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Effect of drip fertigation levels on fruit characters of Aonla (*Emblica officinalis* Gaertn.) cv. NA-7

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Abstract
Investigations were undertaken to study the influence of drip fertigation levels on Leaf NPK and yield characters 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 leaf NPK content and yield attributes 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 leaf N, P and K during 2011-2012 and 2012-2013 vegetative, flowering and harvesting stages respectively. The fruit attributing characters viz., average fruit weight (40.5 g and 42.5g), fruit volume (2.12 cc and 2.32 cc), fruit length (3.80 cm and 4.00 cm), fruit diameter (3.80 cm and 4.15 cm), pulp weight (39.0 g and 40.9) and stone weight (1.55 g and 1.60 g) were also found to be higher in the same treatment than with soil application of recommended doses of NPK and higher dose fertigation. 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 and fruit characters

Introduction
Aonla (*Emblica officinalis* L. Gaertn) is an important indigenous emerging fruit crop owing to its hardiness and ability to withstand adverse soil and climatic conditions and belongs to the family Euphorbiaceae subfamily Phyllanthoideae (Arun *et al*., 2009) [2]. It is originated in tropical South East Asia particularly South India (Virendra Singh *et al*., 2009) [14]. It is being cultivated since ancient times in India. The fruit is highly nutritive for human consumption. It is the richest source of vitamin C (600-1300 mg/100g) among the fruits next to Barbados cherry and also useful for general improvement of health and medicinal purpose (Ram Kumar *et al*., 2011) [9]. Aonla is mainly cultivated in Mayanmar, Bangladesh, Sri Lanka Iran and Iraq. India ranks first in the world in Aonla area and production. The area under Aonla cultivation in India is about 77,000 hectares with an annual production 8, 26,000 tonnes (Anon, 2011) [1]. 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) [13].
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 NPK$tree^{-1}year^{-1}$ 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 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

Average Fruit Weight

The treatments registered significant influence on average fruit weight. The average fruit weight ranged from 23.0 to 40.5 g during 2011-2012 and 23.5 to 42.5 g during 2012-2013. The treatment receiving 125 per cent RDF fertigation (T_8) recorded the highest average fruit weight of 40.5 and 42.5 g in 2011-2012 to 2012 -2013 respectively. The second best treatment was observed in T_7 (100 per cent RDF as fertigation 37.2 and 38.0 g). The least average fruit weight (23.0 and 23.5g) was recorded in T_1 in 2011-2012 to 2012 -2013 respectively.

Pooled mean values of average fruit weight showed that application of 125 per cent RDF fertigation (T_8) recorded the highest average fruit weight of 41.50 g. It was followed by 100 per cent RDF (T_7) as fertigation (37.60 g). The lowest average fruit weight (23.25 g) was recorded by control (T_1) The lowest average fruit weight (23.25 g) was recorded by control (T_1) (Table.1) Hanamanth (2002) [5] and Singh *et al.* (2006) [12] also noticed similar response for fertigation in mango.

Fruit Length

The different treatments registered a significant influence on average fruit length. The average fruit length ranged from 2.30 to 3.80 cm during 2011-2012 and 2.40 to 4.00 cm during 2012-2013. The treatment received with 125 per cent RDF fertigation (T_8) recorded the highest average fruit length of 3.80 and 4.00 cm in 2011-2012 to 2012 -2013 respectively. It was followed by (T_7) 100 per cent RDF fertigation (3.60 cm and 3.70 cm). The lowest fruit length was recorded in (T_1) control (2.30 cm) during 2011-2012 and 2.40 cm in 2012-2013.

Pooled mean values of average fruit length showed that application of 125 per cent RDF through fertigation (T_8) recorded the highest average fruit length of 3.90 cm. It was followed by 100 per cent RDF (T_7) through fertigation (3.65 cm). The lowest fruit length (2.35 cm) was recorded by control (T_1) The IAA oxidase activity, which was low in the treatment providing 125 per cent RDF, should have facilitated better auxin level in the plant system which, in turn, could have improved the fruit length (Vijayakumar, 2001) [15]. (Table.1).

Fruit Diameter

The different treatments registered a significant influence on average fruit diameter. The average fruit diameter ranged from 2.15 to 3.80 cm during 2011-2012 and 2.30 to 4.15 cm during 2012-2013. The treatment 125 per cent RDF through fertigation (T_8) recorded the highest average fruit diameter of 3.80 and 4.15 cm in 2011-2012 to 2012 -2013 respectively. It was followed by 100 per cent RDF (T_7) through fertigation (3.60 cm and 3.90 cm). The lowest average fruit diameter of 2.15 cm during 2011-2012 and 2.30 cm in 2012-2013 was recorded in control.

Pooled mean values of average fruit diameter showed that application of 125 per cent RDF fertigation (T_8) recorded the highest average fruit diameter of 3.97 cm. It was followed by 100 per cent RDF (T_7) fertigation (3.75 cm, respectively). The lowest average fruit diameter (2.22 cm) was recorded by control (T_1). The fruit circumference was significantly influenced by greater flux of potash into fruits which might enhance water entry into cells by osmotic processes and produce an increase in cell expansion and fruit circumference Ruiz (2006) [11]. The positive effects of K on fruit circumference were also observed in orange grooves (Opazo and Razeto, 2001) [8] and grapes (Ruiz, 2000) [10]. (Table.1).

Fruit Volume

Application of conventional fertilizers and water soluble fertilizers through drip irrigation system had significant influence on fruit volume. Among the different treatments, (T_8) *i.e.* application of 125 per cent RDF through fertigation recorded the highest fruit volume (2.21 cc and 2.32 cc) in both years. It was followed by T_7 (1.93.cc and 2.03 cc) in 2011-2012 to 2012 -2013, respectively. The lowest fruit volume was registered by control T_1 (1.25 cc and 1.32 cc) during 2011-2012 to 2012 -2013 respectively.

