

Study of Comparative Performance of Drip, Micro Sprinkler Fertigation System and Surface Irrigation in Groundnut (*Arachis hypogaea* L.)

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Abstract A field investigation was carried out during the January to April 2015 to evaluate the performance of drip, micro sprinkler fertigation system and surface irrigation in groundnut. The experiment comprising three treatments of three irrigation methods viz., pressurized drip irrigation, micro sprinkler and surface irrigation were evaluated in randomized block design with three replications. Drip irrigation at 100% PE with 100% RDF as WSF re-

corded significantly higher plant height (40.17 cm), root volume (4.98 cm³), root dry weight (2.45 g plant⁻¹), number of pegs per plant (32.10), number of pods per plant (27.00), no of mature pods per plant (22.83) pod yield (3495 kg ha⁻¹), haulm yield (6452 kg ha⁻¹), harvest index (0.351), crude protein (26.32%), WUE (15.88 kg ha mm⁻¹), and NUE (23.30 kg kg⁻¹ NPK ha⁻¹) as compared to micro sprinkler fertigation and surface irrigation. Whereas, dry weight per plant (27.48 g), LAI (3.42), pod filling per cent (84.57%), peg-pod conversion per cent (84.11%) and oil content (51.80%) which was statistically on par with micro sprinkler at 100% PE with 100% RDF as WSF but superior over surface irrigation, however root length (17.01 cm) under drip irrigation at 100% PE with 100% RDF as WSF was at par with surface irrigation. Highest net return Rs 134712 ha⁻¹) was recorded under irrigation at 100% PE with 100% RDF as WSF followed by micro sprinkler at 100% PE with 100% RDF as WSF and least in surface irrigation, higher cost of drip system leads to lower B : C ratio (2.13) under drip irrigation at 100% PE with 100% RDF as WSF. The overall performance of drip irrigation at 100% PE with fertigation at 100% RDF as WSF can be highly useful to facilitate adequate availability of water and nutrients via fertigation for the groundnut production and least under surface irrigation.

Keywords Drip and micro sprinkler fertigation, Groundnut, Yield, Yield attributes, Economics.

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Introduction

Groundnut (*Arachis hypogaea* L.), popularly known as “King” of oilseeds. In India it is grown on an area of 5.53 m ha, having annual production of 7.4 m t with an average productivity of 1338 kg ha⁻¹ [1]. It occupies a predominant position oilseed economy. There are various factors limiting the productivity of groundnut, among them judicious management of available soil moisture and nutrients are crucial for improving the crop productivity. The irrigation can give maximum benefits to the crop only if supply of nutrients during plant growth is maintained in the soil and vice-versa is also true. Development of appropriate water management technologies to maximize the crop productivity per drop of water is the need of hour. The use of micro irrigation offers a great degree of control over water and fertilizer application (fertigation) to meet the requirement of crops. Irrigation scheduling by micro irrigation systems is usually based on water requirement of crop to maintain a favorable soil water content in the root zone, for precise application of water soluble fertilizers and other agricultural chemicals. It helps to achieve yield gains up to 100% , water savings up to 40 to 80%, and associated fertilizer, pesticide and labor savings over conventional irrigation systems [2]. Ware et al. [3] reported that micro sprinkler system recorded significantly higher plant height, number of leaves, leaf area, and dry matter per plant compared to other methods of irrigation in groundnut. Bodre et al. [4] found higher leaf area index at 100% NPK on tomato under the drip fertigation, similarly [5] studied that under drip fertigation of cauliflower at 1.2 ETc irrigation regimes and 100% RDF resulted improved physiological parameters in cauliflower at all crop growth stages. Jainard Meena [6] revealed that application of water soluble fertilizer through drip irrigation under groundnut resulted higher number and weight of mature pods/plant, 100-kernel weight and shelling out turn, ultimately resulted higher yield. Vijayalakshmi et al. [7] revealed that in groundnut at 100% PE with 100% RDF by micro sprinkler resulted in total water use of 423 mm that leads to 30% water saving over conventional irrigation and maximum pod yield. Therefore, efforts are now directed to harness available quantity of water and put

them to efficient use to realize higher productivity per drop [8]. On the other hand groundnut is very important crop for edible oil seed economy in India. In view of the above, an investigation was undertaken to assess the comparative performance of drip, micro sprinkler fertigation system and surface irrigation in groundnut at harvest stage.

