

Original Research Article

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Influence of Precise Land Development Technique on Soil Moisture Variability and Water Saving in Groundnut (*Arachis hypogaea* L.) Production

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ABSTRACT

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For efficient irrigation and higher yields precise laser land development is often advocated as the most effective water saving method. Land levelling, having impact on moisture storage and distribution conditions in the field both spatially and temporally, affects crop growth and yields. Hence, the field experiments were conducted in the research farm of the University of Agricultural Sciences (UAS) Raichur to investigate the effect of laserland levelling on the performance of groundnut (*Arachis hypogaea* L.) and also the effect of laser levelling on spatial and temporal variability of topographic conditions, irrigation and water use efficiencies. The treatments comprised levelling methods viz., L₁- laser land levelling with 0.2% slope, L₂-laser land levelling with 0.4% slope, L₃-traditional land levelling method and L₄- no levelling and irrigation methods viz., I₁- border strip irrigation and I₂-check basin irrigation. The soil moisture studies after 24 hours of a rainfall event indicated that both the average soil moisture in soil depth (0-15 cm) and uniformity coefficient (C_u) of its distribution were maximum (45.14 and 94.84 and 41.18 and 93.49 per cent) in 0.2 and 0.4 % slope laser levelled plots (L₁ and L₂), respectively. Traditional levelling method (L₃) recorded lower values of 35.19 and 83.33 %, while the same were least (25.10 and 77.11 %) in unlevelled control plot (L₄). The standard deviation indicating spatial variability of soil moisture was minimum (2.79 and 3.46 %) with more uniform and higher moisture conservation in laser levelled plots followed by 7.22 % in traditional levelled plot and the maximum of 8.89 per cent in unlevelled plot. The trend was same even after 7 days of rainfall events in respect of soil moisture storage, depletion and uniformity coefficient. The average uniformity coefficient of laser levelled plots was the highest (89.77%) followed by L₃ (77.67%) and the least in case of L₄ (73.15%). The results also showed that laser levelling could decrease the water application rates considerably when compared to traditional and no levelling. The highest per cent water saving was observed in laser levelled fields with 0.4 % slope (28.03 and 40.50%) followed by laser levelled fields with 0.2 % slope (23.61 and 36.89%) over traditional and unlevelled fields respectively. Mean of both the laser land levelling cases registered 63.68 % more water productivity over traditional leveling establishing the fact that laser levelling saves valuable water with the highest water productivity of groundnut production.

Introduction

In India, groundnut (*Arachis hypogaea* L.) is grown in an area of 6.4 M ha with a production of 7.21 M t. It accounts for 28.44 % of the total world groundnut area and contributes 24.69 per cent to the world production. Six major groundnut growing states are Gujarat, Andhra Pradesh, Tamil

Nadu, Rajasthan, Karnataka and Maharashtra which contribute to 90 % of total groundnut area of India. Karnataka ranks fifth in the country with a production of 0.38 M t from an area of 0.76 M ha (Anon., 2012). The average productivity of groundnut in India is 1,125 kg ha⁻¹, which is far below the world's average pod yield of 1,449 kg ha⁻¹. Where irrigation is possible, higher groundnut yields are

achieved and there has been a substantial increase in area under irrigated groundnut in India during the past five decades.

For efficient irrigation and higher yields precise laser land development is often advocated as the most effective water saving method. Laser Land levelling increases crop germination and yields and improves water distribution (Rickman, 2002). It also enhances irrigation efficiency (Sattar *et al.*, 2003, Rajput *et al.*, 2004) and increases cultivable land area up to 3-5 per cent (Jat *et al.*, 2005). The precise land levelling methods have resulted in smoother soil surface, reduction in time and water required to irrigate the field, more uniform distribution of water in the field, more uniform moisture environment for crops, more uniform germination and growth of crops. The foremost objective of the laser land levelling is to enhance efficiency of irrigation water, which ultimately saves water leading to higher water productivity. However, no such data on water saving and water productivity impacts of land levelling in groundnut production was available in India in general and Karnataka in particular. Therefore, a study was initiated to determine the effect of laser land leveling soil moisture variability and water saving in groundnut production.

