla. This study was aimed to evaluate the fertigation system involving drip irrigation methods; various levels of fertilizers with a comparison on the farmers practice (surface irrigation + soil application of RDF) on leaf NPK and yield per tree of aonla.

Materials and Methods

A field experiment was conducted at the Department of Horticulture, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai during the year 2011-12 and 2012-13. The research experiment conducted at College Model Orchard, Krishi Vigyan Kendra was aimed to standardize the fertigation schedule for aonla, to study the effect of fertigation with N, P and K fertilizers on growth, yield and quality of aonla. The details of materials used T_1-Surface Irrigation with soil application of 100% RDF (Control), T_2-Drip Irrigation with soil application of 100 % RDF T_3-Drip Fertigation of 75% RDF as Commercial Fertilizers, T_4-Drip Fertigation of 100 % RDF as Commercial Fertilizers, T_5-Drip Fertigation of 125% RDF as Commercial Fertilizers T_6-Drip Fertigation of 75% RDF as Water Soluble Fertilizers (WSF), T_7-Drip Fertigation of 100% RDF as Water Soluble Fertilizers (WSF) T_8- Drip Fertigation of 125% RDF as Water Soluble Fertilizers (WSF). All other recommended package of practices were followed to raise the crop as per the Crop Production Techniques of Horticultural Crops (2012). For the treatment T_1-Soil application with surface irrigation was done in two split doses during April and September. For the treatment T_2-Soil application with drip irrigation was done in two split doses during April and September. For drip fertigation treatments (T_3- T_5) P was applied as basal through SSP, N and K were injected at weekly in equal splits. For drip fertigation treatments (T_6- T_8) the WSF namely MAP, SOP and Urea were injected at weekly intervals in equal splits (52 weeks). RDF: 200:500:200 g NPK/tree/year.

Results and Discussion

Soil nitrogen content at vegetative stage

All the treatments produced a significant effect on the soil nitrogen content in the vegetative stage. Among the different treatments implemented, the treatment T_8 (125 per cent RDF through fertigation) showed the highest soil nitrogen content at vegetative stages (256.4 kg/ha during 2011-2012 and 265.2 kg/ha during 2012-2013). It was followed by (100 per cent RDF through fertigation) T_7 (237.8 kg/ha during 2011-2012 and 250.3 kg/ha at during 2012-2013). The control (T_1) recorded the least available soil nitrogen (186.9 kg/ha and 198.5 kg/ha), in both years.

Pooled mean values showed that the application of 125 per cent RDF through fertigation (T_8) recorded the highest available soil nitrogen content at vegetative stage of 260.80 kg/ha. It was followed by (100 per cent RDF through fertigation) 260.80 kg/ha T_7. T_1, recorded the least available of soil nitrogen at vegetative stage (192.70 kg/ha). Fertigation of macro nutrients had resulted in the enhanced absorption of N by crops that ultimately led to higher yield. Similar findings were reported by Papadopoulos (1987) and Colla *et al*. (2001).

Soil nitrogen content at flowering stage

All the treatments produced a significant effect on the soil nitrogen content in the flowering stage. Among the different treatments implemented, the treatment T_8 (125 per cent RDF through fertigation) showed the highest soil nitrogen content at flowering stage (250.2 kg/ha during 2011-2012 and 256.3 kg/ha during 2012-2013) at flowering stage respectively. It was followed by T_7 (100 per cent RDF through fertigation), 234.49 kg/ha during 2011-2012 and 238.4 kg/ha at during 2012-2013 at flowering stage respectively. The control (T_1) recorded the least available of nitrogen (175.6 kg/ha and 190.2 kg/ha).