Materials and Methods

A field experiment was conducted during January 2015 to April 2015, at Tamil Nadu Agricultural university, Coimbatore, India. The soil was sandy clay loam with slightly alkaline in pH (7.24), low organic carbon (0.235), medium available N (305 kg ha⁻¹), available P₂O₅ (20.12 kg ha⁻¹) and available K₂O (169.27 kg ha⁻¹). A total rainfall received during the cropping period was 4.3 mm only. The daily mean maximum and minimum temperatures were 32.7°C and 21.3°C, respectively. The mean pan evaporation per day was 5.6 mm with average relative humidity of 60.8% during the cropping period. The experiment was laid out with groundnut variety TMV13 in a randomized block design (RBD) and replicated thrice comprised three treatments (selective treatments are taken to avoid confusion) viz. T₁-DI at 100% PE + fertigation at 100% RDF with WSF, T₂-Micro sprinkler at 100% PE + fertigation at 100% RDF with WSF, T₃-Surface irrigation (5 cm depth) + soil application at 100% RDF with NF, DI : Drip irrigation, PE : Pan Evaporation, RDF : Recommended dose of fertilizers, WSF : Water soluble fertilizers, NF : Normal fertilizers).

The field was ploughed with tractor drawn disc plough followed by two ploughings with cultivator and the clods were broken with rotavator. The field was uniformly levelled and formed raised bed of 120 cm bed width and 30 cm furrow width for drip irrigation treatments, 360 cm bed width with 30 cm furrow for micro sprinkler treatments and check basin was formed for control plot so as to have uniform population. The recommended dose of fertilizer (RDF) at 25 : 50 : 75 kg NPK ha⁻¹ with row spacing of 30 × 10 cm was maintained, with bed size 28.8 m² (drip : 24 × 1.2 m, micro sprinkler : 8 × 3.6 m). Drip and micro sprinkler irrigation was based on daily pan evaporation (PE) and fertigation was based on

nutrient uptake pattern at different growth stage of groundnut, at once in three days interval and the volume of irrigation water was calculated by using following formula :

$$\text{Volume of irrigation (V)} = 3 \text{ days CPE} \times \text{Kp} \times \text{Kc} \times \text{Area (m}^2\text{)} \times \text{Wp} - \text{ER}$$

Where, CPE - Cumulative pan evaporation for three days (mm), Kp- Pan factor (0.8), Kc - Crop coefficient, Wp- Wetted percentage (80%) for drip, 100% for micro sprinkler (As overlapping was 100%), Area - 28.8m²; ER - Effective rainfall.

The surface irrigation was given at 0.8 IW/CPE ratio with 5 cm depth of water. The required quantity of water soluble fertilizers (WSF) viz., N, P₂O₅ and K₂O were applied as urea 46 : 0 : 0, all 19 (19 : 19 : 19), MAP (12 : 61 : 0) and SOP (0 : 0 : 52) were used drip and micro sprinkler whereas, for surface application urea, MOP and SSP (0 : 16 :) were used. The water source from bore well was pumped through 7.5 HP motor and it was conveyed to the main field using 63 mm outer diameter (OD) PVC pipes after filtering through hydro cyclone and disc filter. For fertigation, ventury was installed with 1 Hp booster pump before disc filter with regulating valves. From the end of mainline, sub mains of 40 mm diameter PVC pipes were connected. Drip laterals of 16 mm OD having 40 cm emitter spacing was fixed in the sub mains with a lateral spacing of 60 cm having two laterals per bed with a discharge rate of 4 lph at 1 kg cm² and each plot consists of two laterals for irrigating 4 rows of crops whereas, under micro sprinkler system plane laterals of 16 mm OD was fixed in the sub mains with a lateral spacing of 3.2 m having one plane lateral per bed. On along the laterals micro sprinkler had spaced at 1.5 m apart with a discharge rate of 44 lph at 1 kg cm² with diameter throw 3 m, each plot consists of one lateral for irrigating 12 rows of crops.

