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Research Article

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# Nitrogen distribution under sub surface drip fertigation system on banana cv. RASTHALI

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## Summary

The sub surface drip fertigation is a technique to applay both water and fertilizers through drip irrigation system during the recent years were shown to be very effective in achieving higher water and fertilizer use efficiencies.The nutrient mobility study revealed that fertigation treatments maintained higher concentration of available nitrogen around root zone of banana compared to surface irrigation with soil application of recommended dose of fertilizers where most of the nutrients moved to deeper layer due to leaching fraction of applied fertilizers. In general, subsurface drip fertigation of 100 per cent RDF treatments in combination with liquid biofertilizers maintained higher available NPK in the post harvest soil compared to surface irrigation with soil application of recommended dose of fertilizers. Further, drip fertigation integrated with liquid biofertilizers created favourable condition for multiplication of beneficial micro-organisms in the rhizosphere region.

**Key words :** Subsurface drip fertigation, Nutrient mobility, Nitrogen, Banana

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## Introduction

The sub surface drip fertigation allows precise timing and uniform distribution of fertilizer nutrients. By definition, fertigation is the precise application of water soluble fertilizer through sub surface drip (Billsegars, 2003).

Banana is a heavy feeder both in respect of nutrients and water. Irrigation through basin and fertilizer application through soil leads to heavy losses of water and nutrients. Under such conditions, drip fertigation will be useful for increasing the water and fertilizer use efficiency. Fertigation has proved successful in commercial banana cultivars like Robusta (Mahalakshmi *et al*., 2001); Nendran (Pandey *et al*., 2001) and Ney Poovan (Srinivas, 1997) with fertilizer and water economy. Fertigation can save 20 to 30 per cent of fertilizers, while improving the yield and quality as compared with common methods of fertilizer application (Malakouti, 2004).

It is an efficient and agronomically sound method of providing soluble plant nutrients directly to the active plant root zone. The increasing acres of micro-irrigated crops provides an excellent opportunity to explore new methods of providing complete and balanced plant nutrient programmes that have the potential to improve plant health and increase yields. Proper fertigation management begins with knowledge of the nutrient status of the soil. (Harjinder Singh *et al.,* 2004; Mishra *et al.,* 2006; Mmolawa and Or, 2000 and Selva Rani, 2009).

The mobility of nutrients in the soil depends on the quantity and kinds of fertilizer applied, form of nutrient ions, moisture content of the soil and other reacting ions present in soil solution. The availability of nutrients at root zone of the crops influences the uptake and yield of the crop. Leaching, volatilization and fixation of nutrients in the soil are some of the factors that affect the availability of soil nutrients (Arulraja, 2008; Ryan, 2002 and Rauschkolb *et al.*, 1976).

Further, under subsurface drip irrigation, when fertigation is combined, nutrient use efficiency could be as high as 90 per cent compared to 40-60 per cent in conventional fertilizer application methods (Bar-Yosef, 1999). Adoption of subsurface drip fertigation system may also help in increasing yields and quality parameters due to improved irrigation, nutrients and energy use efficiencies (Palwe *et al*., 2007 and Rivera *et al*., 2006).

## Resource and Research Methods

Field experiment was carried out at AICRP- Water Management block, Agricultural College and Research Institute, Madurai during 2010 - 2011 to study the effect of subsurface drip fertigation on growth, yield, quality and economics of banana cv. RASTHALI.

