International Journal of Agricultural Sciences
Volume **10** | Issue 1| January, 2014 | 276-279

RESEARCH PAPER

Growth, nutrient uptake and seed cotton yield as influenced by foliar nutrition and drip fertigation in cotton hybrid

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Abstract : Field experiments were carried out over two years at Agricultural College and Research Institute, Coimbatore during winter seasons of 2011-12 and 2012-13 to study the effect of drip and surface irrigation methods with foliar nutrition on nutrient uptake and growth of hybrid cotton. Treatments comprised of three levels of drip fertigation at 50 per cent, 75 per cent and 100 per cent recommended dose of fertilizer (RDF) with urea, urea phosphate and muriate of potash in combination with foliar spray of 2 per cent Di-ammonium phosphate (DAP) and 1 per cent urea phosphate. Surface irrigation with soil application of 100% RDF and drip irrigation with soil application of 100 per cent RDF using conventional fertilizers in combination with foliar nutrition of 2 per cent DAP and 1 per cent urea phosphate were also included for comparison. The highest plant height, more LAI, DMP and higher seed cotton yield of 3676 and 3521 kg ha^{-1} during 2011-12 and 2012-13, respectively were recorded under drip fertigation with 100 per cent recommended dose of NPK and foliar spray of 1 per cent urea phosphate. Drip irrigation at 100 per cent recommended dose of NPK and foliar spray of 1 per cent urea phosphate also significantly increased the cotton growth in terms of plant height, LAI, DMP and seed cotton yield over surface irrigation with soil application of fertilizer.

Key Words : Drip fertigation, Foliar spray, Growth, Nutrient uptake, Seed cotton yield

View Point Article : Ayyadurai, P. and Manickasundaram, P. (2014). Growth, nutrient uptake and seed cotton yield as influenced by foliar nutrition and drip fertigation in cotton hybrid. *Internat. J. agric. Sci.*, **10** (1): 276-279.

Article History : Received : 29.07.2013**; Revised :** 21.10.2013**; Accepted :** 19.11.2013

INTRODUCTION

Cotton is potentially an important commercial crop, which has vital role in textile industry. It is extensively grown in areas where conventional irrigation methods are usual practices. However, the seed cotton yields and water use efficiency achieved under conventional surface irrigation methods are low. In advanced countries frontier irrigation technologies like drip irrigation have been introduced for cotton. This technology not only use each drop of water most efficiently but also results in good crop growth and yield advantage due to stable moisture content maintained always near the root zone of the cotton crop by way of frequent irrigation at shorter intervals. Drip irrigation has the added advantage as the water soluble fertilizers can be injected through the system via fertigation in précised amounts and when required to match the crop needs. By fertigation 25-30 per cent fertilizer saving is possible from the recommended dose resulting in reduced cost of fertilizers and application costs. Drip fertigation system resulted in saving of 50 per cent irrigation water and 60 kg N ha^{-1} with higher water and N use efficiency in hybrid cotton (Sankaranarayanan *et al*., 2007).

The foliar application of plant nutrients regulates the biochemical changes in seed and increases the yield of cotton (Chaudhary *et al*., 2001). Foliar nutrition is restored to reduce the cost of cultivation by reducing the amount of fertilizer thereby it is preferred with the intention of meeting the immediate needs of the plant and reducing the quantity of fertilizer and to solve the problem wherever, soil applications are not possible. But there exists limited evidence on the foliar nutrition improving the seed cotton yield. It is often assumed that foliar nutrition in combination with drip irrigation systems in cotton is most preferable and

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the available literature to support this viewpoint is very much scanty. Hence, the present study has been planned to assess the impact of drip fertigation and foliar nutrition in winter irrigated cotton.

MATERIAL AND METHODS

Field experiments were conducted at Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, India during winter seasons of 2011-12 and 2012 -13 to evaluate the effect of drip fertigation and surface irrigation methods under foliar nutrition on growth, productivity and nutrient uptake of winter irrigated cotton var. Chiruta Bt 2. The soil type of experiment site was sandy clay loam with low in available N, medium in P and high in K with pH of 7.5. The soil had 22.6 per cent moisture at field capacity and 11.4 per cent at permanent wilting point with a bulk density of 1.41 g cc^{-1}.