The observations on different parameters were recorded and analyzed statistically. Growth parameters, yield and yield attributes, water use efficiency (WUE), nutrient use efficiency (NUE) and economics were calculated. Mean differences were tested by 'F' test at (5%) level of significance (LOS). Critical difference (CD) at % level of significance was

used for comparison among treatments. The data were statistically analyzed by using the standard procedure as suggested by Gomez and Gomez [9].

Results and Discussion

Information pertaining to comparative performance of drip, micro sprinkler system at 100% PE with 100% RDF as WSF and surface irrigation at 0.8 IW/CPE with 100% RDF as NF at harvest stage is given in Table 1, Figure 1 and 2.

Growth parameters

An appraisal of data bestowed in Table 1 expounds that different treatments of irrigation fertigation exerted their significant influence on growth parameters of groundnut viz., plant height (cm), dry weight per plant (g) and LAI during the crop growing season. Drip irrigation at 100% PE with 100% RDF as WSF recorded significantly higher plant height (40.17 cm) over micro sprinkler at 100% PE with 100% RDF as WSF and surface irrigation at 0.8 IW/CPE with 100% RDF as NF, while dry weight per plant (27.48 g) and LAI (3.42) was statistically on par with micro sprinkler at 100% PE with 100% RDF as WSF but superior over surface irrigation. Water and nutrient are the major constituents of plant, which helps in cell division, cell elongation and ultimately the growth of the plant. The higher frequency of irrigation and increased availability of soil moisture under drip and micro sprinkler fertigation might have led to effective absorption and utilization of available nutrients, which in turn might have helped in better meristematic activity of the plant in terms of growth [10].

Root parameters

A perusal of data presented in Table 1 and shown in Figure 2, indicates that drip irrigation at 100% PE with 100% RDF as WSF recorded longer root length (17.01 cm) which was on par with surface irrigation at 0.8 IW/CPE with 100% RDF as NF (16.38 cm) followed by micro sprinkler at 100% PE with 100% RDF as WSF, whereas drip irrigation at 100% PE with 100% RDF as WSF significantly higher root volume (4.98 cm³) and root dry weight (2.45 g

Table 1. Comparative performance of drip, micro sprinkler fertigation system and surface irrigation in groundnut at harvest stage. DI - Drip Irrigation, RDF - Recommended dose of fertilizers, WSF -water soluble fertilizers, NF-Normal fertilizers, ## Data statistically not analyzed.

Specification	DI at 100% PE + fertigation at 100% RDF with WSF	MS at 100% PE + fertigation at 100% RDF with WSF	Surface irrigation (5 cm depth) + soil application at 100% RDF with NF	SEd	CD (p=0.5)
Growth parameters					
Plant height (cm)	40.17	37.83	30.20	1.38	2.95
Dry weight per plant (g)	27.48	25.40	16.65	1.16	2.48
LAI	3.42	3.31	2.82	0.11	0.23
Root parameters					
Root length (cm)	17.01	15.51	16.38	0.65	1.40
Root volume (cm ³)	4.98	4.39	3.22	0.21	0.45
Root weight (g plant ⁻¹)	2.45	2.07	1.49	0.10	0.21
Yield attributes and yield					
Number of pegs plant ⁻¹	32.10	29.17	23.90	1.09	2.34
Number of pods plant ⁻¹	27.00	23.63	17.09	0.88	1.89
No of mature pods plant ⁻¹	22.83	18.97	12.03	0.71	1.51
Pod filling per cent	84.57	80.25	70.43	2.82	6.05
Peg-pod conversion per cent	84.11	81.03	71.50	2.52	5.41
Pod yield (kg ha ⁻¹)	3495	2922	1902	135.27	290.16
Haulm yield (kg ha ⁻¹)	6452	5596	4406	220.98	474.01
Harvest index	0.351	0.343	0.302	0.01	0.02
Quality characters					
Oil content (%)	51.80	50.02	47.70	1.19	2.56
Protein content (%)	26.32	24.90	22.61	0.99	2.12
Water and nutrient studies					
WUE (kg ha mm ⁻¹)	15.88	10.62	4.79	##	##
NUE (kg kg ⁻¹ NPK ha ⁻¹)	23.30	19.48	12.68	0.63	1.36
Economics					
Cost of cultivation (Rs ha ⁻¹)	119606	88215	59331	##	##
Gross return (Rs ha ⁻¹)	254353	212907	139755	##	##
Net return (Rs ha ⁻¹)	134747	124692	80424	##	##
B : C ratio	2.13	2.41	2.36	##	##

