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Influence of Fertigation on Yield, Quality, Water Use and Economics of Ratoon Banana in Inceptisols under Semi-Arid Maharashtra

K. D. Kale[1]*, S. D. Shinde[1], S. R. Pawar[1] and D. D. Pawar[2]

[1]*Interfaculty Department of Irrigation Water Management, MPKV, Rahuri - 413 722, Maharashtra.*
[2]*Dr. Annasaheb Shinde College of Agricultural Engineering and Technology, MPKV, Rahuri - 413 722, Maharashtra.*

Abstract: The trial was conducted under field conditions to study the effect of fertigation on yield, quality, water use and economics of ratoon banana during 2013-14 at Interfaculty Department of Irrigation Water Management, MPKV Rahuri. There were nine treatments replicated thrice in randomized block design. The results indicated that 100% RDF through monoammonium phosphate (12:61:00) recorded significantly higher yield (82.35 t ha^{-1}) and it was at par with fertigation @ 80% RDF applied through special grade fertilizer (9:5:33) and balanced N and P_2O_5 (T_6) and fertigation @ 80% RDF applied through monoammonium phosphate (12:61:00). The treatment T_6 saved 20 per cent fertilizer and had 12.71% increases in yield over drip irrigation with 100% RD of conventional fertilizer application method (T_8). Fertigation with water soluble fertilizers had a positive effect on pulp: peel ratio and TSS of banana as compared to conventional method (T_8). The higher net monetary returns and water productivity was observed in fertigation treatment T_2 to tune of Rs. 4,27,798 ha^{-1} and Rs. 434 per cm respectively.

Keywords: *Drip fertigation, ratoon banana, yield, quality, water use and economics*

Introduction

Banana (*Musa paradisica*) is one of the most widely grown fruit crop in India. India ranks first in production (24.46 million tonnes) of bananas from an area of 0.65 million ha with productivity of 37.0 t ha^{-1}. Maharashtra ranks second in area and production of the banana after Tamil Nadu with an area of 0.74 lakh ha producing 4.65 million tones of banana and productivity of 62.9 t ha^{-1} (Anonymous 2014). Indian farmers mostly adopt surface irrigation for banana resulting in heavy water losses and prolonged application of excess water disturbs soil-air-water balance resulting in decay of roots (Kadao *et al*. 2001 and 2002), loss of costly fertilizers due to leaching. Thus, there is a need of efficient and water saving technology such as drip and sprinkler irrigation systems. Fertigation is a technology of applying water soluble fertilizer through drip irrigation which has number of advantages over traditional methods like high nutrient use efficiency, increased yield and quality.

Fertigation allows frequent, uniform and precise application of nutrients through drip directly into the active root zone as per need of crop which results into higher yield and higher fertilizer use efficiency over conventional method of fertilizer application (Shaymaa *et al.* 2009). The present investigation was undertaken to study the influence of fertigation on yield, quality, water use and economics of ratoon banana in an Inceptisols under semi-arid Maharashtra.

*Corresponding author : (Email: kd_kale@rediffmail.com)

Materials and Methods

The field experiment was conducted during 2013 to 2014 at research farm of Interfaculty Department of Irrigation Water Management, Mahatma Phule Krishi Vidyapeeth Rahuri. Agro- climatically, the area falls under the scarcity zone of Maharashtra with annual average rainfall of 523 mm which is mostly erratic and uncertain in nature. The clayey texture and 80 cm deep soil had pH 8.15, available N 157.0 kg ha^{-1} (low), available P 14.20 kg ha^{-1} (medium) and available K 465.0 kg ha^{-1} (high). The soil had good drainage with moisture content at field capacity, permanent wilting point and available water content to the tune of 39.20, 17.90 and 21.30 per cent, respectively. The experiment was laid out in randomized block design with nine treatments and replicated thrice. The treatments were T_1-Fertigation @ 100% RDF applied through mono ammonium phosphate (12:61:00); T_2-Fertigation @ 80% RDF applied through mono ammonium phosphate (12:61:00); T_3-Fertigation @ 60% RDF applied through mono ammonium phosphate (12:61:00); T_4-Fertigation @ 80% RDF applied through special grade (9:5:33) without balancing the N and P_2O_5; T_5-Fertigation @ 60% RDF applied through special grade (9:5:33) without balancing the N and P_2O_5; T_6-Fertigation @ 80% RDF applied through special grade (9:5:33) and balanced N and P_2O_5; T_7-Fertigation @ 60% RDF applied through special grade (9:5:33) and balanced N and P_2O_5; T_8-Drip irrigation @ 100% RD of CF applied through soil and T_9-Drip irrigation without fertilizer. The RDF for ratoon banana was 200: 40: 200; N: P_2O_5: K_2O g $plant^{-1}$ for fertigation as well as for conventional fertilizer treatments. For fertigation namely urea, monoammonium phosphate (12:61:00) and sulphate of potash (SOP, 0:0:50) and special grade fertilizer (9:5:33) were used. The urea, single super phosphate (SSP) and muriate of potash used as conventional fertilizers. The water-soluble fertilizers were applied as per growth stages in all the treatments in 18 fortnight splits. In first 4 splits, the per cent of applied NPK was 15:30:10; in 5-8 splits, the per cent of applied NPK was 40:50:20; in 9-12 splits, the per cent of applied NPK was 25:20:25; in 13-14 splits, the per cent of applied NPK was 20:00:30 and in 15-18 splits, the per cent of applied NPK was 00:00:15. In case of treatment T_8, the N, P and K were applied through soil. Nitrogen was applied in two splits *i.e.* 1st at planting and 2nd at 4 months after planting (MAP). The recommended dose of phosphorous was applied as basal and potassium was applied in four equal splits at 30,165, 255 and 300 days after planting (DAP) through soil. The tissue culture banana sapling (*var.* grand naine) of two months old was planted at a spacing of 1.5m X 1.5m. The ratoon banana crop was started from 1st October, 2013.