The experiment was laid out in Randomized Block Design replicated thrice. Three fertilizer levels as fertigation and two foliar sprays were included in the study. The treatments were T_1 - Surface irrigation and soil application of 100% RDF; T_2 - Surface irrigation and soil application of 100% RDF + foliar spray of 2 per cent DAP ; T_3 - Surface irrigation and soil application of 100% RDF + foliar spray of 1 per cent urea phosphate; T_4 - Drip irrigation and soil application of 100% RDF; T_5 - Drip irrigation and soil application of 100% RDF + foliar spray of 2 per cent DAP ; T_6 - Drip irrigation and soil application of 100% RDF + foliar spray of 1 per cent urea phosphate; T_7 - Drip fertigation at 100% RDF; T_8 - Drip fertigation at 100% RDF + foliar spray of 2 per cent DAP ; T_9 - Drip fertigation at 100% RDF + foliar spray of 1 per cent urea phosphate; T_{10}- Drip fertigation at 75% RDF; T_{11} - Drip fertigation at 75% RDF + foliar spray of 2 per cent DAP ; T_{12} - Drip fertigation at 75% RDF + foliar spray of 1 per cent urea phosphate; T_{13}- Drip fertigation at 50% RDF; T_{14} - Drip fertigation at 50% RDF + foliar spray of 2 per cent DAP ; T_{15} - Drip fertigation at 50% RDF + foliar spray of 1 per cent urea phosphate. The crop was raised by adopting all the recommended package of practices for irrigated cotton. Irrigation scheduling was done at 0.60 IW/CPE ratio with 5 cm depth for surface irrigation treatments. Under drip irrigation it was scheduled once in three days with 100 per cent CPE.

In surface irrigation, under ridges and furrow method the spacing of 90 x 60 cm was maintained and sowing was done on one side of the ridge. Under drip irrigation, paired row spacing of 120/60 x 60 cm was maintained and sowing was done on raised beds.

Fertigation was done through venturi injector to individual plots. Fertilizer solution was prepared and kept in plastic container and connected with suction device of venturi. Fertigation was given as per the schedule prescribed for cotton. The recommended dose of fertilizer (RDF) 150:75:75 of NPK kg per hectare was applied. Nitrogen, phosphorus and potassium were applied in the form of urea, urea phosphate and muriate of potash, respectively.

As per treatment schedule, foliar spray of 1 per cent urea phosphate and 2 per cent DAP were imposed during four growth stages in cotton at 45, 60, 75 and 90 DAS. For preparation of 1 per cent solution of urea phosphate and 2 per cent solution DAP 1 kg of urea phosphate and 2 kg of DAP were dissolved in 100 litres of water and were sprayed over the crop canopy during evening hours using high volume knapsack sprayer. Various biometric observations on plant growth at 120 DAS and nutrient uptake at harvest were recorded and statistically analyzed and discussed below.

RESULTS AND DISCUSSION

Among the different treatments, drip fertigation with 100 per cent recommended dose of NPK and foliar spray of 1 per cent urea phosphate (T_9) registered significantly the highest values on plant height, LAI and DMP at 120 DAS (Table 1). This might be due to précised application of water as drops only at the root zone, which maximized the water availability by maintaining the soil moisture always nearer to the field capacity (Cetin and Bilgel, 2002 and Veeraputhiran *et al*., 2002) in addition to combined application of water soluble fertilizer and foliar sprays at critical growth stages of the crop (Saravanan *et al*., 2012)

Foliar spray treatments *viz*., 1% urea phosphate and 2% DAP registered increased growth components *viz*., plant height, LAI and DMP over no foliar spray treatment (Table 1). This could be attributed to the effective conservation of moisture and nutrients, which in turn reflected in favourable crop growth and vegetative biomass (Virdia and Patel, 2000). Significant favourable relationship was found between irrigation methods and foliar spray on growth components. Drip irrigation with foliar spray increased the growth components as compared to surface irrigation. It is mainly due to soil moisture always maintained nearer to the field capacity under both foliar sprayed and no foliar sprayed plots of under drip irrigation and irrigation was practiced a shorter intervals of once in three days under drip irrigation irrespective of foliar spray of nutrients. Even under surface irrigation method foliar spray with 1 per cent urea phosphate increased the growth components over foliar spray of 2 per cent DAP and no foliar spray treatments.

