Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

J P P Journal of Pharmacognosy and Phytochemistry

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(1): 866-869
Received: 01-11-2017
Accepted: 02-12-2017

Uddipta Ghosh
Research Scholar, Department of Soil and Water Engineering, Faculty of Agricultural Engineering, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Nabanita Sarkar
Research Scholar, Department of Soil and Water Engineering, Faculty of Agricultural Engineering, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Ranajit Kumar Biswas
Professor. Department of Soil and Water Engineering, Faculty of Agricultural Engineering, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Correspondence
Uddipta Ghosh
Research Scholar, Department of Soil and Water Engineering, Faculty of Agricultural Engineering, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

A review on performance evaluation of drip irrigation system in banana cultivation

Uddipta Ghosh, Nabanita Sarkar and Ranajit Kumar Biswas

Abstract
Banana *(Musa sp.)* is the second most important fruit crop in India next to mango. Its year round availability, affordability, varietal range, taste, nutritive and medicinal value makes it the favorites fruit among all classes of people. This study attempts at reviewing the effect of drip irrigation in banana *(Musa paradissica* L). The total water requirement of banana plants is about 900-1200 mm for its entire life cycle and this can be met both through natural precipitation (rainfall) as well as supplementary irrigation. India is struggling with the challenges of water scarcity, including water for crops. Drip irrigation is introduced primarily to save water and increase the water use efficiency in agriculture. However, it also delivers many other economic and social benefits to the society. In this system water is applied drop by drop or by micro jet, on the soil surface or below it (sub-surface), at a rate lower than the infiltration of the soil. In this article, intensive research works regarding water management for banana has been reviewed and discussed so that a definite perception may be generated for the farmers as well as future researchers.

Keywords: Banana, supplementary irrigation, drip irrigation, sub-surface, infiltration

Introduction
Banana in India is known as instant energy provider, which is cheap, nutritious and available all round the year. It is an important fruit crop grown in India next to mango. The area under banana was 7.09 lakh hectares in 2008-09 and the production was 26.22 million tonnes in 2008-09 (Anonymous, 2009) [1]. It contributes more than 2.8% to GDP of agriculture in India. Banana requires large quantity of water during its life cycle. In winter, Irrigation is provided at an interval of 7-8 days while in summer it should be given at an interval of 4-5 days (Sharma and Kispotta, 2016) [30]. However, during rainy season irrigation is provided if required as excess irrigation will lead to root zone congestion due to removal of air from soil pores, thereby affecting plant establishment and growth. In all, about 70-75 irrigations are provided to the crop. India has one of the largest irrigated areas in the world, but its per-capita as well per-hectare availability of water is one of the lowest in the world. The efficient and judicious use of both water and fertilizer is the key for improving agricultural production and productivity in the country. Owing to various reasons the demand for water for different purposes has been continuously increasing in India, but the potential water available for future use has been declining at a faster rate (Saleth, 1996; CWC, 2005) [28, 6]. The agricultural sector (irrigation), which currently consumes over 80 percent of the available water in India, continues to be the major water-consuming sector due to the intensification of agriculture (Saleth, 1996; MoWR, 1999, Iyer, 2003) [28, 7, 3]. Due to water scarcity, the available water resources should be utilized very effectively through water saving irrigation technologies to maximize the yield. Furrow and basin irrigation methods are commonly adopted to irrigate the crop, which causes adverse effects of water excess and water stress (Hedge and Srinivas, 1990; Raina *et al*. 2011) [12, 27]. Drip irrigation is the most efficient and new technology of irrigation in India to supply precise amounts of water directly into the vicinity of root zone at right time, matching with the consumptive water demand of plant for optimum growth, improved yield and quality of produce with substantial water saving (Kumar *et al.*, 2005; Shashidhara *et al.*, 2007; Thangaselvabai *et al.*, 2009) [16, 32, 33, 37]. The drip method of irrigation also helps in reducing over-exploitation of groundwater that partly occurs in surface irrigation. Water saving through drip irrigation system is estimated to be in the range of 12-84 per cent in different crops, besides its beneficial impact on crop yields (Narayanamoorthy, 1996; 1997) [20, 21]. Drip irrigation refers to frequent application of small quantities of water on or below the soil surface as drops. It embodies the philosophy of irrigating the root zone instead of entire land. The drip fertigation method has considerable potential to improve water and fertilizer use efficiency.