The experiment was laid out in Randomized Block Design (RBD) with three replications. The treatments consisted of $T_1$- Surface irrigation with soil application of recommended dose of fertilizers, $T_2$- Subsurface drip fertigation of 100 per cent RDF (P as basal, N and K through drip as urea and white potash), $T_3$- Subsurface drip fertigation of 100 per cent RDF as WSF (WSF – Urea, 13: 40: 13, $KNO_3$), $T_4$- Subsurface drip fertigation of 100 per cent RDF (50% P and K as basal, remaining N, P and K as WSF), $T_5$- Subsurface drip fertigation of 75 per cent RDF ( P as basal, N and K through drip as urea and white potash) + LBF, $T_{6-}$ Subsurface drip fertigation of 75 per cent RDF as WSF (WSF – Urea, 13: 40: 13, $KNO_3$) + LBF, $T_7$- Subsurface drip fertigation of 75 per cent RDF (50% P and K as basal, remaining N, P and K as WSF) + LBF, $T_8$- Subsurface drip fertigation of 100 per cent RDF (P as basal, N and K through drip as urea and white potash)+LBF, $T_9$- Subsurface drip fertigation of 100 per cent RDF as WSF (WSF – Urea, 13: 40: 13, $KNO_3$) + LBF, $T_{10}$- Subsurface drip fertigation of 100 per cent RDF (50% P and K as basal, remaining N, P and K as WSF)+LBF and $T_{11}$- Subsurface drip irrigation with LBF alone (no inorganic).

The recommended dose of fertilizers for banana is 200:35:300 g NPK plant$^{-1}$. Banana cv. RASTHALI was used as the test crop. Subsurface drip irrigation was scheduled once in three days and fertigation was given once in six days starting from 15 days after planting to 300 days after planting. The nutrient mobility in soil was estimated by analyzing available NPK. The soil sampling was done at emitting point (laterals placed at 25 cm depth of soil from surface) and 15 cm horizontally away from the emitting point of the same lateral. Similarly, the soil samples were also collected from 0-25, 25-50 and 50 – 75 cm depth of profile (vertical) between the drippers. The soil sampling was done 24 hours after fertigation at flowering stage of the crop.

The soil samples collected were air dried, powdered and passed through a 2 mm sieve and stored in clean polythene bags. The samples were used for the determination of available nitrogen, phosphorus and potassium. The available N, P and K both in horizontal and vertical dimensions were mapped by using Surfer 7 software. Surfer software developed by Golden Software of USA is a contouring package which includes 3D surface mapping programme that runs under Microsoft windows.

## Research Findings and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

### Effect of subsurface drip fertigation on nutrient mobility :

The mobility of nutrients in soil depends on the source, levels of applied fertilizers and forms of nutrient ions. The moisture content influenced the availability of nitrogen in the soil. The mobility of the nutrients had been assessed from the soil sample taken 24 hours after fertigation at various distance from dripper both horizontal and vertical directions.

