

Irrigation methods and fertilizer application effects on growth and yield parameters, yield, economics and water use efficiency in groundnut

Abstract

The present investigation was carried out at Agricultural Research Station, Bhavanisagar, Erode district of Tamil Nadu to study the effect of irrigation methods and fertilizer application effects on growth and yield parameters, yield, economics and water use efficiency in groundnut. The various irrigation methods followed were I₁ - Drip irrigation, I₂ - Drip fertigation, I₃ - Sub surface drip irrigation, I₄ - Sub surface drip fertigation, I₅ - Sprinkler irrigation and I₆ - Conventional method of irrigation as main plot treatments and the various methods of application of fertilizers were S₁ - Absolute control (No fertilizer), S₂ - Recommended dose of NPK fertilizers through normal fertilizers / Recommended dose of NPK fertilizers through water soluble fertilizers (According to the irrigation treatment) and S₃ - S₂ + Vermicompost @ 5 t ha⁻¹ imposed as subplot treatments, and the treatments were replicated thrice. The experiment was laid out in strip plot design in a plot size of 15 M². Application of recommended dose of fertilizers (25: 50 : 75 kg NPK ha⁻¹) along with vermicompost @ 5 t ha⁻¹ with sub surface drip fertigation recorded highest growth and yield attributes, yield, high Benefit Cost Ratio and water use efficiency as compared to the other treatments in groundnut (var. VRI 3).

Key words: Irrigation methods, Fertilizer application, Growth and yield parameters, Yield, Economics, Water use efficiency, Groundnut

Introduction

Peanut (*Arachis hypogaea* L.) is an important oilseed and food legume crop of the tropical and subtropical world. The peanut kernels contain 45–55% oil and 25–34% protein and are the fourth most important source of edible oil and the third most important source of protein in the world. Though high in fat, peanut primarily

contains good fat (unsaturated and free from trans types) and helps to maintain blood cholesterol levels and therefore friendly to heart. Peanut oil is good from both nutritive and culinary point of views as it contains good quantities of monounsaturated fatty acids (MUFA) (oleic acid, 40–50%) and polyunsaturated fatty acids (PUFA) (linoleic acid, 25–35%). With this high oleic/linoleic ratio, peanut oil has a relatively longer shelf-life. The tocopherol (approx. 0.9 mg g⁻¹ oils) and antioxidant present in peanut oil prevent the development of rancidity (Jain and Meena, 2015)

In India, peanut is one of the important oilseed crops and occupies an area of 5.86 M ha with the production of 8.27Mtonnes and productivity of 1411 kg ha⁻¹ (2010–11) which is quite low as compared to other countries. Among the various factors that limit the productivity of peanut, efficient use of available water and fertilizer is highly critical for improving the crop productivity (Jain *et al.*, 2018).

A review on the use of fertigation by Jat *et al.* (2011) from ICRISAT, Hyderabad, suggested that to make agriculture sustainable and economically viable, there is a need to promote fertigation on a large scale by the concerned stakeholders/farmers. Over and above, fertigation by means drip irrigation clearly assures the saving of two important resources, water, and nutrient, and thus economically viable for farmers by one-time cost investment of drip system installation. Therefore, the present investigation was carried out to study the effect of irrigation methods and fertilizer application on growth and yield parameters, yield, economics and water use efficiency in groundnut.

Materials and methods

A field experiment was conducted at Agricultural Research Station, Bhavanisagar, Erode district of Tamil Nadu. The soil type of the experimental site was red sandy loam, neutral (pH 7.7) with low organic carbon (0.12 %) and available nitrogen (252 kg ha⁻¹), and medium in available phosphorus (13.0 kg ha⁻¹), and high in potassium (535 kg ha⁻¹). The experiment consisted of six irrigation methods, *viz.*, I₁ - Drip irrigation, I₂ - Drip fertigation, I₃ - Sub surface drip irrigation, I₄ - Sub surface drip fertigation, I₅ - Sprinkler irrigation and I₆ - Conventional method of irrigation as main plots and three fertilizer schedules, *viz.*, S₁ - Absolute control (No

fertilizer), S₂ - Recommended dose of NPK fertilizers through normal fertilizers / Recommended dose of NPK fertilizers through water soluble fertilizers (According to the irrigation treatment) and S₃ - S₂ + Vermicompost @ 5 t ha⁻¹ as subplots, allotted in strip plot design using three replications. The recommended dose of fertilizer was 25: 50: 75 kg NPK ha⁻¹ (treated as 100% NPK) and supplied through urea, single superphosphate, and muriate of potash, respectively. In surface method of irrigation, the recommended doses of NPK were applied in furrows at the time of sowing. Whereas in drip irrigation, phosphorus (P) was applied as per treatments in furrows as basal dose, and N and K were applied as per treatments through fertigation through drip. Groundnut variety VRI was the test crop. The intercultural operations like spraying herbicides, gap filling, hand weeding, gypsum application, earthing up and plant protection measures were followed as per crop production guide. The irrigation and fertilizer application were followed as per the treatment schedule. The growth and yield parameters *viz.*, the plant height, number of branches, number of leaves, leaf length and leaf breadth, number of pods / plant and pod yield were recorded during harvest of the crop.