Materials and Methods

The field experiments in the medium textured soils of University of Agricultural Sciences (UAS) Raichur during *kharif* seasons of 2013 and 2014 were conducted to see the effect of laser land levelling techniques on water saving in groundnut production. The field experiment was laid out on one ha field with split plot design with levelling methods *viz.*, L₁-laser land levelling with 0.2% slope, L₂-laser land levelling with 0.4% slope, L₃-traditional land levelling method and L₄-no levelling (control) as main treatments and

irrigation methods *viz.*, I₁-border strip irrigation and I₂-check basin irrigation as sub-treatments. It was replicated four times.

Laser unit

A commercial unit of laser guided land leveller (Model GL-522) was used for the study and one directional slopes of 0.2 and 0.4% were given. Laser levelling unit consist main components *viz.*, Laser transmitter, laser receiver, hydraulic valve and control box and its operational view is shown in Fig. 1. The layout details of field experiment are shown in Fig. 2.

Soil moisture variability

Land levelling affects moisture storage and distribution conditions *viz.*, mean, standard deviation (SD) and uniformity co-efficient (C_u) in the field both spatially and temporally. Soil moisture in depths of 0-15 cm was measured on volumetric basis using a precise and calibrated TDR (Time Domain Reflectometer). The soil moisture measurement was done after 24 hours of rainfall and 7 days of rainfall event. The rainfalls received during these days were 18.6 and 29.2 mm and 15.6 and 16 mm, respectively. The spatial and temporal variability of soil moisture (0-15 cm) due to rainfall events as affected by different land levelling methods is given in Table 1. It indicates soil moisture varied both spatially and temporally. The mean soil moisture content (%) on volume basis in different locations of all levelling treatments taken by TDR showed that soil moisture (0-15 cm) in the same treatments was distributed and varied differently.

After a day of rainfall event, both the mean soil moisture and uniformity co-efficient (C_u) of its distribution were maximum in plots levelled by laser leveller.

They were 45.14 and 94.84 and 41.18 and 93.49 per cent in plots with laser levelling 0.2 and 0.4 per cent slope *i.e.* L₁ and L₂ respectively. The same were 35.19 and 83.33 per cent for traditional plot (L₃). The lowest mean soil moisture content (%) and uniformity co-efficient (C_u) of 32.29 and 77.11 were observed in Control plot (L₄). The standard deviation data indicated spatial variability was minimum (2.79 and 3.46) in laser levelled plots (L₁ and L₂) followed by traditional levelled plot (7.22). The highest standard deviation of 8.89 was observed in L₄ indicating higher spatial variability of soil moisture storage. After one week of rainfall event, the same trend was observed in respect of soil moisture storage, depletion and uniformity coefficient. The mean of uniformity coefficient of laser levelled plots (both L₁ and L₂) was the highest (89.77%) followed by L₃ (77.67%). The lowest uniformity coefficient (73.15%) was observed in L₄.

Quantity of water used (m³ ha⁻¹) and water saving

The pooled data regarding irrigation water used (m³ ha⁻¹) and per cent water saving as influenced by different land levelling and irrigation methods for groundnut production are presented in Table 2.

The plot levelled using laser leveller with 0.4 per cent slope (L₂) required the lowest quantity of irrigation water of 1562.88 m³ ha⁻¹. It was followed by plot levelled using laser leveller with 0.2 per cent slope (1658.88 m³ ha⁻¹) and traditional levelled plot (2171.52 m³ ha⁻¹). The control plot with no levelling used the highest quantity of water of 2628.48 m³ ha⁻¹.

The highest per cent water saving was observed in the plot with 0.4 per cent slope, L₂ 40.54 per cent, when compared with

unlevelled plot (L₄). Whereas, the plot with 0.2 per cent slope (L₁) recorded higher per cent water saving of 36.89. The magnitudes of water saving in traditional levelling method (L₃) were 17.38 per cent over control. Also, laser land levelling method, L₂ recorded water saving of 28.03 per cent and L₁ registered 23.61 per cent over traditional method of levelling, L₃.

From the pooled data, it could be observed that the irrigation water used (m³ ha⁻¹) and per cent water saved in border strip irrigation method (I₁) were considerably less (1875.84 m³ ha⁻¹ and 12.14%) when compared to 2135.04 m³ ha⁻¹ in check basin irrigation (I₂). The similar trend was noticed with the depth of irrigation water applied. Considering the pooled effective rainfall during crop period, the total quantity of water required for groundnut was the least in L₂ (50.20 cm), followed by 51.20 and 56.30 cm in L₁ and L₃, respectively. The water requirement was the highest in L₄ (60.90 cm).