Table 1 Effect of drip fertigation levels on available Soil nitrogen (kg/ha) at vegetative, flowering and harvesting stages of aonla cv.NA-7

Treatments	Soil Nitrogen (Vegetative)		Pooled mean 2012-2013	Soil Nitrogen (Flowering)		Pooled mean 2012-2013	Soil Nitrogen (Harvesting)		Pooled mean 2012-2013
	2012	2013		2012	2013		2012	2013	
T_1	186.9	198.5	192.70	175.6	190.2	182.90	184.1	186.2	185.15
T_2	205.7	214.3	210.00	190.4	204.3	197.35	195.8	201.2	198.55
T_3	207.2	215.6	211.40	196.7	207.4	202.05	198.4	201.3	199.80
T_4	212.5	220.2	216.35	204.9	214.7	209.80	205.2	207.2	206.20
T_5	230.4	230.5	230.44	220.3	220.8	220.55	212.5	212.6	212.54
T_6	209.6	217.3	213.45	200.3	212.3	206.30	204.1	206.5	205.30
T_7	237.8	250.3	244.05	234.6	238.4	236.49	221.2	221.4	221.30
T_8	256.4	265.2	260.80	250.2	256.3	253.24	224.6	226.3	225.45
SEd	4.524	5.447	3.540	4.353	4.848	3.258	3.396	4.816	2.946
CD (0.05)	9.704	11.684	7.258	9.337	10.400	6.679	7.285	10.331	6.040

Pooled mean values showed that the application of 125 per cent RDF through fertigation T_8 recorded the highest available soil nitrogen content at flowering stage of 253.24 kg/ha it was followed by T_7 (100 per cent RDF through fertigation) 236.49 kg/ha and the lowest soil nitrogen content was recorded in T_1 182.90 kg/ha (control). Increased nutrient status in soil is due to accumulation of carbohydrates, which may take place gradually with the advancement of growth phase. Similar findings were also reported by Papadopoulos (1987), Shirgugre *et al.* (2000).

Soil nitrogen content at harvesting stage

All the treatments produced a significant effect on the soil nitrogen content in the harvesting stage. Among the different treatments implemented, the treatment T_8 (125 per cent RDF through fertigation) showed the highest soil nitrogen content at harvesting stage (224.6 kg/ha during 2011-2012 and 226.3 kg/ha during 2012-2013). It was followed by T_7 (100 per cent RDF through fertigation) 221.2 kg/ha during 2011-2012 and 221.4 kg/ha at during 2012-2013 respectively. The control (T_1) recorded the least available of soil nitrogen (184.1 kg/ha and 186.2 kg/ha).

Pooled mean values showed that the application of 125 per cent RDF through fertigation, T_8 recorded the highest available soil nitrogen content at harvesting stage of 225.45 kg/ha. It was followed by T_7 (100 per cent RDF through fertigation) 221.30 kg/ha. The lowest available soil nitrogen was observed in T_1 (185.15 kg/ ha). These results are in conformity with Petillo (2000), Colla *et al.* (2001) and Ummaheswarappa *et al*., (2005). Increased nutrient status in soil is due to accumulation of carbohydrates, which may take place gradually with the advancement of growth phase.

Soil phosphorous content at vegetative stage

All the treatments produced a significant effect on the soil phosphorous content in the vegetative stage. Among the different treatments implemented, the treatment T_8 (125 per cent RDF through fertigation) showed the highest soil phosphorous content at vegetative stage (20.8 kg/ha during 2011-2012 and 21.7 kg/ha during 2012-2013). It was followed by T_7 (100 per cent RDF through fertigation) 18.4 kg/ha during 2011-2012 and 18.9 kg/ha at during 2012-2013 respectively. The control (T_1) recorded the least available phosphorous (9.3 and 10.7 kg/ha) in both the years.

Pooled mean values showed that the application of 125 per cent RDF through fertigation recorded the highest available soil phosphorus content at vegetative stage of 21.25 kg/ha. It was followed by T_7 (100 per cent RDF through fertigation) 18.65 kg/ha. Phosphorus plays a key role in energy transfer system of plants. In the present study, relatively higher phosphorus content was noticed in soil with application of 125 per cent RDF as WSF through fertigation. This finding was in accordance with Patel and Chadha (2002) in grapes. It may be due to the fact that Phosphorus may be utilized for higher metabolite production for enhanced activity of the plant due to fertigation.

