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Water and Nutrient Scheduling for Drip Fertigated *Rasthali* (AAB) Banana

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Abstract
A field experiment was conducted at Agronomic Research Station, Kerala Agricultural University, Chalakudy during 2017-2020 to study nutrient scheduling for drip fertigation under various irrigation levels for banana var. Poovan (*Rasthali* AAB). The experiment was laid out in factorial RBD with three levels of irrigation (I_1 @ 50% Pan Evaporation (PE), I_2 @ 75% PE, and I_3 @ 100% PE) and three levels of fertigation (F_1 @100% recommended dose of fertilizer (RDF) of Kerala Agricultural University (KAU), F_2 @ 75% RDF and F_3 @ 75% RDF along with 25% foliar application). These treatments were compared with farmers practice (control) that include basin application of water once in six days and soil application of fertilizers at 2 and 4 months after planting. Fertilizer application was scheduled with P as soil application and nitrogen and potassiumas drip fertigation at weekly intervals. Results of the experiment conducted for three years showed that irrigation @ 75% PE and fertigation @75% RDF could give significantly higher yield, water productivity, nutrient use efficiency and benefit cost ratio. Effect of fertigation showed significant influence on bunch weight and number of fingers. Bunch weight in F_2@ 75% drip fertigation (11.68kg/plant), was on par with F_3 (11.926 kg) in which 75% drip fertigation + 25% foliar spray was given. Bunch weight in the treatment F_2 was 30% increase over the control.

Key words: Drip irrigation, Fertigation, Nutrient scheduling, Poovan banana

Introduction

Banana, popularly known as "Apple of paradise" is the most common source of fruit available throughout the year. It is cultivated in more than 130 nations on an area of 10.1 million hectares, yielding 121.85 million tonnes (FAO, 2009). In India, banana account for 33.4% of total area for fruit production. Due to the presence of favourable climatic conditions, the southern states of India lead in banana production. In Kerala, cultivation is based on a vast range of cultivars that have been suited to domestic production as well as the uses and preferences of local customers (Smitha et al., 2020). *Rasthali* banana, commonly called "Poovan" in Kerala is gaining more importance because of its sweetness, aroma, religious acceptability etc.

The key determinants in the production of banana are water and nutrients. Pandey et al., (2005) clearly proved that applying prescribed quantities of vital nutrients at specific growth stages is required for excellent banana output. Drip method of irrigation in an efficient irrigation technology, delivers a meticulous quantity of water directly into the vicinity of the rootzone at the appropriate time, combining with the consumptive water requirements of plants for optimum growth which enhances the yield and quality of the crop while significantly reducing water use. Drip fertigation

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offers several advantages over traditional fertilizer application methods since it is the most efficient way of giving nutrients directly to the site of a high concentration of active roots and when the crop needs them. The ability to reduce nutrient element losses associated with conventional fertiliser use can be achieved by scheduling fertiliser applications based on requirements (Solaimalai et *al*., 2005). Fertigation can improve fertiliser use efficiency, nutrient uptake, quality parameters and save up to 30% on fertilizer, resulting in a significantly increased total mass of plant, improved phenological and bunch characteristics, higher fruit yield and quality of banana over conventional fertiliser application (Pawar and Dingre, 2013). Under these circumstances, the present study was carried out to evolve irrigation and fertigation scheduling in banana var. Poovan.

Materials and methods

A field experiment was carried out at Agronomic Research Station, Chalakudy to find out water and nutrient scheduling in drip fertigated banana var. Poovan during 2017–2020. Experimental site received an annual rainfall of 2669 mm in 2017, 3256 mm in 2018 and 3506 mm in 2020. The soil of the experimental site was acidic with sandy clay loam texture. The experiment was laid out in factorial RBD with three levels of irrigation and three levels of fertigation which were compared with farmers' practice in which basin application of water (surface irrigation) once in every six days and fertilizers at 2 and 4 months after planting were given. Altogether, there were ten treatments (3×3+1=10) with three replications. Different levels of irrigation include I_1 @ 50% PE, I_2 @ 75% PE and I_3 @100% PE. Irrigation was given on alternate days as per the treatment. The irrigation water requirement was calculated using the formula,