There was a significant difference observed in water requirement of groundnut as influenced by different land leveling methods. The pooled depth of irrigation water requirements were 15.7 and 16.7 cm in L₂ and L₁, respectively. The same were very much higher to the tune of 23.7 and 19.8 cm over control (L₄) and traditional plots (L₃), respectively. The highest per cent water saving was observed in both the laser land levelling treatments L₂ and L₁ (28.00 and 23.50%, respectively) when compared with traditional levelling method (L₃) and (40.50 and 36.80%, respectively) over control *i.e.* unlevelled plot (L₄). The water saving was mainly due to precise levelling in laser levelled plots leading to smooth and faster water front advance thereby quick uniform distribution of water. But in traditional levelling and unlevelled plots it was not so smooth.

Table.1 Spatial and temporal variability of soil moisture (0-15cm) due to rainfall events as affected by different land levelling methods

Treatment Location	Soil moisture content (%) after a day of rainfall event				Soil moisture content (%) after 7 days of rainfall event			
	L ₁	L ₂	L ₃	L ₄	L ₁	L ₂	L ₃	L ₄
1	41.30	41.20	30.10	35.00	21.86	17.39	11.88	22.93
2	43.80	41.20	41.70	44.40	24.54	13.20	12.04	11.64
3	48.70	39.40	30.70	39.20	20.00	17.97	22.80	16.67
4	40.40	39.60	49.20	18.60	17.69	15.97	19.85	10.77
5	43.30	38.30	30.90	23.60	23.48	22.94	13.64	15.42
6	48.70	38.90	33.20	34.50	15.38	19.95	18.94	21.28
7	45.80	45.60	37.70	37.90	21.26	21.20	22.90	8.92
8	49.10	45.20	28.00	25.10	15.89	24.38	9.97	7.71
Mean	45.14	41.18	35.19	32.29	20.01	19.13	16.50	14.42
SD	2.79	3.46	7.22	8.89	3.41	3.71	5.21	5.63
C _u	94.84	93.49	83.33	77.11	86.40	84.35	72.00	69.20

Legend:

L₁ : Laser land levelling method with 0.2 per cent slope,

L₂ : Laser land levelling method with 0.4 per cent slope,

L₃ : Traditional land levelling method

L₄ : No land levelling (control)

Table.2 Quantity of water applied and per cent saving for groundnut production as influenced by different land levelling methods

Treatment	Average time of irrigation (h ha ⁻¹)	Total quantity of irrigation water applied (m ³ ha ⁻¹)	Total depth of irrigation water applied (cm)	Quantity of irrigation water saved in L ₁ , L ₂ and L ₃ over control (L ₄) and I ₁ over I ₂ (m ³ ha ⁻¹)	Quantity of irrigation water saved in L ₁ and L ₂ over traditional (L ₃) and I ₁ over I ₂ (m ³ ha ⁻¹)
L ₁	8.3	1658.88	16.6	969.60 (36.89)	512.64 (23.61)
L ₂	7.8	1562.88	15.6	1065.60 (40.54)	608.64 (28.03)
L ₃	10.8	2171.52	21.7	456.96 (17.38)	---
L ₄	13.1	2628.48	26.3	--	--
I ₁	9.4	1875.84	18.8	259.20 (12.14)	259.20 (12.14)
I ₂	10.7	2135.04	21.4	--	--

Legend:

L₁ : Laser land levelling method with 0.2 per cent slope, I₁ : Border strip irrigation method

