Enhancing Growth, Yield and Quality of Banana through Subsurface Drip Fertigation

P.P.Mahendran*1, M.Yuvaraj*2, C.Parameswari*2, A.Gurusamy*1 and S.Krishnasamy*1

Abstract - Field experiment was carried out during 2010-2011 at Water Management block, Agricultural College and Research Institute, Madurai, Tamil Nadu, India using banana as test crop. Subsurface drip fertigation of 100 per cent recommended dose of fertilizers (50% P and K as basal, remaining N, P and K as water soluble fertilizers)+liquid bio fertilizers and subsurface drip fertigation of 100 per cent recommended dose of fertilizers (Urea, 13:40:13,KNO₃)+ liquid bio fertilizers were equally effective in increasing growth and physiological parameters of banana. The highest bunch yield, quality parameters and water use efficiency of banana were recorded in subsurface drip fertigation of 100 per cent recommended dose of fertilizers (Urea, 13:40:13,KNO₃)+ liquid bio fertilizers compared to surface irrigation with soil application of recommended dose of fertilizers. It is desirable to maintain more than 3.90, 0.38 and 4.50 per cent NPK respectively in leaf at shooting stage to obtain a higher yield from banana.

Keywords - Banana, subsurface drip fertigation, fruit quality, water use efficiency

I. INTRODUCTION

SUBSURFACE drip system is potentially more efficient in arid and semi arid regions of India because it provides water directly to the root zone, minimizing evaporative losses. In subsurface drip irrigation system, inline drippers are placed below the ground surface to conserve water, control weeds, and minimize runoff [6]. Subsurface drip irrigation has the inherent advantage of securing system safety against pilferage, damage by animals and farm machinery during intercultural operations. 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 [2]. Adoption of subsurface drip fertigation system may also help in increasing yields and quality parameters due to improved irrigation, nutrients and energy use efficiencies.

India is the largest producer of banana in the world with the production of 97.38 metric tonnes of banana from an area of 8.25million hectares. Among the horticultural crops, banana contributes maximum to the agricultural gross domestic product (GDP) of India to the tune of 1.99 per cent [7]. Balanced nutrient management is the key to increased plant use efficiency and to achieve the required crop yield in an efficient, economical and sustainable manner. This may indicate that the need for the application of different nutrients at specific times, in a particular order to derive the maximum benefit from the application of a given quantity of nutrients. Banana being a gross feeder requires high amount of nutrients for proper growth, development and optimum production. Subsurface drip irrigation has tremendous potential in enhancing the banana productivity. But specific studies on amount of irrigation water and depths of placement of drip lateral for banana crop under subsurface drip irrigation do not appear to have caught the attention of researchers’ so far.

II. MATERIALS AND METHODS

Field investigation was carried out to evaluate the performance of water soluble and liquid bio fertilizers on banana crop under sub surface drip fertigation system. The field was uniformly leveled and trenches were dug to a depth of 25 cm at 120 x 60 cm spacing. After laying the drip laterals at 25 cm depth the trenches were closed. Then the pits were dug for planting of Raathali suckers at 180 cm distance in between the two laterals running at 60 cm apart. The planting of suckers was done and irrigation and fertigation schedules were carried out as per the treatments and surface irrigation was given based on IW/CPE ratio of 1.0 with a depth of irrigation at 5 cm. Drip irrigation was given once in three days based on evapotranspiration and fertigation was planned once in six days upto 300 days.. The liquid bio fertilizers were also applied as per the treatment schedule.