IR = Epan × spacing × wetted area

IR = irrigation requirement (m^3)

Epan = pan evaporation from US class A open evaporimeter (mm) × Pan coefficient

Wetted area was taken as 10% - upto 2 months after planting, 40% - 2 -6 months,
100% > 6 months

Fertigation treatments included F_1 @100% recommended dose of fertilizer (RDF) of KAU, 2016, F_2 @ 75% RDF and F_3 @ 75% RDF along with 25% foliar application. Tissue culture plants of banana were planted in 2018, 2019 and 2020 during December at a spacing of 2.1 m × 2.1 m. Drip method of irrigation was used with drippers of discharge rate 8 l/h and 2 drippers were laid on either side of the crop.

Fertilizers were applied as per the treatment as urea, rock phosphate and muriate of potash in which phosphorus fertilizer, rock phosphate was given as basal dose. Soil and plant samples were collected at regular intervals and analysed. Observations on different parameters were recorded, tabulated and analysed by using the technique of analysis of variance (ANOVA).

Results and Discussion

Effect of different levels of treatments on yield, irrigation water productivity (IWP), water productivity (WP) in the experiments conducted during 2017, 2018 and 2020 are given in Table 1. Effect of different levels of irrigation was not found to be significant in the first year and second year, but in the third year, yield was significantly higher in the treatment I_3 where 100% irrigation was given. Effect of fertigation on crop yield was significantly superior in the treatment F_2 during first year, but in the second year the main effect was not found to be significant. However, the individual effect of treatments was significantly superior in the third-year study. Similarly, effect of fertigation as significantly highest in F_2 and F_3 compared to F_1. Water productivity and irrigation water productivity were significantly highest when the crop was irrigated at 50% PE. Effect of all the treatments were found to be significantly superior when compared to control treatment in which basin application of

Table 1. Effect of treatments on yield, Irrigation water productivity (IWP) and overall water productivity (WP) in Poovan banana

Treatments	2017			2018			2020		
	Yield (kg/ha)	IWP (kg/m^3)	WP (kg/m^3)	Yield (kg/ha)	IWP (kg/m^3)	WP (kg/m^3)	Yield (kg/ha)	IWP (kg/m^3)	WP (kg/m^3
Irrigation levels (I)									
I_1-50%PE	30250	8.892	5.558	19542	6.816	4.216	18103	4.989	3.193
I_2-75%PE	30741	6.024	3.765	25464	5.321	3.292	19295	3.545	2.269
I_3-100%PE	31547	4.637	2.898	26932	3.969	2.455	21825	3.007	1.925
CD (0.05)	NS	0.638	0.399	NS	1.054	0.652	2566	0.452	0.289
Fertigation (F)									
F_1-100%RDF	28700	6.018	3.761	20842	4.489	2.777	16856	3.302	2.113
F_2 -75 %RDF	33493	7.009	4.381	25935	5.809	3.594	19512	3.806	2.436
F_3-75%RDF+25% foliar	30345	6.526	4.079	25162	5.807	3.593	22856	4.433	2.837
CD (0.05)	2881	0.638	0.399	NS	1.054	0.652	2566	0.452	0.289

Table 2. Effect of treatments on growth and yield parameterspooled for three years in Poovan banana