The adequate plant protection measures were adopted as and when required. The water requirement per plant (litres/day) to be applied through drip irrigation was calculated by the climatologically approach method (Allen *et al*. 1998). The reference evapotranspiration was estimated using Evapotranspiration Monitoring unit. In drip irrigation system water was applied on alternate day.

The quality of banana fruits was assessed in terms of pulp: peel ratio, TSS and acidity. TSS was determined by hand refractometer. The acidity was determined by titrating the juice sample with 0.1 *N* NaOH using phenolphthalein as an indicator. The total cost of cultivation was worked out by adding the system cost and operational cost of respective treatments. Net monetary returns were worked out by subtracting the cost of production from the gross returns for each treatment and benefit: cost ratio is the ratio of gross income to the total cost of cultivation ha^{-1}.

The water productivity (Rs ha^{-1} mm) was calculated by dividing the corresponding values of the net seasonal income with water used (Pawar *et al*. 2013). The statistical analysis was carried out as outlined by as Panse and Sukhatme (1985).

Results and Discussion

Yield of Banana

The banana yield (Table 1) ranged from 48.08 t ha^{-1} to 82.35t ha^{-1}. The maximum yield of 82.35 t ha^{-1} was obtained in T_1 treatment and it was significantly higher

than other treatments baring T_6 treatment (79.66 t ha^{-1}) and T_2 treatment (77.21 t ha^{-1}). It was 36.72% higher than conventional method of fertilizer application *i.e.* T_8 treatment (60.23 t ha^{-1}). The higher yield under fertigation over conventional fertilizer applied to soil could be attributed to the regular application of nutrients (18 splits) in the active root zone of the crop. The treatment without fertilizer (T_9) produced the lowest banana yield (48.08 t ha^{-1}). The yield of banana (79.66 t ha^{-1}) under drip irrigation with 80% RD of fertigation (T_6) was significantly higher than 100% RD of conventional fertilizers applied through soil (T_8). It indicates that fertigation using water soluble fertilizers can save fertilizer requirement of banana upto 20%. These results are in confirmation with those reported by Rongate *et al.* (2017).

Table 1. Yield and quality of ratoon banana fruits as influenced by different treatments

Treatment	Yield (t ha^{-1})	% increase in yield over CF (T_8)	Pulp : peel ratio	Total soluble solids (%)	Acidity (%)
T_1	82.35	36.72	2.65	21.72	0.31
T_2	77.21	28.19	2.60	20.8	0.34
T_3	67.89	12.71	2.57	20.33	0.35
T_4	72.96	21.13	2.59	20.8	0.33
T_5	65.52	8.78	2.56	20.33	0.35
T_6	79.66	32.25	2.63	21.65	0.32
T_7	70.84	17.61	2.59	20.66	0.34
T_8	60.23	-	2.54	19.8	0.37
T_9	48.08	-	2.5	18.2	0.4
S.E. $\pm$	1.84	-	0.015	0.024	0.010
CD at 5 %	5.44	-	0.04	0.072	0.031

Quality of banana fruits

The quality parameters of banana fruits *viz.* pulp: peel ratio, TSS and acidity were significantly influenced by fertigation treatments (Table 2). The treatment T_1 had significantly higher values for pulp: peel ratio (2.65) and TSS (21.72^0) than other treatments and it was at par with treatment T_6. Similar results were reported by Dahiwalkar *et al.* (2004). Treatment T_1 had the lowest acidity (0.31 %) but it was at par with T_6 (0.32%) and T_4 (0.33%). Acidity decreased with increase in fertilizer level confirming the findings of Singh *et al.* (1977).