Drip irrigation in banana plantations has helped in saving water and offers a great promise, owing to precise and direct application of water in the root zone of plants (Shashidhara *et al*. 2007; Agrawal and Agrawal 2005) [32, 33, 2]. In addition, due to higher frequency of irrigation, ensuring availability of moisture at critical crop growth stages saves the plants from moisture stress throughout the growing period (Dahiwalkar *et al*. 2004) [7]. The other issue related to drip irrigation is its economic viability and the farmers are often reluctant to adopt this method due to their weak resource base. Therefore, the objective of this paper is to review the banana cultivation under drip irrigation system and to identify the efficiency of drip system which affect the different growth and yield parameters in comparison to other conventional irrigation system.

Effect on growth parameters

From the experiment which was conducted at the District of Kaushambi (U.P.), observed that adoption of drip irrigation over flood irrigation as 8.46% higher in plant height, 17.24% more as girth of plant, 2.94% more as average number of leaves (Sharma and Kispotta, 2016) [30]. Pramanik and Patra (2016) [24] evaluated that the pooled data on plant height, pseudostem girth, leaf number, leaf length, leaf breadth, leaf area and leaf area index (LAI) at shooting stage both plant and ratoon crops showed maximum values with drip irrigation at 70% which differed significantly from other irrigation levels.

Effect of irrigation treatments on crop duration

Shashidhara *et al*. (2007) [32, 33] who found that the drip irrigation minimized the days to harvest (398 days) as compared to surface method of irrigation (435 days). Sharma and Kispotta (2016) [30] reported that the fruit setting took place 28 days earlier and the average harvesting period was less by 32 days in Drip irrigation system.

Yield and yield components

Pramanik and Patra (2016) [24] reported that drip irrigation resulted in significantly the highest yield in both plant (39.87 t/ha) and ratoon crop (36.85 t/ha) over conventional method of irrigation. Shashidhara *et al.* (2007) [32, 33] reported that drip irrigation increased yield of banana to the extent of 5.94% and 3.54%, respectively as compared to surface irrigation. Thadchayini and Thiruchelvam (2005) [36] reported 31% higher banana yield in drip irrigation compared to surface irrigation. Sharma and Kispotta (2016) [30] reported that Yield is 21.95% more. 38.82% water is being saved by drip system. Pramanik and Biswas (2012) [23] showed that the drip fertigation method resulted in considerably higher yield in plant (39.87 t/ha) and ratoon crop (36.85 t/ha) as compared with those obtained by conventional method of irrigation (37.09 and 34.84 t/ha for plant and ratoon crop respectively). Hegde and Srinivas (1991) indicated an increase in the banana yield under drip irrigation compared to the basin irrigation. Shashidhara *et al*. (2007) [32, 33] who reported higher length of fruit and fruit thickness of banana under drip irrigation compared to surface irrigation. The increase in fruit yield was due to the improvement in bunch weight of banana under drip fertigation, possibly due to enhanced water utilization through drip, better nutrients uptake and excellent soil-water-air environment in the root zone (Singandhupe *et al*., 2003). Young *et al.*, (1985) [34, 38] stated that drip irrigation of banana crop produced double the yield obtained from a well managed sprinkler irrigation system in Hawaii. The yield improvement under drip irrigation was mainly due to the maintenance of soil near field capacity throughout the growth period in the active root zone, leading to low soil suction, which thereby facilitated better water utilization, higher nutrients uptake and excellent maintenance of soil-water-air relationship with a higher oxygen concentration in the root zone (Kumar *et al*., 2007; Raina *et al*., 1999, 2011) [26, 27]. Pramanik *et al.* (2014) [25] observed that under this drip fertigation treatment, the yield of both plant and ratoon crop was also higher (32.5% and 26.4% for plant and ratoon crop, respectively) as compared to in the conventional method of irrigation.

