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Yield and economics of summer groundnut (*Arachis hypogaea* L.) as influenced by different irrigation regimes and land configurations

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Abstract
A field experiment entitled, on "Studies on irrigation regimes and land configurations on growth and yield of summer groundnut (*Arachis hypogaea* L.)" was conducted at Agronomy Farm, Rajarshee Chhatrapati Shahu Maharaj College of Agriculture, Kolhapur (M.S.), India during summer, 2020. The experiment was laid out in split plot design with three replications and twelve treatment combinations consist of main plot with four irrigation regimes, *viz.*, I_1- 0.6 IW/CPE, I_2- 0.8 IW/CPE, I_3- 1.0 IW/CPE, I_4- 1.2 IW/CPE, and sub plot with three land configurations *viz.*, L_1- Broad Bed Furrow, L_2- Ridges and furrow, L_3- Flat bed. The analyzed results indicated that application of water at 1.0 IW/CPE was at par with 0.8 IW/CPE and 1.2 IW/CPE significantly superior over 0.6 IW/CPE in respect of yield attributes and yield viz., number of pods plant^{-1}, weight of pods plant^{-1} (g), dry pod yield (q ha^{-1}), dry haulm yield (q ha^{-1}), biological yield (q ha^{-1}), shelling (%), weight of 100 kernels (g), sound mature kernel (%) and harvest index (%). For land configurations broad bed furrow recorded significantly superior yield attributes and yield viz., number of pods plant^{-1}, weight of pods plant^{-1} (g), dry pod yield (q ha^{-1}), dry haulm yield (q ha^{-1}), biological yield (q ha^{-1}), shelling (%), weight of 100 kernels (g), sound mature kernel (%) and harvest index over flat bed and found at par with ridges and furrows. The significantly maximum gross and net monetary ratio and Benefit cost ratio was obtained with irrigation regimes of 1.0 IW/CPE over 0.6 IW/CPE, and it was at par with 0.8 IW/CPE and 1.2 IW/CPE. For land configuration broad bed furrow recorded maximum gross and net monetary ratio and Benefit cost ratio as compared to flat bed and found at par with ridges and furrows.

Keywords: irrigation regimes, land configurations, attributes, economic, summer, *Arachis hypogaea* L

Introduction
Groundnut (*Arachis hypogaea* L.) is legume cash crop for the farmers in arid and semi-arid regions. Oilseed crops are the economic backbone of agricultural produce in India, and it is an important oilseed and supplementary food crop of India. Groundnuts are a good source of calcium, phosphorus, iron, zinc and boron and all B vitamins except B_{12}, also rich source of thiamin, riboflavin, nicotinic acid, and vitamin E. Due it's to importance for oil, protein, food, medicine, and industrial use groundnut is grown all over the world. During 2019-2020 it was sown 50.95 lakh hectares as compared in 2018-2019 was 39.12 lakh ha. To meet the ever-increasing demand of vegetable oil, improvement of production of major oilseed crops through area expansion and productivity by adoption of improved technology is most important. Productivity of groundnut is low in the *kharif* season due to monsoon uncertainties and disease epidemics, which limits its cultivation in the rainy season. Higher and stable yields can be obtained in summer mainly because of bright sunshine, least incidence of insects, pests, and diseases. Consumption of water by irrigation sector is 83% and it can be decreased up to 72% by 2025(Mo WR, 2014) [7]. As a result, in a restricted water environment, the need of the future age is to raise yields and water use efficiency. Therefore, various water conservation strategies such as irrigation timing based on cumulative pan evaporation, land configurations and others must be prioritized. In the present day of water scarcity, optimum method of irrigation plays a vital role in economizing irrigation water and enhancing crop yield. Various approaches have been advocated for scheduling irrigation to groundnut crop in different seasons and soil types. The evaporative demand from the atmosphere is regarded crucial in defining the main element in crop water requirements, and it has gained relevance lately (Prihar *et al*., 1974) [12]. Based on irrigation water depth (IW) and cumulative pan evaporation (CPE), a climatological approach can be better utilized to schedule irrigation. Irrigation scheduling can greatly reduce the excess costs of wasting water and fuel without negatively impacting plant growth.