Water use

The total water used by ratoon banana under drip method was 985.6 mm (Table 3). Fertigation @ 100% RDF applied through mono ammonium phosphate (12:61:00) resulted into 36.72 per cent increase in yield over conventional fertilizer applied through soil (T_8). The maximum water use efficiency of 83.60 kg ha^{-1} mm was recorded in treatment T_1 followed by T_6 (80.87 kg ha^{-1} mm) and lowest WUE (48.81 kg ha^{-1} mm) was observed in T_9.

Table 2. Water use and water use efficiency of ratoon banana

Treatment	Depth of water applied (mm)	Effective Rainfall (mm)	Total Water use (mm)	WUE (kg ha^{-1}mm)
T_1	913.1	72.5	985.6	83.60
T_2	913.1	72.5	985.6	78.39
T_3	913.1	72.5	985.6	68.92
T_4	913.1	72.5	985.6	74.09
T_5	913.1	72.5	985.6	66.52
T_6	913.1	72.5	985.6	80.87
T_7	913.1	72.5	985.6	71.91
T_8	913.1	72.5	985.6	64.75
T_9	913.1	72.5	985.6	48.81

Table 3. Economics of ratoon banana as influenced by different treatments

Treatment	Cost of cultivation (Rs ha^{-1})	Gross monetary returns (Rs ha^{-1})	Net monetary returns (Rs ha^{-1})	B:C ratio	Water productivity (Rs ha-mm^{-1})
T_1	252758	617625	346867	2.44	370
T_2	151277	579075	427798	3.83	434
T_3	129996	509175	379179	3.91	385
T_4	271398	547200	275802	2.02	280
T_5	219990	491400	271410	2.23	275
T_6	291358	604950	313592	2.08	318
T_7	235351	531300	295949	2.26	300
T_8	118903	451125	332222	3.79	337
T_9	66242	338100	271390	5.10	275

Economics

Cost of cultivation

The total seasonal cost of cultivation was computed by adding the seasonal cost of drip irrigation system and operating cost. The total seasonal cost of drip irrigation system for 1.5 m lateral spacing for planting of banana and considering 12 months crop period. Results showed that the higher cost of cultivation was observed in fertigation treatments than conventional fertilizer applied through soil (Table 3) because of higher cost of water-soluble fertilizers (WSF). The highest cost of cultivation was observed in treatment T_6 (Rs. 2,91,358) followed by T_4 (Rs.2,71,398) and the lowest cost of cultivation was observed in T_9 (Rs. 66,242) as the cost of water-soluble fertilizers was more than that of conventional fertilizers.

Net monetary returns

The maximum net monetary returns of Rs**.** 4,27,798 per ha were obtained in T_2 treatment due to the higher fruit yield followed by T_3 (Rs**.**3,79,179). Drip fertigation without fertilizer (T_9) gave lowest yield of fruits hence, the net monetary returns was also lowest *i.e.* Rs. 2,71,390 (Table 3) at the market price of Rs**.** 5,000 tonnes^{-1} for all the treatments. These results are in close conformity with the findings of Pawar *et al.* (2013). The maximum B:C ratio was recorded in drip irrigation without fertilizer (T_9) followed by T_3 treatment. The lower B:C ratio (1.69) was observed in T_6 due to higher cost of water soluble fertilizers.

Water productivity

The maximum water productivity was recorded in treatment T_2 (Rs. 434 ha^{-1} mm) water used followed by treatment T_3 (Rs. 385 ha^{-1} mm). The minimum water productivity was recorded for drip irrigation without fertilizer (T_9) *i.e.* Rs. 275 ha^{-1} mm water used.

Conclusion

The significantly higher yield of banana was obtained in treatment comprising of fertigation @ 100% RDF and which was 36.72% higher than drip irrigation @ 100% RD of conventional fertilizer application. The treatment of fertigation @ 100% RDF recorded significantly higher net monetary returns and net profit mm^{-1} of water over drip irrigation @ 100% RD of conventional fertilizer application. It can be concluded that fertigation @ 80% RDF in 18 splits at fortnight interval is necessary for achieving the higher yield, maximum monetary benefits and water productivity of banana (*var.* grant naine) in medium deep black soils of semi- arid Maharashtra.

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