Soil phosphorous content at flowering stage

All the treatments produced a significant effect on the soil phosphorous content in the flowering stage. Among the different treatments implemented, the treatment T_8 (125 per cent RDF through fertigation) showed the highest soil phosphorous content at flowering stage (19.5 kg/ha during 2011-2012 and 19.8 kg/ha during 2012-2013). It was followed by T_7 (100 per cent RDF through fertigation) 16.9 kg/ha during 2011-2012 and 17.8 kg/ha at during 2012-2013. The least soil phosphorous content in the flowering stage is 8.6 kg/ha during 2011-2012 and 9.1kg/ha during 2012-2013 in control (T_1)

Pooled mean values showed that the application of 125 per cent RDF through fertigation (T_8) recorded the highest available soil phosphorus content at flowering stage (19.65 kg/ha) and it was followed by T_7 (100 per cent RDF through fertigation), 17.35 kg/ha. The least soil phosphorus content at flowering stage is 8.85 kg/ha in control (T_1)

Soil phosphorous content at harvesting stage

All the treatments produced a significant effect on the soil phosphorous content in the harvesting stage. Among the different treatments implemented, the treatment T_8 (125 per cent RDF through fertigation) showed the highest soil phosphorous content at harvesting stage (16.7 kg/ha during 2011-2012 and 17.2 kg/ha during 2012-2013). It was followed by T_7 (100 per cent RDF through fertigation) (15.1 kg/ha during 2011-2012 and 15.4 kg/ha during 2012-2013). The least soil phosphorous content in the harvesting stage is 8.0 kg/ha during 2011-2012 and 8.3kg/ha during 2012-2013 in control (T_1)

Pooled mean values showed that the application of 125 per cent RDF through fertigation recorded the highest available soil phosphorus content at harvesting stage of 16.95 kg/ha. It was followed by T_7 (100 per cent RDF through fertigation), 15.25 kg/ha. The least soil phosphorus content at flowering stage is 8.15 kg/ha in control (T_1)

Soil potassium content at vegetative stage

All the treatments produced a significant effect on the soil potassium content in the vegetative stage. Among the different treatments implemented, the treatment T_8 (125 per cent RDF through fertigation) showed the highest soil potassium content at vegetative stage (180.60 kg/ha during 2011-2012 and 185.60 kg/ha during 2012-2013). It was followed by T_7 (100 per cent RDF through fertigation) (168.90 kg/ha during 2011-2012 and 172.30 kg/ha at during 2012-2013). The least soil potassium content in the vegetative stage is 119.70 kg/ha during 2011-2012 and 123.70 kg/ha at during 2012-2013 in T_1

Table 2 Effect of drip fertigation levels on available soil phosphorus (kg/ha) at vegetative, flowering and harvesting stages of aonla cv.NA-7

Treatments	Soil phosphorus (Vegetative)		Pooled mean	Soil phosphorus (Flowering)		Pooled mean	Soil phosphorus (Harvesting)		Pooled mean
	2012	2013	2012-2013	2012	2013	2012-2013	2012	2013	2012-2013
T_1	9.3	10.7	10.00	8.6	9.1	8.85	8.0	8.3	8.15
T_2	12.2	12.6	12.40	11.5	11.8	11.64	9.6	10.2	9.90
T_3	12.3	14.1	13.20	12.0	13.5	12.75	10.4	10.9	10.65
T_4	14.6	15.8	15.20	14.0	14.7	14.35	11.8	12.1	11.95
T_5	16.8	17.5	17.15	16.2	16.2	16.20	14.2	15.0	14.60
T_6	13.9	15.2	14.55	13.2	13.8	13.50	11.0	11.3	11.15
T_7	18.4	18.9	18.65	16.9	17.8	17.35	15.1	15.4	15.25
T_8	20.8	21.7	21.25	19.5	19.8	19.65	16.7	17.2	16.95
SEd	0.365	0.459	0.293	0.326	0.340	0.235	0.216	0.256	0.168
CD (0.05)	0.784	0.985	0.601	0.699	0.729	0.482	0.464	0.549	0.344

Pooled mean values showed that the application of 125 per cent RDF through fertigation (T_8) recorded the highest available soil potassium content at vegetative stage of 183.10 kg/ha. It was followed by T_7 (100 per cent RDF through fertigation) 170.60 kg/ha. The lowest soil potassium content at vegetative stage is 121.69 kg/ha in control (T_1) (**Table 3**) Potassium (K), being a protoplasmic factor, is an essential plant nutrient. Many enzymes are activated by K and it is also involved in photo and oxidative phosphorylation, thus augmenting the energy required for fruit growth. Application of 125 RDF as WSF through fertigation registered the highest K content in leaf (Table 3). Drip fertigation with 125 per cent RDF enhanced the absorption of potassium at all stages of tree growth. Fontes *et al*. (2000)