Total water Requirement

Pramanik and Patra (2016) [24] reported that higher water use and lower irrigation water use efficiency were observed under the conventional surface irrigation. Khalifa (2006) [14] observed that the quantities of water applied to banana plants were 15964 m^3/ha, 20201 m^3/ha, 27642 m^3/ha, 30635 m^3/ha and 32928 m^3/ha under drip irrigation regimes 40%, 60%, 80%, 100% and 120% of (ET_c), respectively compared to 116905 m^3/ha for surface irrigation. Moreover, Sharmasarkar *et al*. (2001) [31] reported that the amount of applied irrigation water with the drip system was lower than that applied by surface irrigation. Bashour and Nimah (2004) [5] reported that the trickle irrigation saved about 50% of the water used in surface irrigation. Similarly, Fulton *et al.* (1991) [9, 10] found that more water was applied with the furrow systems compared to the drip system. Aujla *et al.* (2007) [3] reported a saving of 25% water on drip irrigation compared with furrow irrigation. Pramanik and Biswas (2012) [23] evaluated that the irrigation water use was found to be the highest under conventional method of irrigation (57.00 cm and 33.00 cm for plant crop and ratoon crop respectively) for the entire life cycle of the crop. Similarly, Fulton *et al*. (1991) [9, 10] found that more water was applied with the furrow systems compared to the drip system. Pramanik *et al.* (2014) [25] observed that the irrigation water-use was found to be highest under the conventional method of irrigation (57.0 cm for plant crop and 33.0 cm for ratoon crop) for the lifecycle of the crop. The irrigation requirement of the crop was found to be lower in plants under drip fertigation. Considerable saving in water (41.7% in plant and 40.4% in ratoon crop) was observed in drip fertigation under 60 per cent CPE and 80 per cent RDF. The water-saving was about 29 per cent in banana due to adoption of drip irrigation over flood irrigation (Narayanamoorthy, 2003) [22]. They have further added that water required to produce one quintal of banana under drip method is only 1.33 horse power (HP) hours of water against the requirement of 3.17 HP hours of water under flood irrigation.

Water Use Efficiency

Salvin *et al.* (2000) [29] studied the efficiency of drip irrigation in banana. They stated that highest WUE was recorded in plants under drip irrigation at lowest WUE was recorded in the basin irrigated plants (146.09 Kg/ha-cm). Pramanik and Biswas (2012) [23] showed that WUE was higher in plants under drip fertigation then those conventional methods of irrigation. Hassanli *et al*. (2009) [11] who stated that the maximum irrigation water use efficiency was obtained with the drip irrigation and the minimum was obtained with the furrow method. Khalifa (2006) [4] observed that the highest irrigation water productivity (1.43 and 1.40 kg/m^3) was obtained with 120% and 100% of ETc under drip irrigation and the lowest was (0.30kg/m^3) with surface irrigation. Similarly, Muralikrishnasamy *et al*. (2006) [18] found that the

maximum irrigation water use efficiency was recorded on drip irrigation compared with surface irrigation. Pramanik and Patra (2016) [24] reported that higher irrigation water use and lower irrigation water use efficiency were observed under the conventional surface irrigation as compared to varying levels of drip irrigation. The drip system delivers precise amount of water directly into the root zone matching with crop evapotranspiration demand which probably resulted in higher water use efficiency under drip irrigation as compared to traditional surface irrigation (Srinivas *et al*., 2001) [35]. Pramanik *et al*. (2014) [25] observed that the water-use efficiency (WUE) was found to be higher in plants under drip fertigation than under the conventional methods of irrigation.