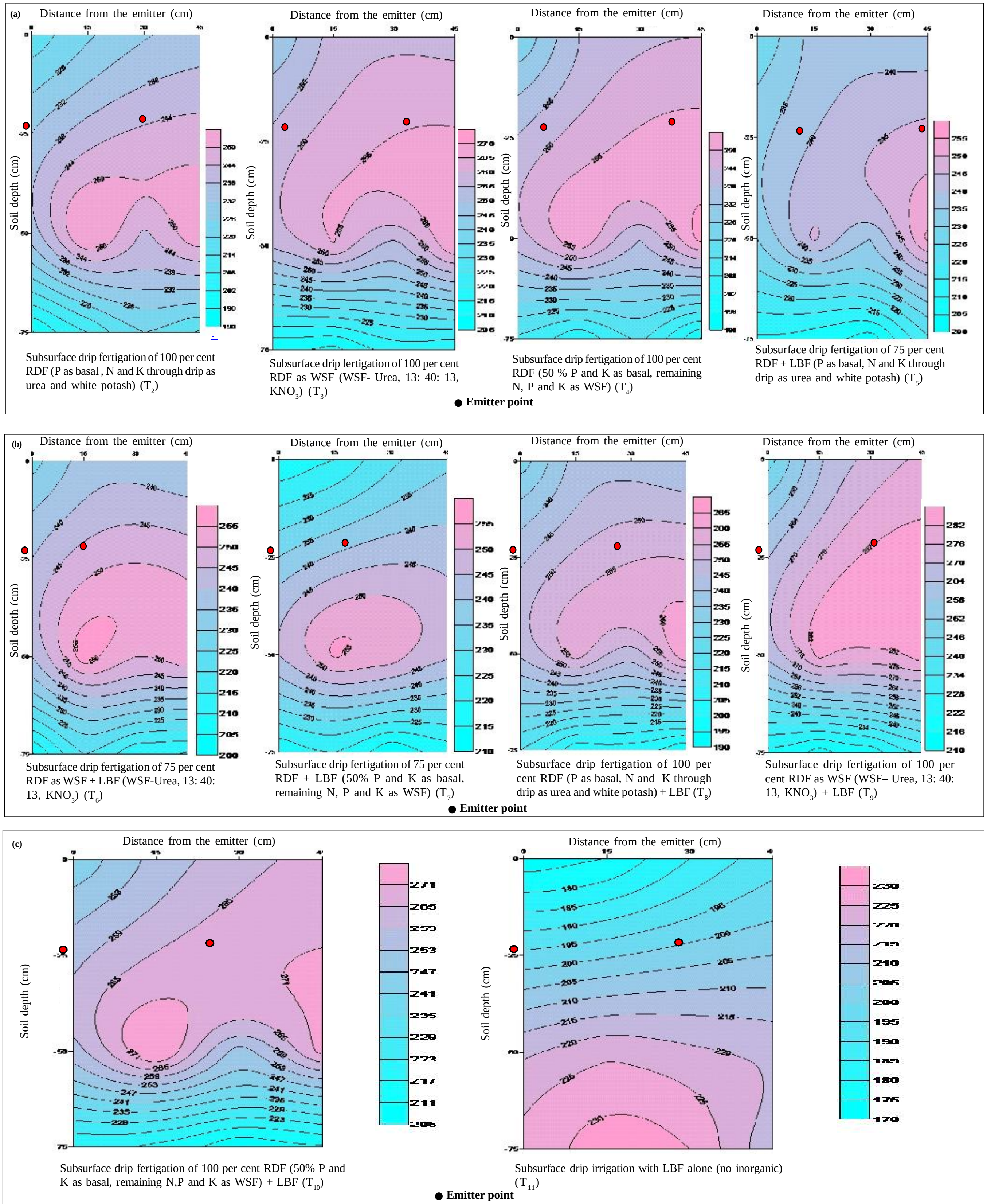
### Nitrogen:

There was a significant variation in N distribution between drip fertigation and surface irrigation with soil application of recommended dose of fertilizers. In general, comparatively more N was available in the soil which received water soluble fertilizers than conventional fertilizers. The distribution of available nitrogen in the soil varied both horizontally and vertically from the emitting point. The available nitrogen in drip fertigated