Land configuration is critical in determining the efficacy of crop management strategies such as irrigation, nutrient application, and weed control, among others. Groundnut is having characteristic mechanism i.e., geotropism therefore loose and well aerated soil surface has favorable impact on pod penetration and development. Hence, land configuration is important in planting of summer groundnut. Keeping this in view, an agronomic experiment was conducted to study the effect of irrigation regimes and land configurations growth and yield of summer groundnut in sub-montane zone of Maharashtra.

Materials and Methods

A field experiment was conducted at Agronomy Farm, Rajarshee Chhatrapati Shahu Maharaj College of Agriculture, Kolhapur (M.S.), India during summer, 2020 to study the effect of irrigation regimes and land configurations on growth and yield of summer groundnut (*Arachis hypogaea* L). The soil of the experimental plot was sandy clay loam in texture, low in available N (171.27 kg ha^{-1}), moderately high in available P_2O_5 (18.26 kg ha^{-1}), medium in available K_2O (183.19 kg ha^{-1}) and slightly alkaline in reaction (pH 7.81). The experiment was laid out in split plot design with three replications and twelve treatment combinations consist of main plot with four irrigation regimes *viz.*, I_1- 0.6 IW/CPE, I_2- 0.8 IW/CPE, I_3- 1.0 IW/CPE, I_4- 1.2 IW/CPE, and sub plot with three land configurations *viz.*, L_1- Broad Bed Furrow, L_2- Ridges and furrow, L_3- Flat bed. The gross and net plot size were 4.80 m x 4.00 m and 3.60 m x 3.00 m, respectively. The Recommended Dose of Fertilizer (NPK Kg ha^{-1}) was applied by using urea and single super phosphate by placement method. The variety of crop JL-1085 (Phule Dhani) was sown on 10th of March 2020 during experimentation by dibbling method at spacing 30 cm × 10 cm with different irrigation regimes and land configurations. The land configuration practices viz., broad bed furrow of 150cm with 120 cm top and 30 cm furrow width (L_1), ridges and furrows (60 cm wide ridge, 60 cm wide furrow) (L_2), flatbed method (L_3) were prepared. Three common irrigations, viz., first immediately after sowing, second and third at 7 days interval after first irrigation for proper germination and establishment of the plants. The treatments were comprised four irrigation regimes i.e., 0.6, 0.8, 1.0 and 1.2 IW/CPE ratio with 5 cm water depth as main plot. Scheduling of irrigation was done as per CPE values calculated viz., 83.4, 62.5, 50 and 41.6 mm in respective plots. Daily evaporation data was recorded from the USWB open pan evaporimeter installed in agrometeorological observatory. In all, 7 (83.4 mm), 9 (62.5 mm), 10 (50 mm) and 12 (41.6 mm) irrigations were applied as per treatments. The experimental data was statistically analyzed by using a standard method of "analysis of variance" as reported by Panse and Sukhatme (1967) [9].

Result and Discussion

Effect on yield attributing characters of groundnut

Effect of irrigation Regimes

Irrigation regimes had a substantial impact on the yield attributing characters of groundnut. Application of irrigation at 1.0 IW/CPE recorded significantly superior number of pods $plant^{-1}$ (47.41g), weight of pod $plant^{-1}$ (47.64g), weight of 100 kernels (47.27g), SMK (78.72%), shelling (67.98%) over irrigation at 0.6 IW/CPE (Table 1). The 0.8 IW/CPE and 1.2 IW/CPE treatments gave at par results with treatment 1.0 IW/CPE. The increase in soil moisture reduces soil strength and facilitates easy movement of pods into the ground either throughout the growing period of crop or during critical period of peg formation and penetration, pod initiation. Plants with a high soil moisture regime produced more pods per plant. Similar results were reported Behera *et al*., (2015) [1] and Naresha *et al*., (2019) [8].