Results and Discussion

Growth parameters

The growth parameters *viz.*, plant height, number of branches, number of leaves, leaf length and leaf breadth were recorded and reported in table 1 and 2. The data indicated that, among the main plot treatments I₄ (sub surface drip fertigation) recorded the highest plant height (45.2 cm) and it is on par with I₃ (sub surface drip irrigation). There was significant difference between the main plot treatments. Among the subplot treatments the highest plant height (44.4 cm) was recorded by S₃ (recommended dose of NPK fertilizers + vermicompost @ 5 t ha⁻¹) followed by S₂ and S₁. Among the interactions, sub surface drip fertigation with recommended dose of NPK fertilizers + vermicompost @ 5 t ha⁻¹ (I₄S₃) recorded the highest plant height. The interaction effect was not significant.

The data on number of branches and number of leaves of groundnut indicated that, among the main plot treatments I₄ (sub surface drip fertigation)

recorded the highest number of branches (6.7) and number of leaves (64.5). The main plot treatments not significantly influenced the number of leaves and number of branches. Among the subplot treatments the highest number of branches (7.1) and number of leaves (67.4) were recorded by S₃ (recommended dose of NPK fertilizers + vermicompost @ 5 t ha⁻¹). The number of branches and number of leaves were significantly influenced by subplot treatments. Among the interactions, sub surface drip fertigation with recommended dose of NPK fertilizers + vermicompost @ 5 t ha⁻¹ (I₄S₃) recorded the highest number of branches and number of leaves. The interaction effect was not significant.

Table 1. Growth parameters of groundnut as influenced by treatments

Treatments	Plant height (cm)				Number of branches				Number of leaves			
	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean
I ₁	38.4	40.9	43.4	40.9	6.0	6.6	7.2	6.6	55.5	61.2	67.9	62.0
I ₂	37.4	42.2	43.0	40.9	6.1	6.5	7.2	6.6	57.9	64.9	69.1	63.9
I ₃	42.4	43.9	48.1	44.8	5.4	6.4	7.8	6.6	58.0	64.2	71.2	64.4
I ₄	42.2	44.2	49.3	45.2	6.3	6.6	7.1	6.7	65.6	58.7	69.2	64.5
I ₅	39.6	41.1	41.4	40.7	6.3	5.3	5.9	6.5	54.2	57.5	65.4	59.0
I ₆	38.0	39.5	41.1	39.6	5.5	6.0	6.7	6.0	50.6	53.8	61.4	55.3
Mean	39.7	42.0	44.4		5.8	6.3	7.1		57.1	60.0	67.4	
	SED		CD (0.05)		SED		CD (0.05)		SED		CD (0.05)	
I	1.37		3.05		0.75		NS		3.7		NS	
S	0.92		1.9		0.16		0.35		2.4		4.9	
I at S	2.30		4.9		0.82		1.81		6.1		12.9	
S at I	2.25		NS		0.41		NS		5.9		NS	

With respect to leaf length of groundnut, the main plot treatments not significantly influenced the parameter. The treatment I₄ (sub surface drip fertigation) recorded the highest leaf length (5.93 cm). Among the subplot treatments the highest leaf length (5.9 cm) was recorded by S₃ (recommended dose of NPK fertilizers +

vermicompost @ 5 t ha⁻¹) and the treatments S₁ and S₂ were on par with each other. The interaction effect was not significant.

With respect to leaf breadth of groundnut, the main plot treatments were not significantly influenced the parameter. The treatment I₄ (sub surface drip fertigation) recorded the highest leaf breadth (2.93 cm). Among the subplot treatments S₃ (recommended dose of NPK fertilizers + vermicompost @ 5 t ha⁻¹) recorded the highest leaf breadth (3.0 cm) when compared to S₂ (recommended dose of NPK fertilizers) and S₁ (no fertilizer). The interaction effect was significant. Among the interactions, sub surface drip fertigation with recommended dose of NPK fertilizers + vermicompost @ 5 t ha⁻¹ (I₄S₃) recorded the highest leaf breadth.