plant⁻¹) followed by micro sprinkler at 100% PE with 100% RDF as WSF and least in surface irrigation at 0.8 IW/CPE with 100% RDF as NF. Adequate quantity of nutrients and moisture might have resulted in higher root proliferation. So the crops under drip

and micro sprinkler were adequately provided with sufficient moisture, nutrients, soil aeration and finally resulted in higher root growth. Whereas, under irrigation leached off the available nutrients along with it beyond the effective root zone which may

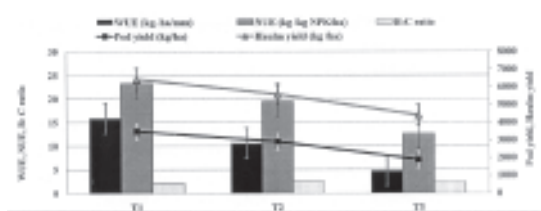


Fig. 1. Effect of drip, micro sprinkler fertigation and surface irrigation on WUE, NUE, B : C ratio, pod yield and haulm yield of groundnut.

therefore not be available to the roots due to poor growth leading to loss of nutrients as well as affecting the root growth of the crop. These results were in lines with the earlier findings [11] and [12].

Yield attributes and yield

The mean data of yield attributes, harvest index presented on Table 1 and yield on Figure 1, indicated that drip irrigation at 100% PE with 100% RDF as WSF recorded significantly higher number of pegs per plant (32.10), number of pods per plant (27.00), no of mature pods per plant (22.83), pod yield (3495 kg ha⁻¹), haulm yield (6452 kg ha⁻¹) and harvest index (0.351) followed by micro sprinkler at 100% PE with 100% RDF as WSF and least in surface irrigation at 0.8 IW/CPE with 100% RDF as NF. However, pod filling per cent (84.57%) and peg-pod conversion per cent (84.11%) was found statistically on par to micro sprinkler at 100% PE with 100% RDF as WSF, and least in surface irrigation. The marked improvement in yield attributes and yield could be due to overall improvement in vigor and crop growth, reflected by improved dry matter accumulation, CGR and LAI [13].

Quality characters

The mean data of quality characters are presented in Table 1. Drip irrigation at 100% PE with 100% RDF as WSF recorded higher oil content (51.80%) which was statistically on par with micro sprinkler at 100% PE with 100% RDF as WSF, whereas crude protein content was recorded significantly higher (26.32)

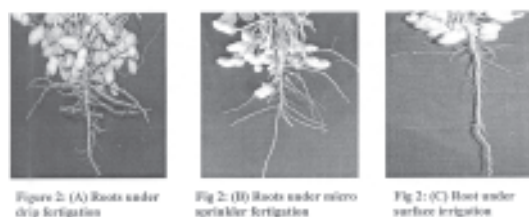


Fig. 2. (A) Roots under drip fertigation. (B) Roots under micro sprinkler fertigation. (C) Root under surface irrigation.

over micro sprinkler at 100% PE with 100% RDF as WSF and least values were recorded under surface irrigation at 0.8 IW/CPE with 100% RDF as NF. The higher oil contents probably a result of better filling and bold kernels [14], where as higher protein was due to more availability of nutrients particularly nitrogen which is an integral part of protein [7].

Water and nutrient studies

A perusal of data presented in figure 1. Highest WUE (15.88 kg ha⁻¹ mm⁻¹), and NUE (23.30 kg kg⁻¹ NPK ha⁻¹) were observed under drip irrigation at 100% PE with 100% RDF as WSF followed by micro sprinkler at 100% PE with 100% RDF as WSF and least in surface irrigation at 0.8 IW/CPE with 100% RDF as NF. This was attributed to better availability of moisture and nutrients throughout growth stages in drip and micro sprinkler systems leading to better uptake of nutrients, production of dry matter and in turn economic yield [15].