Pooled mean values of fruit volume suggested that application of 125 per cent RDF through fertigation (T_8) recorded the highest fruit volume of 2.26 cc followed by 100 per cent RDF through fertigation T_7 (1.97 cc). The lowest fruit volume (1.28 cc) was recorded by control (T_1) The results are in agreement with that of Brantley and Warren (1960) [3], Deswal and Patil (1984) [4] Mrinalini and Tiwari (1988) [7] and Lata and Singh (1993) [6]. (Table.2)

Pulp Weight

During both the seasons, the pulp weight was observed to be significantly differed between the treatments. Application of 125 per cent RDF fertilizers through fertigation T_8 recorded the highest pulp weight (39.0 and 40.9 g) during 2011-2012 to 2012 -2013 respectively as compared to other treatments T_7 (35.5 and 36.3 g) during 2011-2012 to 2012 -2013 respectively recorded the next best treatment. The control registered a value of 20.9 and 21.2 g during 2011-2012 to 2012 -2013 respectively.

Pooled mean values of pulp weight suggested that application of 125 per cent RDF through fertigation recorded the highest pulp weight of 39.95 g. It was followed by $T_7$100 per cent RDF through fertigation (35.90 g). The lowest pulp weight (21.05g) was recorded by control (T_1) It is already established that in the later stage *i.e.* fruit development, the element K facilitates better translocation of assimilates towards developing sink *i.e.* fruit especially to increase the dry matter content after the fruit dormancy period *i.e.* after fruit attains 73 mm size (Table.2).

Stone Weight

Observations made on stone weight showed significant differences among the treatments. Among all the treatments, 125 per cent RDF through fertigation T_8 showed lowest stone weight (1.55g and 1.60 g) during 2011-2012 to 2012 -2013 respectively. It was followed by the application of 100 per cent RDF through fertigation (T_7) (1.68g and 1.72 g during 2011-2012 to 2012 -2013 respectively) and the control registered a highest value of 2.12g and 2.32 g during 2011-2012 to 2012 -2013, respectively.

Pooled mean values of stone weight showed that application of 125 per cent RDF fertigation (T_8) recorded the lowest stone weight of 1.56 g followed by 100 per cent RDF through fertigation T_7 (1.70 g respectively). The highest stone weight of 2.22 g was recorded by control (T_1). A reduction in stone weight was observed invariably under all the treatments, comparing to the pulp weight. This could have been due to the higher dry matter accumulation by the treatments invariably at the time of maturity. Generally the seeds decrease its growth two months after fruit dormancy break (Table.2)

Table 1: Effect of drip fertigation levels on fruit characters of Aonla cv.NA-7

Treatments	Average Fruit Weight (g)		Pooled mean 2012-2013	Fruit length (cm)		Pooled mean 2012-2013	Fruit diameter (cm)		Pooled mean 2012-2013
	2012	2013		2012	2013		2012	2013	
T_1	23.0	23.5	23.25	2.30	2.40	2.35	2.15	2.30	2.22
T_2	27.5	28.7	28.10	2.50	2.80	2.65	2.68	2.80	2.74
T_3	29.0	31.0	29.99	2.70	2.90	2.80	2.75	3.00	2.87
T_4	31.8	32.7	32.25	3.20	3.30	3.25	2.90	3.20	3.05
T_5	35.7	36.7	36.20	3.30	3.40	3.35	3.15	3.50	3.32
T_6	30.0	32.3	31.15	2.90	3.00	2.95	2.80	3.20	3.00
T_7	37.2	38.0	37.60	3.60	3.70	3.65	3.60	3.90	3.75
T_8	40.5	42.5	41.50	3.80	4.00	3.90	3.80	4.15	3.97
SEd	0.593	0.715	0.464	0.067	0.080	0.052	0.070	0.062	0.047
CD at 5 %	1.273	1.533	0.952	0.144	0.171	0.107	0.151	0.134	0.097

Table 2: Effect of drip fertigation levels on fruit characters of Aonla cv.NA-7

Treatments	Fruit Volume (cc)		Pooled mean 2012-2013	Pulp weight (g)		Pooled mean 2012-2013	Stone weight (g)		Pooled mean 2012-2013
	2012	2013		2012	2013		2012	2013	
T_1	1.25	1.32	1.28	20.9	21.2	21.05	2.12	2.32	2.22
T_2	1.40	1.56	1.48	25.5	26.4	25.95	2.05	2.29	2.17
T_3	1.45	1.62	1.53	27.0	28.8	27.90	1.96	2.21	2.08
T_4	1.53	1.81	1.67	30.0	30.8	30.40	1.83	1.91	1.87
T_5	1.74	1.94	1.84	33.9	34.9	34.40	1.77	1.83	1.80
T_6	1.49	1.73	1.61	28.1	30.2	29.15	1.91	2.11	2.00
T_7	1.93	2.03	1.97	35.5	36.3	35.90	1.68	1.72	1.70
T_8	2.21	2.32	2.26	39.0	40.9	39.95	1.55	1.60	1.56
SEd	0.033	0.036	0.025	0.687	0.816	0.533	0.030	0.031	0.021
CD at 5 %	0.071	0.078	0.051	1.473	1.751	1.093	0.065	0.068	0.044

Conclusion

Fruit characters such as average fruit weight, fruit length, fruit diameter, fruit volume, pulp weight and stone weight of the fruits were significantly enhanced due to application of 125 per cent RDF as WSF through drip in both the years of experimentation.

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