Effect of land configurations

Land configurations had a substantial impact on the yield attributing characters of groundnut. The broad bed furrow recorded significantly maximum number of pods $plant^{-1}$ (47.26g), weight of pod $plant^{-1}$ (45.87g), weight of 100 kernels (46.96g), SMK (78.48%), shelling (67.26%) over flatbed (Table 2). However, it was on par with ridges and furrows. Due to loosened and porous soil in the broad bed furrow, it was easier to store rainwater and have a larger root system, which resulted in higher water and nutrient uptake by the crop. Timely moisture availability led to higher growth of plant and finally gave rise to higher pod filling. The increased number of branches and more reproductive growth and conversion of flowers in pods only due to more conserved soil moisture at peak period of pod development. It might have resulted in increased number of pods per plant. Similar results were observed Subrahmaniyan and Kalaiselvan (2006) [13], and Jaypaul (1996) [3].

Effect of Interaction

The interaction effect between irrigation regimes and land configurations treatments the was found to be non-significant in respect of yield attributing characters of groundnut.

Effect on yield of groundnut

Effect on irrigation regimes

Irrigation at various regimes had a substantial impact on groundnut dry pod and dry haulm yield. Among irrigation regimes, the application at 1.2 IW/CPE recorded significantly the highest dry pod yield (27.84 q ha^{-1}) and haulm yield (39.60 q ha^{-1}) of groundnut over 0.6 IW/CPE (Table 2). However, it was at par with application of irrigation at 0.8 IW/CPE and 1.2 IW/CPE for dry pod yield and haulm yield respectively. The lowest dry pod yield and haulm yield was obtained at 0.6 IW/CPE ratio. With the 1.0 IW/CPE ratio, adequate moisture availability combined with higher irrigation frequency resulted in luxurious crop growth and, as a result, raised the values of yield attributes when compared to 0.6 IW/CPE ratio treatment. Higher pod yields with more frequent irrigation (1.0 IW/CPE ratio) might be due to positive impact on yield-related features like number of kernels pod^{-1}, number of pods per plant, 100 kernel weights, and finally leading to highest dry pod yield and dry haulm yield. Similar results were recorded by Pawar *et al*., (2013) [11], Behera *et al*., (2015) [1] and Tambe *et al*., (2017) [14].

Effect on land configurations

The different land configurations treatments significantly differed in respect of the dry pod yield and dry haulm yield. The highest dry pod yield (27.34 q ha^{-1}) and dry haulm yield (38.94 q ha^{-1}) of groundnut was observed in BBF layout, it was significantly superior over flatbed (Table 2). However, it was on par with ridges and furrows layout. The broad bed furrow provided a loose soil mass with sufficient moisture. These conditions favored efficient peg penetration and pod development, which resulted in an increase in groundnut dry pod yield and dry haulm yield. Similar results were recorded by Vekariya *et al*., (2015) [15] and Patil *et al*., (2007) [10].

Effect on Interaction

The interaction effect between irrigation regime and land

configuration was found to be non-significant in respect of yield of summer groundnut.

Effect of different treatments on economics studies

Effect on irrigation regimes

Irrigating crop at 1.0 IW/CPE recorded significantly highest gross monetary returns (150813 Rs ha^{-1}) net monetary returns (83539 Rs ha^{-1}) and B:C ratio (2.24) of groundnut over 0.6 IW/CPE treatment (Table 3). However, it was at par with 0.8 IW/CPE and 1.2 IW/CPE. The lowest gross monetary returns, net monetary returns, and B:C ratio were obtained at 0.6 IW/CPE. Similar results were reported by Madhuri devi *et al.*, (2019) [6], Dhale *et al*., (2021) [2] and Kamble *et al*., (2018) [5].

Effect on land configurations

The broad bed furrow recorded significantly highest gross monetary return (148102 Rs ha^{-1}), net monetary return (80788 Rs ha^{-1}) and B:C ratio (2.20) of groundnut over flatbed (Table 3). However, it was at par with ridges and furrow. Similar results were reported by Kamble *et al.*, (2017) [4] and Vekariya *et al*., (2015) [15].

Effect of interaction

The interaction effect was found to be non-significant in respect of gross monetary returns, net monetary returns, and B:C ratio of summer groundnut.

