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RESEARCH ARTICLE :

Phosphorous mobility under sub surface drip fertigation system on banana cv. rasthali

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SUMMARY : The 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 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 nutrient mobility study revealed that fertigation treatments maintained higher concentration of available phosphorous 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. Fertigation of phosphorous at various levels also resulted in more available phosphorous at all soil layers compared to soil application of fertilizers.

KEY WORDS :
Subsurface drip fertigation, Nutrient mobility, Phosphorous, Banana

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BACKGROUND AND OBJECTIVES

Phosphorus is one of the most important macronutrient next to nitrogen in limiting crop production. Despite its importance in plants growth and metabolism, phosphorus is the least accessible macronutrient and hence most frequently deficient nutrient tin many agricultural soils because of its low availability and its poor recovery from the applied fertilizers (Balemi and Negisho, 2012).

Because of low P solubility and desorption, only a small proportion of phosphate ions exist in the soil solution for plant uptake even under optimum P fertilization making P fertilizer recovery to be lower compared to other nutrient containing fertilizers. Holford (1997). Moreover, P mobility in soil is very restricted due to its strong retention by soil oxides and clay minerals Hanson *et al*. (2006), (Balemi and Negisho, 2012) and the greater portion of required phosphate ions reach the root surface via diffusion Lambers *et al*. (2006).

Soil application of commonly available P fertilizers generally results in poor utilization efficiency principally because phosphate ions are rapidly undergo precipitation and adsorption reactions in the soil, which remove them from the soil solution. Consequently, there is little or no movement of phosphate from point of contact with the soil. Therefore, there is inefficient utilization of applied P fertilizers. The use of acid fertilizers in drip systems may be beneficial in many ways other than the direct benefit from the added P, such as increased solubility of soil native P minerals, increased availability of other nutrients and micronutrients and prevention of chemical clogging of the fertigation system (Haynes and Swift, 1987).

Simultaneous delivery of water and nutrients directly to roots has been shown to be advantageous for a variety of crops e.g. tomatoes: (Hanson and May, 2004; Hartz and Bottoms, 2009), Since subsurface drip irrigation (SDI) can restrict the size of the root system to the wetted volume of soil (Bravdo and Proebsting 1993; Fereres and Soriano, 2007), it is essential to maintain a continuous supply of moisture and nutrients during the entire growth cycle. The spacing and location of SDI lines can also be important during the germination and seedling phases of production. Adoption of SDI may require changes to some field operations, such as tillage, but SDI systems can be used for several consecutive years.

RESOURCES AND METHODS

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. The surfer software developed by Golden Software of USA is a contouring package which includes 3D surface mapping program that runs under Microsoft windows.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions 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.

Phosphorous :

The soil available P was higher in drip fertigation with fully water soluble fertilizers compared to conventional fertilizers. Even though phosphorous is immobile in soil, application of P in water soluble form resulted in mobility of this nutrient to some distance. Phosphorous applied through fertigation moved laterally up to 15 cm from the emitter and vertically up to 50 cm soil depth below the emitter and thereafter decreased (Fig. 1a, 1b, 1c).

The available P at different soil depth was more in drip fertigation when compared to surface irrigation with soil application of recommended dose of fertilizers. In general higher available P was observed in 25-50 cm depth of soil in all the drip fertigated treatments received water soluble phosphatic fertilizers. Among the treatments, maximum available P was observed under subsurface drip fertigation of 100 per cent RDF as WSF (WSF – Urea, 13: 40: 13, KNO_3) + LBF (T_9) followed by subsurface drip fertigation of 100 per cent RDF (50% P and K as basal, remaining N, P and K as WSF)+ LBF(T_{10}). The depth wise distribution of P in the plots received surface irrigation with soil application of recommended dose of fertilizers revealed that the soil available P was more in surface layer only

The mobility of phosphate ion in soils is of primary importance in plant nutrition. Subsurface drip fertigation caused both horizontal and vertical movement of applied P. The extent of movement of P in the soil from the emitter depends upon the P adsorption capacity of the soil. However, the distance of P movement was found to be proportional to the application rate since movement resulted from saturation of adsorption sites on the soil near the point of application and subsequently mass flow with the soil water Shaymaa *et al. (*2009).