Table 3 Effect of drip fertigation levels on available soil potassium (kg/ha) at vegetative, flowering and harvesting stages of aonla cv.NA-7

Treatments	Soil potassium (Vegetative)		Pooled mean	Soil potassium (Flowering)		Pooled mean	Soil potassium (Harvesting)		Pooled mean
	2012	2013	2012-2013	2012	2013	2012-2013	2012	2013	2012-2013
T_1	119.70	123.70	121.69	112.6	118.5	115.54	110.1	112.6	111.34
T_2	129.60	135.60	132.59	120.7	127.8	124.24	115.3	118.5	116.90
T_3	135.60	137.80	136.70	125.6	129.6	127.60	118.1	120.7	119.40
T_4	145.20	145.80	145.50	137.4	137.5	137.44	130.1	132.3	131.20
T_5	155.70	160.30	158.00	140.2	150.7	145.45	137.6	140.2	138.90
T_6	140.20	142.60	141.40	130.7	133.5	132.10	121.4	125.6	123.50
T_7	168.90	172.30	170.60	152.3	159.9	156.10	140.2	142.3	141.25
T_8	180.60	185.60	183.10	167.8	170.5	169.15	155.6	160.5	158.05
SEd	2.899	3.080	2.115	3.058	3.069	2.166	2.061	3.404	1.990
CD (0.05)	6.218	6.608	4.336	6.561	6.585	4.442	4.421	7.302	4.079

Soil potassium content at flowering stage

All the treatments produced a significant effect on the soil potassium content in the flowering stage. Among the different treatments implemented, the treatment T_8 (125 per cent RDF through fertigation) showed the highest soil potassium content at flowering stage (167.8 kg/ha during 2011-2012 and 170.5 kg/ha during 2012-2013). It was followed by T_7 (100 per cent RDF through fertigation) 152.3 kg/ha during 2011-2012 and 159.9 kg/ha at during 2012-2013. The least soil potassium content in the flowering stage is 112.6 kg/ha during 2011-2012 and 118.5 kg/ha at during 2012-2013 in control (T_1)

Pooled mean values showed that the application of 125 per cent RDF through fertigation recorded the highest available soil potassium content at flowering stage of 169.15 kg/ha. It was followed by T_7 (100 per cent RDF through fertigation) 156.10 kg/ha. The least soil potassium content at flowering stage is 115.54 kg/ha in control (T_1). Dangler and Lacascio (1990) opined that application of N and K in combination with drip irrigation increased the yield by the way of maximizing the mobility of nutrients around the root zone. These results are in agreement with those obtained by El-Gizawy (1992).

Soil potassium content at harvesting stage

All the treatments produced a significant effect on the soil potassium content in the harvesting stage. Among the different treatments implemented, the treatment T_8 (125 per cent RDF through fertigation) showed the highest soil potassium content, 155.6 kg/ha during 2011-2012 and 160.5 kg/ha during 2012-2013. It was followed by T_7 (100 per cent RDF through fertigation) 140.2 kg/ha during 2011-2012 and 142.3 kg/ha during 2012-2013. The least soil potassium content in the harvesting stage is 110.1 kg/ha during 2011-2012 and 112.6 kg/ha during 2012-2013 in control (T_1).

Pooled mean values showed that the application of 125 per cent RDF through fertigation recorded the highest available soil potassium content at harvesting stage of 158.05 kg/ha. It was followed by T_7 (100 per cent RDF through fertigation) 141.25 kg/ha. The least soil potash content at harvesting stage is 111.34 kg/ha in control (T_1) (Table 3). The potassium content in aonla leaf exerted a differential pattern than that of nitrogen and phosphorus. The transformation reactions that took place led to greater availability of potassium in the soil and consequently resulted in better utilization by the plant. It is also possible that the fertigation with 125 per cent RDF might have activated the physiological processes for the rapid absorption and utilization of nutrients for the primary metabolic processes. Similar findings were reported by Ghanta and Mitra (1993), Singh *et al*. (1995) and EI-Sherif *et al*. (1993).

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