Economic analysis

Basavarajappa *et al*. (2010) [4] who found that the highest net returns and the benefit cost ratio were obtained in the drip irrigation treatment which received irrigation at 100% of crop ET and the lowest were obtained in the furrow irrigation treatment. Shashidhara *et al*. (2007) [32, 33] found that drip irrigation had higher benefit cost ratio as compared to surface irrigation. Pramanik and Biswas (2012) [23] observed that the drip fertigation system is more profitable as compared to surface irrigation (conventional method) due to increase in yield of banana plant. Pramanik *et al*. (2014) [25] observed that The drip fertigation system was found more profitable compared to surface irrigation (conventional method) in ratoon crop also due to increase in banana yield. Narayanamoorthy (2003) [22] has concluded that investment on drip is economically viable even without subsidy. Khalifa (2006) [14] showed that drip irrigation is the most economic form and had higher net benefit and high marginal rate of return compared to other treatments. These results indicated that the initial investment cost was higher in drip irrigation and over the long run the yield will be sustainable. Narayanamoorthy (2006) [19] conducted a study to evaluate the impact of drip irrigation on cost of cultivation, production and productivity of different crops. He mentioned that water saving and the water use efficiency of different crops cultivated under drip irrigation are significantly higher when compared to those under flood irrigation. Hence, there is strong basis to encourage the farmers to adopt the drip irrigation method. Dave *et al.*, (2016) [8] conducted an experiment on the comparative economics of banana cultivation under drip and conventional irrigation methods by collecting data from 60 drip farms and 60 non-drip farms of Anand district during 2009-10. Though the investment on drip irrigation system for banana crop was expensive (84115/ha), the total cost of cultivation in drip farms (150098/ha) was slightly less than that in non-drip farms (151735/ha). The yield (13.94 per cent) and net profit (52.76 per cent) of banana in drip farms were higher as compared to non-drip farms.

Conclusion

The study clearly suggests the advantage of drip and fertigation with applying precise amounts of water and fertilizer nutrients over surface irrigation and conventional soil fertilization for banana production. It is concluded from the study that drip irrigation favourably influenced the banana yield which resulted in higher irrigation WUE against lower amounts of water applied. Apart from advantage of water saving over conventional irrigation, drip system proved to be very effective and efficient method of irrigation for cultivation of banana crop. Moreover, benefit-cost ratios with different discount rates indicated that drip investment in banana cultivation is economically significant. The practice of drip irrigation should be encouraged in the banana fields. Since the farmers are getting water for the low cost from the public irrigation system, they are least interested to adopt this technology. Drip irrigation also proved effective on silty clay textured soils like inceptisols and water constrain situation in new alluvium zone of West Bengal. Considering the rapid decline in irrigation-water availability and low water-use efficiency under the conventional method, appropriate initiatives should be taken to increase the area under drip fertigation to avoid demand-supply gap in water-use in the near future. The private benefit-cost ratio, estimated using discounted cash flow technique, has clearly indicated that drip investment is economically viable even without subsidy.

Recommendations

It is observed that farmers are very well aware with the benefits of drip irrigation system but they are hesitant to adopt this technology because they are not having proper information. Training facilities for farmers are essential to increase the adoption of drip irrigation. All registered suppliers under Govt. schemes should provide facilities for training of farmers in operation and maintenance of the system. Extension workers must ensure about spreading awareness of its benefits and also about scarcity of natural resources like water. *Pradhan Mantri Krishi Sinchai Yojana* also focuses on creating sources for assured irrigation, creating protective irrigation by harnessing rain water at micro level through *'Jal Sanchay'* and *'Jal Sinchan'* to ensure 'Per drop-More crop'. Due to delay in receiving amount of Government subsidy on drip set sellers are not ready to give cash discount to farmers on purchase price of drip. Hence it is required to implement the scheme of direct subsidy to farmer like Gujarat state. Now a day the Government of Maharashtra has also adopted this method of subsidy, but it must be rooted in grass route level.