Seed cotton yield was significantly influenced by the treatments and drip fertigation at 100 per cent RDF and foliar spray of 1 per cent urea phosphate registered the higher seed cotton yield during both the years (Table 1). The increase in seed cotton yield under drip fertigation at 100 per cent and foliar spray of 1 per cent urea phosphate was 10.1 and 10.4 per cent; 17.7 and 17.5 per cent; 9.9 and 9.9 per cent; 30.4

and 27.7 per cent; 22.5 and 20.0 per cent; 33.4 and 36.9 per cent; 25.4 and 32.9 per cent; 45.3 and 45.1per cent over drip fertigation at 100 per cent and foliar spray of 2 per cent DAP, drip fertigation at 75 per cent and foliar spray of 2 per cent DAP and 1 per cent urea phosphate, drip fertigation at 50 per cent and foliar spray of 2 per cent DAP and 1 per cent urea phosphate, drip irrigation at 100 per cent and foliar spray of 2 per cent DAP and 1 per cent urea phosphate and surface irrigation method during 2011-12 and 2012-13, respectively. This might be due to production of more vegetative biomass, more flowers and conversion into better bolls and more retention in plants under drip fertigation (Cetin and Bilgel, 2002 and Veeraputhiran *et al*., 2002) and foliar spray (Saravanan *et al.*, 2012). Drip fertigation at 100 per cent

Table 1 : Effect of drip fertigation levels and foliar spray on growth components and yield of cotton

Treatments	Plant height on 120DAS		Leaf area index on 120 DAS		Dry matter production on 120 DAS		Seed cotton yield (kg ha^{-1})	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
T_1 - SI and Soil application of 100% RDF	95.2	91.9	3.522	3.242	5017	4936	2010	1932
T_2 - T_1 + Foliar spray of 2% DAP	97.6	93.2	3.664	3.364	5179	5116	2176	2098
T_3 - T_1 + Foliar spray of 1% $UreaPO_4$	99.8	96.3	3.785	3.408	5206	5137	2250	2172
T_4 - DI and Soil application of 100% RDF	95.6	93.3	3.821	3.487	5279	5159	2053	1975
T_5 - T_4 + Foliar spray of 2% DAP	99.3	97.7	3.864	3.594	5302	5179	2300	2221
T_6 - T_4 + Foliar spray of 1% $UreaPO_4$	102.6	100.6	3.928	3.689	5356	5291	2443	2364
T_7 - DF at 100% RDF with $UreaPO_4$ and MOP	107.9	102.5	4.558	4.467	6832	6748	3004	2873
T_8 - T_7 + Foliar spray of 2% DAP	113.4	109.1	4.826	4.728	7432	7357	3303	3156
T_9 - T_7 + Foliar spray of 1% $UreaPO_4$	121.3	116.4	5.117	4.971	8035	7935	3676	3521
T_{10} - DF at 75% RDF with $UreaPO_4$ and MOP	103.5	99.6	4.490	4.345	6076	5988	2742	2562
T_{11} - T_{10} + Foliar spray of 2% DAP	109.6	104.4	4.728	4.603	6682	6611	3027	2905
T_{12} - T_{10} + Foliar spray of 1% $UreaPO_4$	116.8	112.5	4.956	4.882	7298	7226	3312	3174
T_{13} - DF at 50% RDF with $UreaPO_4$ and MOP	98.9	95.4	3.953	3.877	5678	5493	2324	2279
T_{14} - T_{13} + Foliar spray of 2% DAP	104.3	101.2	4.338	4.240	6281	6168	2618	2547
T_{15} - T_{13} + Foliar spray of 1% $UreaPO_4$	112.1	108.3	4.672	4.509	6923	6791	2915	2817
S.E.±	2.6	2.3	0.109	0.107	291	277	139	130
C.D. (P=0.05)	5.3	4.7	0.224	0.219	596	568	284	267

SI - Surface Irrigation; DI - Drip Irrigation; DF - Drip Fertigation; Foliar spray of four stages at 45, 60, 75 and 90 DAS

Table 2 : Effect of drip fertigation levels and foliar spray on nutrient uptake (kgha^{-1}) of cotton at harvest