**Table 1: Nitrogen mobility and availability (kg ha$^{-1}$) under subsurface drip fertigation**

| Depth (cm) | Distance from drippers (cm) Along laterals | | | |
|---|---|---|---|---|
| | 0* | 15 | 30* | 45 |
| Subsurface drip fertigation of 100 per cent RDF (P as basal, N and K through drip as urea and white potash) ($T_2$) | | | | |
| 0-25 | 216 | 225 | 220 | 234 |
| 25-50 | 235 | 260 | 243 | 256 |
| 50-75 | 195 | 208 | 220 | 213 |
| Subsurface drip fertigation of 100 per cent RDF as WSF (WSF – Urea, 13: 40: 13, $KNO_3$) ($T_3$) | | | | |
| 0-25 | 245 | 257 | 248 | 258 |
| 25-50 | 256 | 265 | 253 | 270 |
| 50-75 | 210 | 208 | 217 | 215 |
| Subsurface drip fertigation of 100 per cent RDF (50% P and K as basal, remaining N, P and K as WSF) ($T_4$) | | | | |
| 0-25 | 230 | 245 | 238 | 250 |
| 25-50 | 248 | 260 | 245 | 262 |
| 50-75 | 219 | 210 | 221 | 204 |
| Subsurface drip fertigation of 75 per cent RDF + LBF ( P as basal, N and K through drip as urea and white potash) ($T_5$) | | | | |
| 0-25 | 225 | 237 | 230 | 236 |
| 25-50 | 230 | 246 | 235 | 256 |
| 50-75 | 209 | 207 | 202 | 219 |
| Subsurface drip fertigation of 75 per cent RDF as WSF + LBF (WSF – Urea, 13: 40: 13, $KNO_3$) ($T_6$) | | | | |
| 0-25 | 228 | 237 | 227 | 235 |
| 25-50 | 240 | 258 | 250 | 254 |
| 50-75 | 204 | 220 | 210 | 209 |
| Subsurface drip fertigation of 75 per cent RDF + LBF (50% P and K as basal, remaining N, P and K as WSF) ($T_7$) | | | | |
| 0-25 | 216 | 220 | 226 | 234 |
| 25-50 | 245 | 256 | 253 | 246 |
| 50-75 | 215 | 220 | 210 | 217 |
| Subsurface drip fertigation of 100 per cent RDF (P as basal, N and K through drip as urea and white potash) +LBF ($T_8$) | | | | |
| 0-25 | 227 | 242 | 235 | 240 |
| 25-50 | 246 | 258 | 247 | 265 |
| 50-75 | 215 | 201 | 202 | 195 |
| Subsurface drip fertigation of 100 per cent RDF as WSF (WSF – Urea, 13: 40: 13, $KNO_3$) +LBF ($T_9$) | | | | |
| 0-25 | 243 | 263 | 253 | 277 |
| 25-50 | 266 | 284 | 280 | 285 |
| 50-75 | 220 | 213 | 218 | 229 |
| Subsurface drip fertigation of 100 per cent RDF (50% P and K as basal, remaining N, P and K as WSF) +LBF ($T_{10}$) | | | | |
| 0-25 | 242 | 255 | 263 | 267 |
| 25-50 | 256 | 280 | 250 | 273 |
| 50-75 | 217 | 215 | 205 | 210 |
| Subsurface drip irrigation with LBF alone (no inorganic) ($T_{11}$) | | | | |
| 0-25 | 172 | 175 | 184 | 193 |
| 25-50 | 219 | 224 | 221 | 219 |
| 50-75 | 226 | 233 | 230 | 216 |
| Depth (cm) | Surface irrigation with soil application of RDF ($T_1$) | | | |
| 0-25 | 205 | | | |
| 25-50 | 224 | | | |
| 50-75 | 258 | | | |

*Dripper points at lateral




Subsurface drip fertigation of 100 per cent RDF (P as basal , N and K through drip as urea and white potash) ($T_2$)

Subsurface drip fertigation of 100 per cent RDF as WSF (WSF- Urea, 13: 40: 13, $KNO_3$) ($T_3$)

Subsurface drip fertigation of 100 per cent RDF (50 % P and K as basal, remaining N, P and K as WSF) ($T_4$)

Subsurface drip fertigation of 75 per cent RDF + LBF (P as basal, N and K through drip as urea and white potash) ($T_5$)

Subsurface drip fertigation of 75 per cent RDF as WSF + LBF (WSF-Urea, 13: 40: 13, $KNO_3$) ($T_6$)

Subsurface drip fertigation of 75 per cent RDF + LBF (50% P and K as basal, remaining N, P and K as WSF) ($T_7$)

Subsurface drip fertigation of 100 per cent RDF (P as basal, N and K through drip as urea and white potash) + LBF ($T_8$)

Subsurface drip fertigation of 100 per cent RDF as WSF (WSF– Urea, 13: 40: 13, $KNO_3$) + LBF ($T_9$)

Subsurface drip fertigation of 100 per cent RDF (50% P and K as basal, remaining N,P and K as WSF) + LBF ($T_{10}$)

Subsurface drip irrigation with LBF alone (no inorganic) ($T_{11}$)