Economics

The value as presented in Table 1 and B : C ratio in Figure 1. Indicated that, highest net return (Rs 134712 ha⁻¹) was recorded under drip irrigation at 100% PE with 100% RDF as WSF followed by micro sprinkler at 100% PE with 100% RDF as WSF and least in surface irrigation at 0.8 IW/CPE with 100% RDF as NF, but due to higher cost of drip system, cost of cultivation for drip with 100% RDF as WSF recorded very high (Rs 119641 ha⁻¹) compare to micro sprinkler and surface irrigation, lower B :

C ratio (2.13) was recorded under drip irrigation at 100% PE with 100% RDF as WSF.

Conclusion

Based on the results of the study, it can be concluded that drip irrigation at 100% PE with 100% RDF as WSF under groundnut significantly improved the growth, yield, yield attributes, quality, WUE, NUE and higher net return followed by micro sprinkler fertigation and least under surface irrigation. Whereas, low B : C ratio due to high cost of drip system. Study also help to understanding the principle of efficient resource utilization and way to boost up the plant productivity of groundnut.

References

1. Anonymous . 2016. Area, production and productivity of groundnut in India. <http://www.indiastat.com/agriculture/2/agriculturalareaanduse/152/areaundercrops19502015/448934/stats.aspx>.
2. El-Habbasha SF, Okasha EM, Abdelraouf RE, Mohammed ASH (2014) Effect of pressured irrigation systems, deficit irrigation and fertigation rates on yield, quality and water use efficiency of groundnut. *Int J Chem Tech Res* 7 : 475—487.
3. Wane S, Bagde H, Bhuyar RC (2009) Effect of different micro-irrigation methods on growth, yield and quality of summer groundnut in Vidharbha. *Green Farming* 2 : 351—353.
4. Badr MA, Abou Hussein SD, El-Tohamy WA, Gruda N (2010) Nutrient uptake and yield of tomato under various methods of fertilizer application and levels of fertigation in arid lands. *Gesunde Pflanzen* 62 : 11—19.
5. Yanglem SD, Tumbare AD (2014) Influence of irrigation regimes and fertigation levels on yield and physiological parameters in cauliflower. *The Bioscan* 9 : 589—594.
6. Jain NK, Meena HN (2015) Improving productivity of ground nut (*Arachis hypogaea* L.) by using water soluble fertilizer through drip irrigation. *Ind J Agron* 60 : 109—115.
7. Vijayalakshmi R, Veerabadran V, Shanmugasundram K, Kumar V (2011) Micro-sprinkler irrigation and fertigation and land configuration as a best management technology package for groundnut. In : 8th international micro irrigation congress. Innovation in technology and management of micro-irrigation for crop production enhancement 21 October 2011, Tehran, Iran, pp 200—207.
8. Sankaranarayanan K, Solaimalai A, Sankaran N (2005) Inter cropping of legumes in fodder sorghum—A review. *Agric Reviews* 26 : 217—222.
9. Gomez KA, Gomez AA (1984) Statistical procedures for agricultural research, 2nd edn. John Wiley Sons, New York, pp 680.
10. Ayotamuno JM, Zuofa K, Sunday OA, Kogbara BR (2007) Response of maize and cucumber intercrop to soil moisture control through irrigation and mulching during the dry season in Nigeria. *Afr J Biotec* 6 : 509—515.
11. Kafkafi U, Tarchitzky J (2011) Fertigation a tool for efficient fertilizer and water management. In : International fertilizer Industry association (IFA) International potash Institute (IPI). Paris, France, pp 25—28.
12. Abdzad Gohari A, Jenabi Haghparast R, Khabbazkar MR (2014) Peanut (*Arachis hypogaea* L.) response to irrigation different methods in North Iran. *Journal Novel Applied Sciences*. J Novel Applied Sci 2014-3-S2/1635-1637.
13. Bhatt Brahma (2012) Response of sweet corn (*Zea mays* L. *saccharata* sturt) to sulfur and zinc fertilization. *Res Crops* 13 : 760.
14. Kimak H, Dogan E, Turkoglu H (2010) Effect of drip irrigation intensity on soybean seed yield and quality in the semi-arid Harran plain, Turkey. *Spanish J Agric Res* 8 : 1208—1217.
15. Gupta AJ, Feza Ahmad M, Bhat FN (2010) Studies on yield, quality, water and fertilizer use efficiency of capsicum under drip irrigation and fertigation. *Ind J Hort* 67 : 213—218.