Treatments	Nitrogen		Phosphorus		Potassium	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
T_1 - SI and Soil application of 100% RDF	60.6	59.8	13.0	12.8	60.3	57.6
T_2 - T_1 + Foliar spray of 2% DAP	64.8	63.7	13.5	13.4	63.4	59.6
T_3 - T_1 + Foliar spray of 1% $UreaPO_4$	67.9	67.1	14.0	13.8	69.7	65.1
T_4 - DI and Soil application of 100% RDF	65.4	64.6	13.8	13.6	68.1	64.4
T_5 - T_4 + Foliar spray of 2% DAP	69.0	67.1	14.5	14.4	70.0	67.6
T_6 - T_4 + Foliar spray of 1% $UreaPO_4$	71.5	69.9	14.8	14.5	71.5	68.2
T_7 - DF at 100% RDF with $UreaPO_4$ and MOP	80.9	79.9	16.6	16.4	80.9	75.3
T_8 - T_7 + Foliar spray of 2% DAP	94.8	93.3	18.6	18.1	95.4	91.6
T_9 - T_7 + Foliar spray of 1% $UreaPO_4$	108.3	102.7	22.8	21.2	105.4	99.6
T_{10} - DF at 75% RDF with $UreaPO_4$ and MOP	73.6	71.2	15.3	15.1	77.9	76.7
T_{11} - T_{10} + Foliar spray of 2% DAP	87.3	86.5	17.2	17.4	87.3	83.4
T_{12} - T_{10} + Foliar spray of 1% $UreaPO_4$	98.8	94.8	20.0	19.2	96.2	92.1
T_{13} - DF at 50% RDF with $UreaPO_4$ and MOP	69.4	67.4	15.0	14.8	74.2	70.9
T_{14} - T_{13} + Foliar spray of 2% DAP	77.7	74.4	17.1	16.9	82.1	78.2
T_{15} - T_{13} + Foliar spray of 1% $UreaPO_4$	86.5	81.5	19.1	18.8	90.6	86.8
S.E.±	3.7	3.3	0.8	0.6	3.8	3.4
C.D. (P=0.05)	7.6	6.8	1.6	1.3	7.7	6.9

SI - Surface Irrigation; DI - Drip Irrigation; DF - Drip Fertigation; Foliar spray of four stages at 45, 60, 75 and 90 DAS

RDF and foliar spray of 1 per cent urea phosphate registered the higher seed cotton yield compared to drip irrigation at 100 per cent with no foliar spray. It is mainly due to soil moisture always maintained nearer to the field capacity under both foliar sprayed and no foliar sprayed plots under drip irrigation. Since, irrigation being practiced at frequent intervals of once in 3 days under foliar sprayed and no foliar sprayed plots under drip irrigation a favourable soil moisture condition was maintained throughout the crop period. Among surface irrigation methods, 1 per cent urea phosphate foliar spray increased the seed cotton yield over 2 per cent DAP foliar spray and no foliar spray treatments.

Different levels of drip fertigation and foliar spray practices influenced the N, P and K uptake significantly (Table 2). Drip fertigation recorded higher N, P and K uptake compared to drip irrigation and surface irrigation methods. This was due to availability of favourable soil moisture throughout the crop growth period, which stimulated the height of plant, expansion of leaf and consequent accumulation of more dry matter. Since the nutrient uptake is a product of nutrient content and DMP, the trend of N, P and K uptake was similar as that of DMP (Constable *et al*., 1990). It was due to conservation of more soil moisture in the root zone of the crop which helped in better utilisation of nutrients which in turn reflected on better growth and production of increased dry matter (Virdia and Patel, 2000). Seed cotton yield, growth attributes and N, P and K uptake were higher under drip fertigation at 100 per cent with foliar spray of 1 per cent urea phosphate and was significantly superior over drip irrigation and surface irrigation with no foliar spray. Thus, it can be concluded that drip fertigation at 100 per cent RDF with foliar spray of 1 per cent urea phosphate is the best suited technology for enhancing the productivity of winter irrigated cotton.

Conclusion:

The present study revealed that the effect of drip fertigation levels, drip and surface irrigation methods in combination with foliar spray on the productivity of winter irrigated cotton grown in Western Zone of Tamil Nadu. Drip fertigation at 100 per cent of recommended dose with foliar spray of 1 per cent urea phosphate has recorded significantly the higher seed cotton yield and nutrient uptake compared to drip fertigation with foliar spray of 2 per cent DAP and surface irrigation with soil application of fertilizer.

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