Available P distribution in soil at all layers was at higher level in subsurface drip fertigated treatments when compared to surface irrigation with soil application of recommended dose of fertilizers. The accumulation of available P at 0 – 25 and 25 – 50 cm was tended to be higher in drip fertigation of 100 per cent RDF as WSF (WSF – Urea, 13:40:13, KNO_3) + LBF because of complete solubility of phosphorus source (Poly feed – 13:40:13) and frequent and small application rates through drip system delivered 20 cm below the surface by means of buried laterals. P fertilizers are more prone to fixation at the point of application. Since the point of application was deeper by 20 cm, more concentration of P was observed at 25-50 cm depth.

Phosphate transport in soil applied treatment (T_1) was too slow for the average rate of root growth into the soil, since P fertilizers are prone to fixation at the point of application. Most of the applied P may be turned to non-soluble form in a short time after its application and the observed concentrations build up in the upper soil layer could affect root growth and create unfavourable conditions for P uptake. This suggested higher response to P fertigation compared to soil application in traditional method. Research has shown that the mobility of P can be increased when they are applied via fertigation Vasane *et al*. (1996), (Badr and Shafei, 2002).

Conclusion :

The available phosphorous distribution in soil at all layers was at higher level in subsurface drip fertigated treatments when compared to surface irrigation with soil application of recommended dose of fertilizers. The accumulation of available phosphorous at 0 – 25 and 25 – 50 cm was tended to be higher in drip fertigation of 100 per cent RDF as WSF (WSF – Urea, 13: 40: 13, KNO_3) + LBF (T_9) because of complete solubility of phosphorus source (Poly feed – 13:40:13) and frequent and small application rates through drip system delivered 20 cm below the surface by means of buried laterals.

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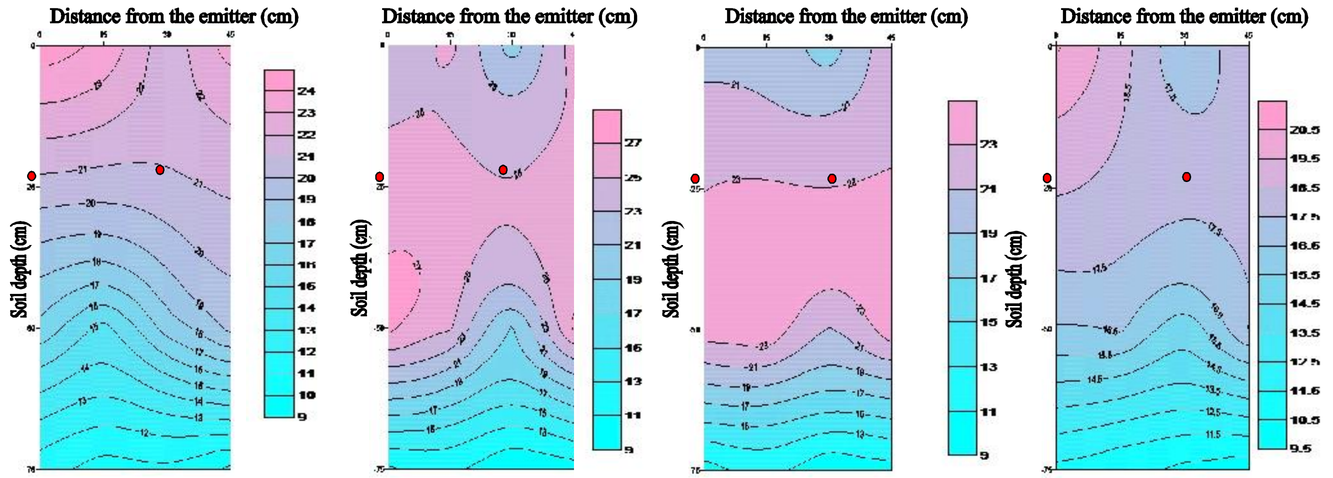