References

1. Anonymous. National Horticulture Database, 2009.
2. Agrawal Narendra, Agrawal S. Effect of drip irrigation and mulches on the growth and yield of banana cv. Dwarf Cavendish. Indian Journal of Horticulture. 2005; 62(3**)**:238-240.
3. Aujla MS, Thind HS, Buttar GS. Fruit yield and water use efficiency of eggplant (Solanum melongema L.)as influenced by different quantities of nitrogen and water applied through drip and furrow irrigation.*Scientia Horticulturae*. 2007; (112):142-148.
4. Basavarajappa HB, Polisgowdar BS, Patil MG. Effectiveness and cost economics of fertigation in brinjal (Solanum melongena L.) under drip and furrow irrigation. Karnataka Journal of Agricultural Science. 2010; 24(3):417-419.
5. Bashour I, Nimah M. Fertigation potentials in the near east region.IPI regional workshop on Potassium and Fertigation development in West Asia and North Africa; Rabat, Morocco, 2004.
6. CWC. Water and Related Statistics, Ministry of Water Resources, Central Water Commission (CWC), Government of India, New Delhi, 2005.
7. Dahiwalkar SD, Divekar BK, Sonawane DA. Relative performance of fertigation on growth, yield and quality of banana. Journal of Maharashtra Agricultural Universities. 2004; 29(2):235-237.
8. Dave AK, Zala YC, Pundir RS. Comparative economics