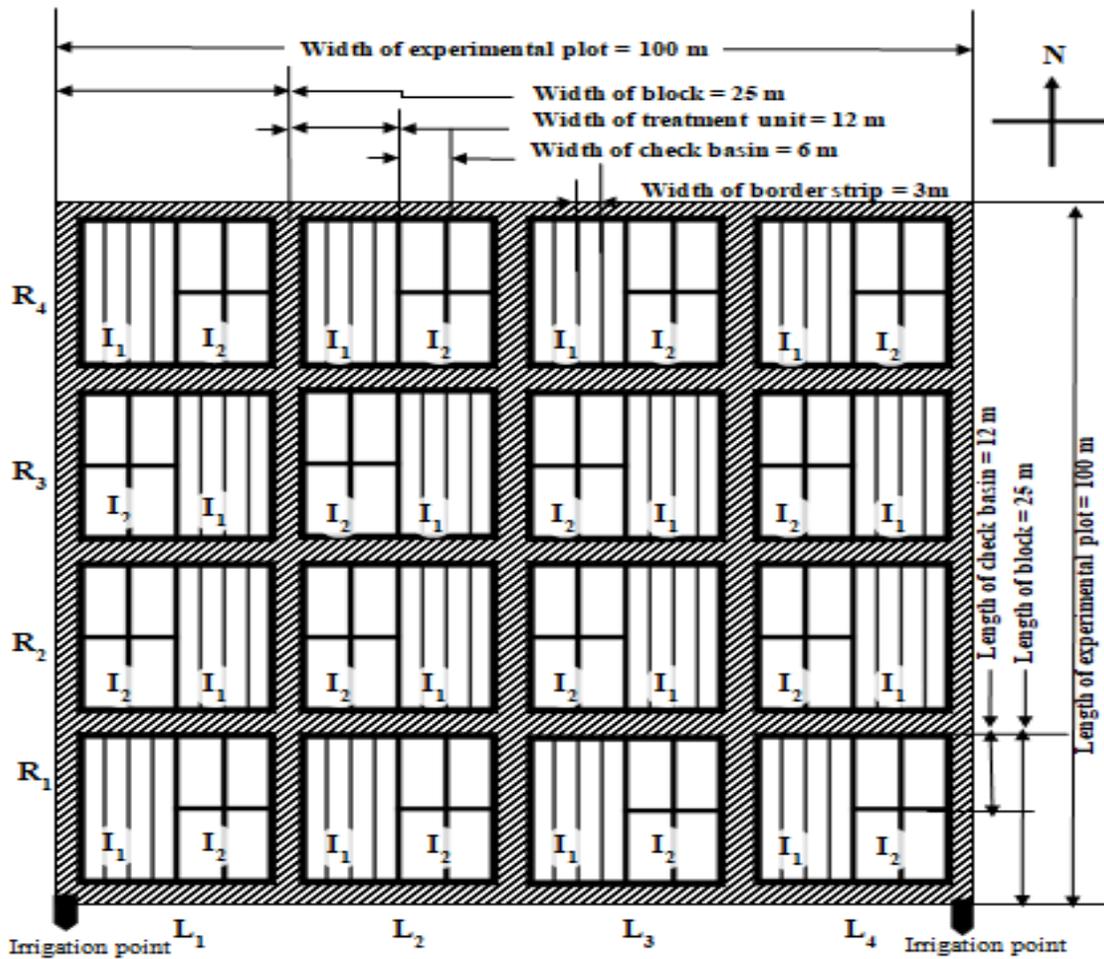
L₂ : Laser land levelling method with 0.4 per cent slope, I₂ : Check basin irrigation method

L₃ : Traditional land levelling method

L₄ : No land levelling (control)



Fig.1 Operational view of the laser land leveling



R₁, R₂, R₃ and R₄ are the replications for all treatments
 L₁, L₂, L₃ and L₄ are the land levelling treatments, I₁ and I₂ are irrigation methods

Fig.2 Layout details of field experiment

Whereas, water has to be applied so that the water reaches the high spots. The uniform distribution and reduced losses (Rajput and Patel, 2004, Abdullaev *et al.*, 2007) in laser levelling plots also led to reduced depth of application and more saving of water. The irrigation time reduced considerably in levelled plots. The similar results on irrigation water requirement, depth and saving were reported by Rickman (2002), Jat and Sharma (2005), Aggarwal *et al.*, (2010), Rajput and Patel (2010), Shahin *et al.*, (2013) and Naresh *et al.*, (2014). Thus, laser land levelling by saving water was proved to be a RCT in agricultural production.

There was uniform distribution of soil moisture and reduced losses in application of irrigation water in laserlevelling plots which led to reduced depth of application and more saving of water. The water front advance was smooth and faster in laser levelled plots with uniform distribution of water. Lowest quantity of irrigation water was used in laser levelled plot with 0.4 per cent slope followed by laser levelled plot with 0.2 per cent slope against traditional levelled plot and the highest quantity in control plot without levelling.

Significant quantity of irrigation water was saved in both laser land leveling techniques with 0.2 and 0.4 % slopes as compared to traditional and nolevelling methods. Laser land levelling by saving water was proved to be a Resource Conservation Technology in groundnut production.

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