Treatments	Height(cm)	Girth(cm)	No. of leaves	Yield(kg/plant)	No. of hands	No. of fingers
Irrigation levels (I)						
I_1-50%PE	247.049	35.431	10.667	10.423	6.952	94.20
I_2-75%PE	247.986	36.172	11.259	11.239	7.174	100.05
I_3-100%PE	242.765	35.962	10.283	11.707	8.264	99.76
CD	NS	NS	NS	0.88	NS	5.158
Fertigation(F)						
F_1-100%RDF	235.852	33.925	10.406	9.864	7.793	91.44
F_2 -75 %RDF	256.35	37.06	11.09	11.679	7.275	99.89
F_3-75%RDF +25% foliar	245.58	36.57	10.70	11.926	7.322	102.69
CD	12.003	1.819	NS	0.88	NS	5.158
I XF						
I_1 X F_1	224.85	32.70	9.92	8.784	6.628	86.47
I_1 XF2	256.51	36.03	11.41	11.25	7.114	97.44
I_1 X F_3	259.77	37.55	10.66	11.236	7.113	98.69
I_2 X F_1	243.92	34.81	10.70	10.061	6.745	92.33
I_2 X F_2	252.03	36.59	11.74	11.64	7.239	100.32
I_2 X F_3	247.99	37.11	11.33	12.015	7.538	107.51
I_3 X F_1	238.77	34.25	10.59	10.746	10.007	95.51
I_3 X F_2	260.51	38.55	10.14	12.148	7.471	101.92
I_3 X F_3	229	35.07	10.11	12.228	7.314	101.86
CD	20.388	NS	NS	NS	NS	NS
Control				8.534	6.267	85.433
F statistic (T vs C)				20.207	1.198	14.816

water once in six days and soil application of fertilizer at two and four months after planting was done. In control treatment yield was 19356 kg/ha which is 30 % lower than F_2. Pawar and Dingre (2013) reported that the reason of low yield in surface irrigation might be that crop had to undergo water stress between two irrigations.

Statistical analysis of the pooled data over three years (Table 2) showed that varied levels of irrigation had significant effect on bunch weight and number of fingers. The effect was significantly highest in the treatments I_2 and I_3 in which 75% PE and 100% PE irrigation was given those performed better than 50% PE and control. Bunch weight per plant in 100% PE was 11.707kg which was comparable to 11.239 kg in I_2 (75% PE). Effect of fertigation on yield characters indicated a significant impact on bunch weight and number of fingers with the treatments F_2 (75% drip fertigation) and F_3(75% drip fertigation with 25% foliar spray) respectively. Treatment F_2 had a bunch weight of 11.639 kg which

Table 3. Effect of treatments on yield, water productivity (WP), nutrient use efficiency (NUE)and B:C ratio pooled for three years in Poovan banana

Treatments	Yield (kg/ha)	IWP kg/m^3	WP kg/m^3	NUE	B:C ratio
Irrigation levels (I)					
I_1-50%PE	23640	6.899	4.322	22.035	2.054
I_2-75%PE	25489	4.963	3.109	23.648	2.214
I_3-100%PE	26551	3.871	2.426	24.594	2.307
CD (0.05)	1996	0.486	0.302	1.93	0.176
Fertigation(F)					
F_1-100%	22371	4.603	2.884	17.129	1.94
F_2 -75 %	26488	5.541	3.47	27.057	2.372
F_3-75% +25% foliar	26821	5.589	3.503	26.091	2.263
CD (0.05)	1996	0.486	0.302	1.93	0.176
I XF					
I_1 X F_1	19923	5.805	3.639	15.255	1.728
I_1 XF2	25515	7.464	4.672	26.062	2.285
I_1 X F_3	25482	7.427	4.655	24.788	2.15
I_2 X F_1	22819	4.444	2.783	17.472	1.979
I_2 X F_2	26399	5.141	3.22	26.965	2.364
I_2 X F_3	27249	5.306	3.323	26.507	2.299
I_3 X F_1	24370	3.56	2.23	18.661	2.113
I_3 X F_2	27551	4.019	2.518	28.143	2.467
I_3 X F_3	27732	4.033	2.53	26.977	2.34
CD (0.05)	NS	NS	NS	NS	NS
Control	19356	2.82	1.77	14.82	1.76
F static (Tvs C)	20.20				

is comparable to F_3 (11.926 kg). The number of hands was not found to be influenced by the levels of irrigation and fertigation. Senthilkumar et al., (2017) reported that in fertigation, fertilizer levels are important in influencing yield attributes. Increasing the levels of N and K increased the plant growth parameters viz. plant girth, number of leaves at harvest and phyllochron. Fertigation lowered crop duration and produced the heaviest bunches, number of hands and fruits.