of Banana cultivation in Anand district of Gujarat. *Economic Affairs***,** 2016; 61(2):305-312.
9. Fulton AE, Oster JD, Hanson BR, Phene CJ, Goldhamer DA. Reducing drains water: furrow vs. subsurface drip irrigation. *Calif. Agric*. 1991; 45(2):4-8.
10. Fulton AE, Oster JD, Hanson BR, Phene CJ, Goldhamer DA. Reducing drains water: furrow vs. subsurface drip irrigation. *Calif. Agric*. 1991; 45(2):4-8.
11. Hassanli AM, Ebrahimizadeh MA, Beecham S. The effects of irrigation methods with effluent and irrigation scheduling on water use efficiency and corn yields in an arid region. *Agricultural water management*. 2009; (96):93-99.
12. Hedge DM, Srinivas K. Growth, productivity and water use of banana under drip and basin irrigation in relation to evaporation replenishment. Indian J. Agron**.,** 1990; 35(1-2):106-112.
13. Iyer, Ramasamy R, Water: Perspectives, Issues, Concerns, Sage Publications, New Delhi, 2003.
14. Khalifa ABA. Comparison of Surface and Drip Irrigation Regimes for Banana (*Musa AAA*) cv. Grand Nain in Gezira, Sudan ((Master Degree dissertation). 2006. Retrievedfromhttps://ruforum.org/system/tdf/Ahmed%20Babiker%20Ahmed%20Khalifa%20%20thesis.pdf?file=1&type=node&id=31642&force=
15. Kumar D, Pandey V. Effect of NPK fertigation on growth, yield and quality of banana 'Rasthali' (AABPathkapoora) in coastal agro-climatic conditions of eastern India. Indian Journal of Agricultural Sciences. 2008; 78(9):798-800.
16. Kumar S, Sharma IP, Raina JN. Effect of levels and application methods of irrigation and mulch materials on strawberry production in north-west Himalayas. J Indian Soc. Soil Sci. 2005; 53(1):60-65.
17. MoWR. Report of the Working Group on Water Availability for Use, National Commission for Integrated Water Resources Development Plan, Ministry of Water Resources, Government of India, New Delhi, 1999.
18. Muralikrishnasamy S, Veerabadran V, Krishnasamy S, Kumar V, Sakthivel S. Drip irrigation and fertigation in Chillies (Capsicum Annuum). 7th International micro irrigation congress. Kuala Lumpur, 2006.
19. Narayanamoorthy A. Efficiency of irrigation: a case of drip irrigation. Occasional Paper National Bank for Agriculture and Rural Development, Mumbai. 2006; 45:38.
20. Narayanamoorthy A. *Evaluation of Drip Irrigation System in Maharashtra*, Mimeograph Series No.42. Gokhale Institute of Politics and Economics, Pune, 1996.
21. Narayanamoorthy A. Beneficial impact of drip irrigation. A study based on western India. Water Resource Journal. 1997; 195:17-25.
22. Narayanamoorthy A. Averting water crisis by drip method of irrigation: A study of two water intensive crops. Indian Journal of Agricultural Economics. 2003; 58(3):427-437.
23. Pramanik S, Biswas RK. Effect of drip-fertigation on soil moisture distribution and irrigation water use efficiency of banana in West Bengal. Journal of Soil and Water Conservation. 2012; 11(3):210-217.
24. Pramanik S, Patra SK. Growth, Yield, Quality and Irrigation Water Use Efficiency of Banana under Drip Irrigation and Fertigation in the Gangetic Plain of West Bengal. World Journal of Agricultural Sciences. 2016; 12(3):220-228.
25. Pramanik S, Tripathi SK, Ray R, Banerjee H. Economic Evaluation of Drip-fertigation System in Banana cv. Martaman (AAB, Silk) Cultivation in New Alluvium Zone of West Bengal. *Agricultural Economics Research Review*, 2014; 27:103-109
26. Raina JN, Thakur BC, Verma ML. Effect of drip irrigation and polyethylene mulch on yield, quality and water-use efficiency of tomato (*Lycopersicon esculentum*). Indian Journal of Agricultural Sciences. 1999; 69:430-33.
27. Raina JN, Sharma Tarika, Suman Shashi. Effect of drip fertigation with differentfertilizers on nutrient distribution in soil, leaf nutrient content and yield of apricot *(Prunus aremeniaca* L.). J Indian Soc. Soil Sci. 2011; 59:268-277.
28. Saleth R Maria. Water Institutions in India: Economics, Law and Policy, Commonwealth Publishers, New Delhi, 1996.
29. Salvin S, Baruah K, Bordoloi SK. Drip irrigation studies in banana cv. Barjahaji (Musa AAA group, Cavendish sub-group), Crop Research, Hisar. 2000; 20(3):489-493
30. Sharma R, Kispotta W. Study on Drip Irrigation in Banana - District of Kaushambi (U.P.). Journal of Business and Management (IOSR-JBM). 2016; 18(1): 10-12.
31. Sharmasarkar F, Sharmasarkar S, Miller SD, Vance GF, Zhang R. Assessment of drip and flood irrigation on water and fertilizer use efficiency for sugar beets. Agricultural Water Management. 2001; (46):241-251.
32. Shashidhara KK, Bheemappa A, Hirevekanagoudar LV, Shashidhar KC. Benefits and constraints in adoption of drip irrigation among the plantation crop growers. Karnataka Journal of Agricultural Science. 2007; 20(1):82- 84.
33. Shashidhara KKA, Bheemappa LV, Hirevenkanagoudar, Shashidhar KC. Benefits and constraints in adoption of drip irrigation among the plantation crop growers. Karnataka J. Agril. Sci. 2007; 20:82-84.
34. Singandhupe RB, Rao GGSN, Patil NG, Brahmanand PS. Fertigation studies and irrigation scheduling in drip irrigation system in tomato crop (*Lycopersicon esculentum* L.). European J. Agron. 2003; 19:327-340.
35. Srinivas K, Reddy BMC, Kumar SSC, Gowda ST, Raghupati HB, Padma P. Growth, yield and nutrient uptake of Robusta banana in relation to N and K fertigation. Indian J. Hort. 2001; 58(4):287-293.
36. Thadchayini T, Thiruchelvam S. An economic evaluation of a drip irrigation project for banana cultivation in Jaffna District. Water professional Day Symposium. Water resources research in Sir Lanka, 2005.
37. Thangaselvabai T, Suresh S, Prem Joshua J, Sudha KR. Banana nutrition - A review. Agric. Rev. 2009; 30:24-31.
38. Young SCH, Sammins TW, Wu I. Banana yield as affected by deficit irrigation and patterns of lateral layouts. Transactions of ASAE. 1985; 28:507-510.