**Fig. 1 : Nitrogen mobility and availability (kg $ha^{-1}$) under subsurface drip fertigation system**

treatments increased steadily with increasing distance from the dripper along the laterals upto a distance of 15 cm. The nitrogen availability increased upto a depth of 25-50 cm there after it declined in all the distances. Among the all samplings, the peak available soil nitrogen was recorded in the soil depth of 25-50 cm at a distance of 15 cm from the dripper. The nitrogen content of the soil decreased with decrease in RDF levels. Subsurface drip fertigation of 100 per cent RDF as WSF (WSF – Urea, 13: 40: 13, $KNO_3$) ($T_3$) recorded higher soil available nitrogen at 25-50 cm soil depth. In case of surface irrigation with soil application of recommended dose of fertilizers, the maximum soil available nitrogen was recorded in 50-75 cm depth of soil (Table 1 and Fig. 1a, b and c).

Banana is one of the most popular and widely grown fruit crops in the world. It responds well to the application of fertilizers and is reported to be a heavy feeder of nitrogen. Efficient use of fertilizer and water is highly critical to sustained agricultural production.Fertilizers applied under traditional methods are generally not utilized efficiently by the crop. In fertigation, nutrients are applied through emitters directly into the zone of maximum root activity and consequently fertilizer use efficiency can be improved over conventional method of fertilizer application. Generally crop response to fertilizer application through drip irrigation has been excellent and frequent nutrient applications have improved the fertilizer use efficiency.

The mobility of nutrients was well pronounced under subsurface drip fertigation system. In all the subsurface drip fertigation levels, the nitrogen concentration in the soil increased as the distance increased from the emitters. The nitrogen concentration in upper soil layer (0-25 cm) was lower than bottom layer (25-50 cm) under all the fertigation levels and at all the distance from the emitting point. The peak nitrogen concentration was recorded in the layer of 25-50 cm depth and at a distance of 15 cm form the dripper. The nitrate ion being mobile and had a tendency to move away from the emitter.

The maximum concentration of nitrogen was noticed under subsurface drip fertigation of 100 per cent RDF as WSF (WSF – Urea, 13: 40: 13, $KNO_3$) + LBF. As the dose of fertilizer reduced, the availability of nutrients also decreased in the root zone.

In general, comparatively more nitrogen was available in the soil which received water soluble fertilizers than straight fertilizers. Similarly, fertigation treatments maintained higher concentration of available N around root zone of banana up to a depth of 25-50 cm soil layer compared to surface irrigation with soil application of recommended dose of fertilizers where most of the N moved to deeper soil layer (50-75 cm) due to higher amount of leaching fraction of fertilizer applied in surface irrigation. Alva and Mozzafari (1995); Vasane *et al*. (1996); Silber *et al*. (2003) and Hebbar *et al*. (2004) also reported that fertigation treatments maintained higher concentration of available nitrogen at shallow depth than deeper layers (Achakzai *et al*., 2012 and Janagarathinam, 2007). The data shows that the nitrogen content in the soil profile neither accumulates at the periphery of the wetting front nor leached from the root zone. These are in accordance with the findings of (Iqbal *et al.*, 2003 and Kadam and Karthikeyan, 2006).

**Conclusion :**

The mobility of nutrients was well pronounced under drip fertigation system. The maximum concentration of nitrogen was noticed under subsurface drip fertigation of 100 per cent RDF as WSF (WSF – Urea, 13: 40: 13, $KNO_3$) + LBF ($T_9$). As the dose of fertilizer reduced, the availability of nutrient also decreased in the root zone. In general, comparatively more nitrogen was available in the soil which received water soluble fertilizers than conventional fertilizers. Fertigation treatments maintained higher concentration of available N around root zone of banana upto a depth of 0-50 cm soil layer compared to surface irrigation with soil application of 100 per cent recommended dose of fertilizers ($T_1$), where most of the N moved to deeper soil layer (50 – 75 cm).

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