Table 1: Yield attributing characters of groundnut as influenced by various treatments at harvest

Treatments	At harvest				
	Number of pods plant^{-1}	Weight of pods plant^{-1} (g)	Weight of 100 kernels (g)	SMK (%)	Shelling (%)
Main Plot: Irrigation Regimes					
I_1 - 0.6 IW/CPE	40.81	38.70	40.56	71.69	60.21
I_2 - 0.8 IW/CPE	46.19	46.07	45.35	77.60	66.63
I_3 - 1.0 IW/CPE	47.41	47.64	47.27	78.72	67.98
I_4 - 1.2 IW/CPE	44.24	43.38	44.84	75.44	63.09
S. Em±	1.32	1.52	1.26	1.42	1.61
C. D. at 5%	4.56	5.26	4.38	4.91	5.56
Sub Plot: Land Configurations					
L_1 -Broad Bed Furrow	47.26	45.87	46.96	78.48	67.26
L_2- Ridge and Furrow	44.09	43.83	43.95	75.56	64.31
L_3- Flat Bed	42.64	42.14	42.60	73.54	61.87
S. Em±	1.11	0.98	1.05	1.15	1.37
C. D. at 5%	3.33	2.93	3.15	3.45	4.11
Interaction: I × L					
S. Em±	2.22	1.96	2.10	2.30	2.74
C. D. at 5%	NS	NS	NS	NS	NS
General mean	44.66	43.95	44.51	75.86	64.48

Table 2: Mean dry pod yield, dry haulm yield, biological yield and harvest index of groundnut as influenced by various treatments

Treatments	At harvest			
	Dry pod yield (q ha^{-1})	Dry haulm yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
Main Plot: Irrigation Regimes				
I_1- 0.6 IW/CPE	23.38	34.63	58.02	40.31
I_2- - 0.8 IW/CPE	25.84	37.50	63.35	40.87
I_3- - 1.0 IW/CPE	27.84	39.60	67.44	41.20
I_4- - 1.2 IW/CPE	25.10	36.66	61.76	40.61
S. Em±	0.81	0.90	1.27	0.92
C. D. at 5%	2.79	3.13	--	--
Sub Plot: Land Configurations				
L_1 -Broad Bed Furrow	27.34	38.94	66.28	41.20
L_2- Ridge and Furrow	25.76	37.04	62.81	41.06
L_3- Flat Bed	23.53	35.31	58.84	39.99
S. Em±	0.56	0.77	0.81	0.81
C. D. at 5%	1.67	2.30	--	--
Interaction: I × L				
S. Em±	1.11	1.53	1.61	1.62
C. D. at 5%	NS	NS	NS	NS
General mean	25.54	37.10	62.64	40.75

Table 3: Mean cost of cultivation, gross monetary returns, and net monetary returns of groundnut as influenced by different treatments

Treatments	Cost of Cultivation (Rs ha^{-1})	Gross monetary returns (Rs ha^{-1})	Net monetary returns (Rs ha^{-1})	B:C ratio
Main Plot: Irrigation Regimes				
I_1- 0.6 IW/CPE	66743	126818	60074	1.90
I_2- - 0.8 IW/CPE	67061	140075	73014	2.09
I_3- - 1.0 IW/CPE	67274	150813	83539	2.24
I_4- - 1.2 IW/CPE	67484	136083	68600	2.02
S. Em±	145	4258	4304	0.06
C. D. at 5%	--	14734	14895	--
Sub Plot: Land Configurations				
L_1 -Broad Bed Furrow	67314	148102	80788	2.20
L_2- Ridge and Furrow	67133	139609	72475	2.08
L_3- Flat Bed	66974	127632	60657	1.91
S. Em±	90.49	2909.99	2919.35	0.04
C. D. at 5%	--	8724	8752	--
Interaction: I × L				
S. Em±	--	5819.98	5838.71	--
C. D. at 5%	--	NS	NS	--
General mean	67140	138447	71307	2.06

Conclusion

1. Among different irrigation regimes, scheduling of irrigation at 1.0 IW/CPE recorded the superior yield of summer groundnut, so irrigation at 1.0 IW/CPE could be beneficial for groundnut.
2. Among different land configurations Broad Bed Furrow (BBF) recorded the maximum yield of summer groundnut, so adopting broad bed furrow could be beneficial for groundnut.
3. Among irrigation regimes irrigation at 1.0 IW/CPE and Broad Bed furrow recorded highest gross monetary, net monetary retunes and B:C ratio so it could be beneficial for summer groundnut.

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