Subsurface drip fertigation of 100 per cent RDF (P as basal, N and K through drip as urea and white potash) (T_2)

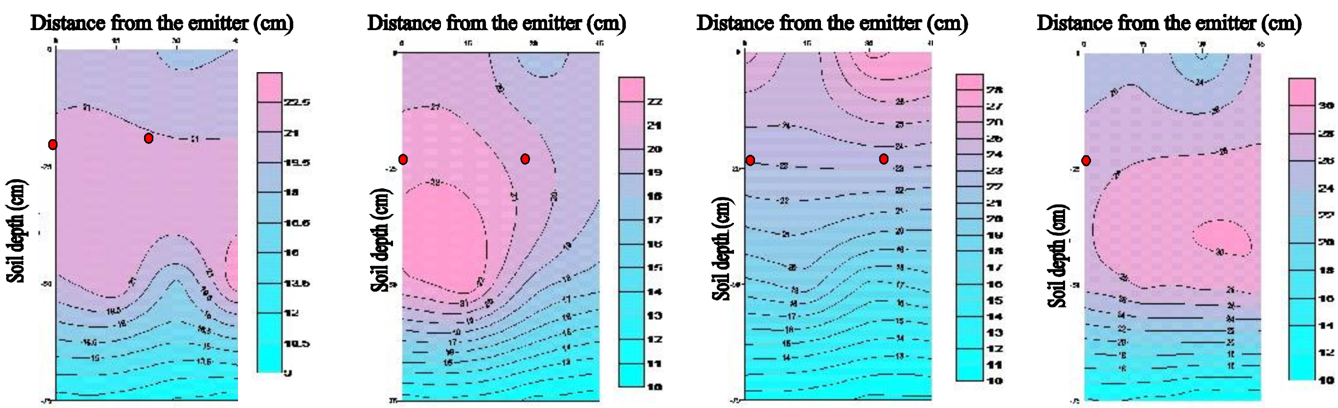
Subsurface drip fertigation of 100 per cent RDF as WSF (WSF – Urea, 13: 40: 13, KNO_3) (T_3)

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)

● **Emitter point**

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



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

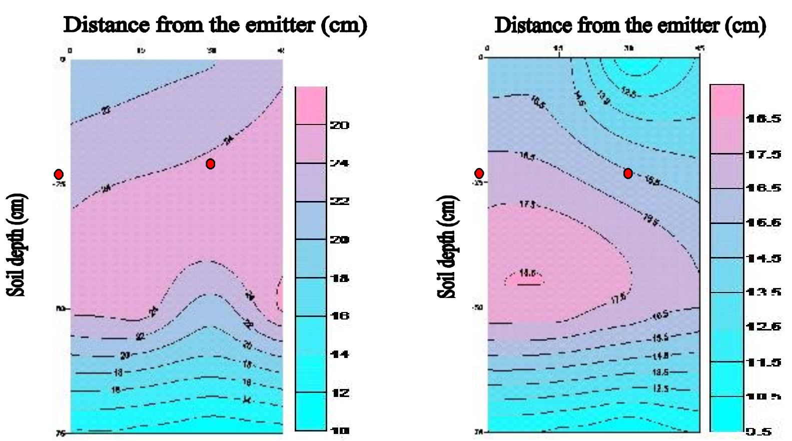
Subsurface drip fertigation of 75 per cent RDF + LBF (50% P and K as basal, remaining N, P and K as WSF) (T_7)

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)

● **Emitter point**

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



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}).

● **Emitter point**

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

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