Effect of treatments on yield, water productivity (WP), nutrient use efficiency (NUE) and B:C ratio (BCR) pooled for three years is given in Table 3. Statistical analysis of the data showed that productivity of Poovan banana is significantly affected by irrigation and fertigation. Bunch weight was significantly superior when drip irrigation was done at 100% PE. Yield of the crop at 100% PE irrigation was 26551.7 kg/ha which is on par with yield at 75% PE of 25489.24 kg/ha. Fertiliser scheduling with phosphorus applied as basal method and nitrogen and potassium as fertigation at weekly intervals, resulted in better bunch and F2 and F3 were on par. Weight was significantly highest with 100% application of recommended fertilizer (F_3) which is on par with 75% RDF (F2). Yield of the crop in the treatment F_3 was 26821. 48 kg/ha (75% nitrogen and potassium were applied as fertigation and balance 25% as foliar spray) and in the treatment F_2 was 26488 kg (75% nitrogen and potassium as fertigation). Water productivity was highest with irrigation at 50% PE. Nutrient use efficiency and benefit cost ratio was highest with fertigation at 75%. Higher yield of banana is attributed to the high nitrogen and potassium nutrient status of the crop. Improved nitrogen content resulted in better leaf size and vegetative growth. The higher potassium status might have improved the translocation of photosynthate from source to sink and ultimately increased the yield (Kumar and Pandey, 2008). Ashok et al., (2017) reported that only 65% of RDF applied can produce yields compared to those of conventional farming. When compared to the check basin technique of irrigation and the way of applying fertilizer through soil manipulation, the efficiency

of water and fertilizer consumption was 25% greater for drip-irrigated plots. Considering the yield, water productivity and economics, drip irrigation at 50% PE. and fertigation at 75% of RDF where phosphorus was applied as basal and nitrogen and potassium as fertigation can be recommended in Poovan banana.

Table 4. Effect of levels of irrigation and fertigation schedule on organic carbon (%) in soil after crop

	F_1	F_2	F_3	Mean
I_1	1.38	1.078	1.251	1.236
I_2	1.055	1.068	1.021	1.048
I_3	1.021	1.171	1.23	1.141
Mean	1.15	1.106	1.167	
	Control - 1.32		CD Irrigation (0.05=0.134)	

Table 5. Effect of levels of irrigation and fertigation schedule on available phosphorus in soil after crop

	F_1	F_2	F_3	Mean
I_1	171.95	146.17	121.81	146.64
I_2	185.94	145.1	111.06	147.36
I_3	135.43	166.94	120.37	140.91
Mean	164.44	152.74	117.75	
	Control – 166.6		CD Fertigation (0.05=28.089)	

Table 6. Effect of levels of irrigation and fertigation schedule on available potassium in soil after crop

	F_1	F_2	F_3	Mean
I_1	270.01	279.18	285.04	278.07
I_2	237.25	251.85	211.49	233.53
I_3	201.27	283.137	209.18	231.19
Mean	236.17	271.39	235.24	
	Control – 201.26	CD(I) NS	CD(F) NS	

Soil samples were analyzed for organic carbon, available phosphorus, available potassium and other nutrients during the crop growth (Table 4 to 6). The organic carbon status in the soil after the crop was not greatly influenced by the treatments. The direct effect of treatment I_3 was on par with I_2 on the available phosphorus status in soil and was significantly superior over I_1. The direct effect of F_3 was on par with F_1 and significantly superior over F_2. Generally available status of P and K was higher in F_1 where 100% RDF was applied. The direct effects of different treatments were not found to have any significant influence on available K status in soil. Further the treatments were not found to significantly influence the soil characteristics when compared to control.

Study on the influence of nutrient dynamics under different moisture regimes in Poovan (*Rasthali*) banana was done during 2017, 2018 and 2020. Results of the experiments showed that the application of drip irrigation at 75% PE at two days interval is sufficient to get significantly higher and sustainable yield. When fertigation was scheduled with P as basal and drip fertigation at weekly interval with 75% RDF of N and K, significantly superior yield was obtained. Effect of treatments were found to be significantly higher and an increase in 30% of yield could be recorded over control treatment in which basin application of water once in six days and soil application of fertilizer at two and four months after planting was done.

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