The experiment was laid out in Randomized Block Design (RBD) with three replications. The treatments consisted of

- T₁ - Surface irrigation with soil application of RDF
- T₂ - Subsurface drip fertigation of 100% RDF (P as basal, N&K through drip as urea & white potash)
- T₃ - Subsurface drip fertigation of 100% RDF as WSF (WSF – urea, 13:40:13, KNO₃)
- T₄ - Subsurface drip fertigation of 100% RDF (50% P&K as basal, remaining NPK as WSF)
- T₅ - Subsurface drip fertigation of 75% RDF +LBF (P as basal N&K through drip as urea and white potash)
- T₆ - Subsurface drip fertigation of 75% RDF as WSF + LBF (WSF- urea, 13:40:13, KNO₃)
- T₇ - Subsurface drip fertigation of 75% RDF + LBF (50% P&K as basal remaining NPK as WSF)

*1 AICRP on Water Management, Department of Agronomy, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai – 625 104, Tamil Nadu, INDIA

*2 Department of Soil and Environment, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai – 625 104, Tamil Nadu, INDIA
fertilizers (Urea, 13:40:13, KNO₃) + liquid bio fertilizers were drip fertigation of 100 per cent recommended dose of available nutrients and better proliferation of roots resulting in might have led to effective absorption and utilization of availability of soil moisture under subsurface drip fertigation (Table I). Higher frequency of irrigation and increased fertilizers (Urea, 13:40:13, KNO₃) + liquid bio fertilizers content and specific leaf weight were recorded in subsurface energy from sunlight. The highest leaf area index, chlorophyll and specific leaf weight plays an important role in pseudostem girth of banana (Table I). The leaf area index, chlorophyll and specific leaf weight were maximum in subsurface drip fertigation over surface irrigation with soil application of recommended dose of fertilizers. This was followed by subsurface drip fertigation of 100 per cent recommended dose of fertilizers (50% P and K as basal, remaining N, P and K as water soluble fertilizers)+liquid bio fertilizers. This yield increase can be attributed to significantly higher number of hands and fingers per bunch and bunch weight per plant in subsurface drip fertigation over surface irrigation with soil application of recommended dose of fertilizers. The distinctive yield advantage reflected in subsurface drip fertigation treatments was further amplified by the application of liquid biofertilizers through drip irrigation water. Similarly, the direct beneficial effects of Azospirillum with recommended dose of fertilizers in increasing bunch yield was reported in tissue cultured Grand Naine banana [3].

C. Fruit Quality

In high value crops like banana, quality standards have become the most important factor influencing monetary yield. The fruit quality parameters like total soluble solids (TSS), ascorbic acid and sugar content were maximum in subsurface drip fertigation of 100 per cent recommended dose of fertilizers (Urea, 13:40:13,KNO₃) liquid bio fertilizers (Table II). Higher fruit quality especially higher sugar content can be explained by the role of potassium which is involved in carbohydrate synthesis, breakdown and translocation and synthesis of protein and neutralization of physiologically important organic acids [9].

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Bunch yield (t/ha)</th>
<th>TSS ('brix)</th>
<th>Ascorbic acid (mg/100g)</th>
<th>Total sugar (%)</th>
<th>Total water use (mm)</th>
<th>Water use efficiency (Kg/ha/ mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>20.73</td>
<td>23.66</td>
<td>15.10</td>
<td>21.49</td>
<td>2203.4</td>
<td>9.40</td>
</tr>
<tr>
<td>T₂</td>
<td>30.25</td>
<td>24.35</td>
<td>16.47</td>
<td>22.15</td>
<td>1884</td>
<td>16.05</td>
</tr>
<tr>
<td>T₃</td>
<td>41.85</td>
<td>24.98</td>
<td>17.99</td>
<td>22.79</td>
<td>1884</td>
<td>22.21</td>
</tr>
<tr>
<td>T₄</td>
<td>35.15</td>
<td>24.28</td>
<td>15.32</td>
<td>22.10</td>
<td>1884</td>
<td>18.65</td>
</tr>
<tr>
<td>T₅</td>
<td>27.06</td>
<td>24.01</td>
<td>15.40</td>
<td>21.82</td>
<td>1884</td>
<td>14.36</td>
</tr>
<tr>
<td>T₆</td>
<td>34.16</td>
<td>24.39</td>
<td>16.36</td>
<td>22.18</td>
<td>1884</td>
<td>18.13</td>
</tr>
<tr>
<td>T₇</td>
<td>31.58</td>
<td>24.04</td>
<td>15.25</td>
<td>21.84</td>
<td>1884</td>
<td>16.76</td>
</tr>
<tr>
<td>T₈</td>
<td>26.07</td>
<td>25.68</td>
<td>16.52</td>
<td>21.99</td>
<td>1884</td>
<td>16.64</td>
</tr>
<tr>
<td>T₉</td>
<td>44.51</td>
<td>26.07</td>
<td>18.42</td>
<td>23.77</td>
<td>1884</td>
<td>23.62</td>
</tr>
<tr>
<td>T₁₀</td>
<td>36.77</td>
<td>27.55</td>
<td>17.55</td>
<td>23.45</td>
<td>1884</td>
<td>19.99</td>
</tr>
<tr>
<td>T₁₁</td>
<td>11.45</td>
<td>23.55</td>
<td>16.27</td>
<td>21.36</td>
<td>1884</td>
<td>6.07</td>
</tr>
</tbody>
</table>