Table 2. Growth parameters of groundnut as influenced by treatments

Treatments	Leaf length (cm)				Leaf breadth (cm)			
	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean
I ₁	5.2	5.2	5.4	5.23	2.4	2.8	2.9	2.70
I ₂	5.3	5.5	6.1	5.63	2.7	2.8	3.1	2.86
I ₃	5.6	5.8	6.3	5.90	2.6	2.9	3.2	2.90
I ₄	5.6	5.9	6.3	5.93	2.6	3.0	3.2	2.93
I ₅	5.0	5.4	5.9	5.43	2.6	2.8	2.9	2.76
I ₆	4.7	5.1	5.3	5.03	2.6	2.7	2.7	2.66
Mean	5.3	5.5	5.9		2.6	2.6	3.0	
	SED		CD (0.05)		SED		CD (0.05)	
I	0.33		NS		0.20		NS	
S	0.12		0.26		0.03		0.07	
I at S	0.41		0.91		0.21		0.47	
S at I	0.30		NS		0.08		0.17	

The pod yield of groundnut is reported in table 3. The pod yield of groundnut was not significantly influenced by the main plot treatments. The yield data indicated that, among the main plot treatments the highest pod yield of 2601 kg ha⁻¹

was recorded by sub surface drip fertigation (I₄) when compared to other methods of irrigation. Among the subplot treatments the highest pod yield was recorded by S₃ (recommended dose of NPK fertilizers + vermicompost @ 5 t ha⁻¹) as 2591 kg ha⁻¹, when compared to S₂ (recommended dose of NPK fertilizers). The subplot treatments significantly influenced the pod yield. Among the interactions, sub surface drip fertigation with recommended dose of NPK fertilizers + vermicompost @ 5 t ha⁻¹ (I₄S₃) recorded the highest pod yield of 3271 kg ha⁻¹. Rank *et al.*, (2003) found that pod yield of peanut at 1, 2, 3, 4, and 5 days irrigation interval (keeping total depth of irrigation water constant) in drip irrigation were statistically at par. However, maximum pod yield value was obtained at 3 days irrigation interval. The average pod yield was increasing from 1 day interval to 3 days interval at decreasing rate and after that it is decreasing at decreasing rate from 3 days interval to 5 days interval. Marked increase in economic yield appeared to be as a result of the beneficial effect of fertigation on growth and yield parameters of the crop (Tables 2 and 3). Further, increased nutrient availability and absorption by the crop at the optimum moisture supply coupled with frequent nutrient supply by fertigation and consequent better formation and translocation of assimilates from source to sink might have increase yield under fertigation (Jayakumar *et al.*, 2014). Irrigation system permits multiple small dose fertilizer applications at different intervals, reducing the risk of leaching compared to fertilizers applied in a single application. Similar were the findings of Singandhupe *et al.* (2003).

Table 3. Yield and yield attributes of groundnut as influenced by treatments

Treatments	Pod yield (Kg ha ⁻¹)				Number of pods / plant			
	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean
I ₁	1433	1752	2422	1937	17.2	24.1	30.9	24.1
I ₂	1489	1945	2675	2188	21.8	30.0	31.4	27.1
I ₃	1845	2433	2889	2237	17.0	28.6	39.8	28.4
I ₄	1978	2555	3271	2601	23.1	28.7	38.2	30.0
I ₅	1380	1687	2366	1798	14.9	20.9	30.9	22.2
I ₆	1050	1278	1922	1679	18.7	20.3	24.5	21.2

Mean	1554	2075	2591		18.8	25.1	32.6	
	SED		CD (0.05)		SED		CD (0.05)	
I	90		192		5.51		NS	
S	29		60		1.86		3.84	
I at S	107		233		6.65		14.5	
S at I	71		147		4.56		NS	

The number of pods / plant of groundnut showed similar trend as that of pod yield. Sub surface drip fertigation with recommended dose of NPK fertilizers + vermicompost @ 5 t ha⁻¹ (I₄S₃) recorded the highest number of pods (30) when compared to other methods of irrigation with various fertilizer treatments. Efficient and greater partitioning of metabolites and adequate translocation and accumulation of photosynthates, amino acids, vitamins etc. to developing reproductive structures under adequate and increased nutrient use efficiency seems to have resulted in increase in the yield attributing characters. The fertigation provided better conducive conditions for better uptake of nutrients and in turn helped the plants to boost their growth leading to the development of yield attributes through supply of more photosynthates towards the reproductive sink compared to conventional method of soil application of nutrients (Jayakumar, *et al.*, 2014).