D. Water Use Studies

Subsurface drip irrigation is an efficient method to deliver water and nutrients to the root zone of plants because water is...
directly applied in subsoil layer to the effective root zone of crop. Since the loss of water was minimum, the water requirement was less in the subsurface drip irrigation system compared to surface irrigation (Table II). The increased water use efficiency recorded under subsurface drip fertigation system was mainly due to better performance of the crop and increased yield by effective utilization of available water and nutrients that were supplied at regular intervals throughout the crop period to meet the crop demand.

E. Leaf NPK

In general, there was an increase in leaf NPK contents in all the treatments up to shooting and thereafter the values declined (Fig. 1, 2, 3). This shows a heavy loading of NPK in leaves during vegetative and shooting stage followed by a decrease in the concentration due to rapid increase in dry matter caused by faster growth of banana crop. It was further observed that the content of NPK was always higher when drip fertigation is integrated with liquid biofertilizers. Figures (1,2,3) illustrate that it is desirable to have more than 3.90, 0.38 and 4.50 per cent NPK respectively in leaf at shooting stage to obtain a higher yield from banana. Different workers have proposed different critical levels of nutrients in third leaf of banana which range from 1.80 to 4.0 per cent for N, 0.17 to 0.29 per cent for P [1] and 1.66 to 5.40 per cent for K [8].

F. Crop duration

The fertigation treatments were effective in producing relatively early crop by advancing harvest (Table III). In the present investigation, subsurface drip fertigation of 100 per cent RDF as WSF (WSF – Urea, 13: 40: 13, KNO3) + LBF completed the shooting 36 days earlier, harvesting by 14 days, thus, reducing total crop duration by about 50 days (Table 2). The early flowering in subsurface drip fertigation with biofertilizers inoculated plants may be ascribed to easy uptake of nutrients and simultaneous transport of growth promoting substances like cytokinin to the auxiliary buds resulting in breakage of apical dominance.

V. CONCLUSION

The study clearly revealed that subsurface drip fertigation of 100 per cent recommended dose of fertilizers (Urea, 13:40:13,KNO3)+ liquid bio fertilizers at six days interval is an ideal practice in enhancing many of the growth, yield attributes, fruit quality and yield of banana. The next best alternative for getting higher yield is subsurface drip fertigation of 100 per cent recommended dose of fertilizers (50% P and K as basal, remaining N, P and K as water soluble fertilizers)+liquid bio fertilizers. Owing to water saving, subsurface drip irrigation may also provide an opportunity to bring additional area under cultivation.

ACKNOWLEDGMENT

First author express sincere thanks and gratitude to International Panaacea Ltd., New Delhi for financial support in sponsoring the research project.

REFERENCES