Economics

Irrigation regimes and fertilizer treatments increased the net return. Sub surface drip fertigation with recommended dose of NPK fertilizers + vermicompost @ 5 t ha⁻¹ (I₄S₃) recorded the highest B : C ratio of 3.03, followed by sub surface drip fertigation with recommended dose of NPK fertilizers (I₄S₂) as 2.90. The lowest B : C ratio of 1.81 was recorded with conventional method of irrigation with no fertilizer (I₆S₁).

Table 4 : **Comparing Income, Cost of cultivation, Net return and B: C ratio for different treatments**

Groundnut					
Treatments	Yield (kg ha ⁻¹)	Income (Rs.)	Cost of cultivation (Rs.)	Net return (Rs.)	B: C ratio
I ₁ S ₁	1433	35825	18500	17325	1.94
I ₁ S ₂	1752	43800	20000	23800	2.19
I ₁ S ₃	2422	60550	25000	35550	2.42
I ₂ S ₁	1489	37225	18500	18725	2.01
I ₂ S ₂	1945	48625	20000	28625	2.43
I ₂ S ₃	2675	66875	25000	41875	2.56
I ₃ S ₁	1845	46125	20500	25625	2.15
I ₃ S ₂	2433	60825	22000	38825	2.76
I ₃ S ₃	2889	72225	27000	45225	2.68
I ₄ S ₁	1978	49450	20500	28950	2.30
I ₄ S ₂	2555	63875	22000	41875	2.90
I ₄ S ₃	3271	81775	27000	54775	3.03
I ₅ S ₁	1380	34500	18500	16000	1.86
I ₅ S ₂	1687	42175	20000	22175	2.00
I ₅ S ₃	2366	59150	25000	34150	2.28
I ₆ S ₁	1050	26250	14500	11750	1.81
I ₆ S ₂	1278	31950	16000	15950	2.00
I ₆ S ₃	1922	48050	21000	27050	2.28

Cost of groundnut seed = Rs. 25.00/ kg

Water use efficiency

The water use efficiency was worked out and furnished Table 5. The results showed that, the highest total water used was noticed in conventional method of irrigation as 667.9 mm and 839.1mm for maize and groundnut respectively. The water use efficiency of treatments indicated that, the highest water use efficiency

values was noted with sub surface drip fertigation as 15.163 kg / ha.mm 6.176 kg / ha.mm for maize and groundnut respectively and the lowest value was noted with conventional method of irrigation as 5.240 kg / ha .mm and 1.251 kg / ha .mm for maize and groundnut respectively.

Table 5. Total water used and water use efficiency

Particu. Treat.	Maize			Groundnut		
	Yield (kg/ha)	Total water used (mm)	WUE (kg/ha.mm)	Yield (kg/ha)	Total water used (mm)	WUE (kg/ha.mm)
I ₁ S ₁	4330	432.5	10.012	1433	529.6	2.706
I ₁ S ₂	5096	432.5	11.783	1752	529.6	3.308
I ₁ S ₃	5567	432.5	12.872	2422	529.6	4.573
I ₂ S ₁	4456	432.5	10.303	1489	529.6	2.812
I ₂ S ₂	5232	432.5	12.097	1945	529.6	3.673
I ₂ S ₃	5952	432.5	13.762	2675	529.6	5.051
I ₃ S ₁	4870	432.5	11.260	1845	529.6	3.484
I ₃ S ₂	5560	432.5	12.855	2433	529.6	4.594
I ₃ S ₃	6364	432.5	14.714	2889	529.6	5.455
I ₄ S ₁	5032	432.5	11.635	1978	529.6	3.735
I ₄ S ₂	5868	432.5	13.568	2555	529.6	4.824
I ₄ S ₃	6558	432.5	15.163	3271	529.6	6.176
I ₅ S ₁	4260	432.5	9.850	1380	529.6	2.606
I ₅ S ₂	4715	432.5	10.902	1687	529.6	3.185
I ₅ S ₃	5368	432.5	12.412	2366	529.6	4.468
I ₆ S ₁	3500	667.9	5.240	1050	839.1	1.251
I ₆ S ₂	4109	667.9	6.152	1278	839.1	1.523
I ₆ S ₃	4600	667.9	6.887	1922	839.1	2.291

Conclusions

Application of recommended dose of fertilizers + vermicompost @ 5 t ha⁻¹ with sub surface drip fertigation recorded the growth and yield attributes and yield of groundnut, high Benefit Cost Ratio and water use efficiency when compared to the other treatments.

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