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Influence of land configuration and nutrient management on yield attributes, yield and economics of groundnut (*Arachis hypogaea* L.)

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Abstract
Field experiment was conducted at the Research Farm of Indira Gandhi Krishi Vishwavidyalaya in Raigarh (C.G.) during the 2019 and 2020 kharif seasons, focusing on groundnut cultivation. The findings highlighted that employing a ridge and furrow land configuration resulted in the highest performance in terms of yield parameters (pods plant^{-1}, kernels pod^{-1}, and 100-kernel weight), overall yields (pods and haulm), and an impressive benefit-cost ratio. Additionally, implementing a nutrient management strategy, specifically 100% Recommended Dose of Nutrients (RDN) (30 kg N, 60 kg P2O5, and 30 kg K2O ha^{-1}) along with 5 tons of Farm Yard Manure (FYM) ha^{-1}, led to the most favorable outcomes in terms of groundnut yield attributes, overall yields, and the benefit-cost ratio.

Keywords: Land configuration, nutrient, pod, haulm, yield, benefit-cost ratio and groundnut

Introduction
Oilseed crops have historically served as the backbone of our country's agricultural economy. Among these vital crops, groundnut (*Arachis hypogaea* L.) stands out as a major leguminous oilseed crop, playing a pivotal role in our agricultural landscape. In Chhattisgarh, it is regarded as a cash crop, primarily cultivated during the kharif and summer seasons. Raigarh district, in particular, contributes significantly to the state's groundnut production, covering 3.81 thousand hectares and yielding 7.80 million metric tons, with an average productivity of 1635 kg ha ha^{-1} (Agriculture Statistics, 2017) [1]. However, several factors have impeded groundnut yield and stability. These include the absence of improved varieties, poor soil fertility, and inadequate adoption of proper agronomic practices influenced by both biotic and abiotic environmental factors (Singh and Joshi, 1993) [14]. Suboptimal yields have been attributed to improper agronomic practices and planting methods, which are location-specific (Variath and Janila, 2017) [18]. Moreover, insufficient and imbalanced nutrient application has contributed to the subpar groundnut yields (Veeramani and Subrahmaniyan, 2010) [19]. Mineral nutrition, particularly secondary and micronutrients, plays a pivotal role in groundnut cultivation (Thakur *et al*., 2010) [16]. Utilizing foliar nutrition can help maintain a balanced nutrient profile within the plant, a task not always achievable through soil uptake alone (Meena *et al*., 2007) [6]. In light of these challenges, a comprehensive field experiment was undertaken to assess the impact of land configuration and nutrient management on groundnut cultivation. This study aims to shed light on practices that can enhance groundnut yields and contribute to the sustainability of this essential oilseed crop.

Materials and Methods
The experimental field featured sandy loam soil and was subjected to a meticulously designed study. Three distinct land configurations, including flat beds, ridge and furrows, and broad bed furrows, were examined. Additionally, six nutrient management practices were evaluated: Absolute control, 100% Recommended Dose of Nutrients (RDN) comprising 30 kg N, 60 kg P2O5, and 30 kg K2O per hectare, 100% RDN with the addition of 5 tons of Farm Yard Manure (FYM) ha^{-1}, 100% RDN with foliar spray of 2% Diammonium Phosphate (DAP) at 30 days after sowing (DAS), 100% RDN with foliar spray of 0.5% Zinc Sulfate (ZnSO4) at 30 DAS, and 100% RDN with foliar spray of 0.2% Boron at 30 DAS. The experiment utilized a split-plot design with three replications. Groundnut variety JL-776 seeds were sown on two separate dates, namely 22.07.2019 and 20.06.2020, with a spacing of 30 cm x 10 cm. Harvesting occurred on 30.11.2019 and 24.10.2020, respectively, as part of this comprehensive agricultural investigation.

Results and Discussion

Pods plant^{-1}, kernels pod^{-1} and 100- kernel weight (g)

The vital yield-related characteristics of groundnut, including pod production, kernel yield, and 100-kernel weight, were significantly influenced by both land configuration and nutrient management, as illustrated in Table-1. Ridge and furrow land configuration (L2) emerged as notably superior to both broad bed furrow (L3) and flat bed (L1). Furthermore, broad bed furrow (L3) also exhibited better results compared to flat bed (L1). Notably, flat bed (L1) recorded the lowest values for pod yield (37.41 plant^{-1}), kernel yield (1.67 pod^{-1}), and 100-kernel weight (37.32 g) among all treatments. In contrast, ridge and furrow (L2) displayed the highest pod yield (40.68 plant^{-1}), kernel yield (1.97 pod^{-1}), and 100-kernel weight (39.95 g). These superior outcomes can be attributed to the ridge and furrow system's enhanced moisture retention and nutrient absorption capabilities, as well as its ability to produce a greater number of branches per plant. This increase in pod production aligns with the findings of Mvumi *et al*. (2018) [9] regarding pods per plant and Patil *et al*. (2007) [12] concerning 100-kernel weight. Patil (1989) [11] has also highlighted the substantial advantages of the furrow method compared to the flat bed method in groundnut cultivation.

Number of pods, kernels and 100-kernel weight were significantly affected by nutrient management. Treatment 100% RDN + 5 t FYM ha^{-1} (N_3) noted significantly the highest number of pod plant^{-1} (43.82), kernels (1.97) pod^{-1}and 100- kernel weight (41.94 g). Similarly, 100% RDN + foliar spray of 2% DAP (N_4) and 100% RDN + foliar spray of 0.5% zinc sulphate (N_5) being at par each other and better than 100% RDN + foliar spray of 0.2% boron (N_6), 100% RDN (N_2) and absolute control (N_1) treatments in respect of pods plant^{-1}. Further, treatment 100% RDN + 2% DAP foliar spray (N_4), 100% RDN + foliar spray of 0.5% zinc sulphate (N_5) and 100% RDN + foliar spray of 0.2% boron (N_6) being on par and better than 100% RDN (N_2) and absolute control (N_1) treatments in respect of number of kernels pod^{-1}. However, in case of 100-kernel weight, 100% RDN + foliar spray of 2% DAP (N_4) recorded a value of 40.32 g and observed better than 100% RDN + foliar spray 0.5% zinc sulphate (N_5), 100% RDN + foliar spray of 0.2% boron (N_6), 100% RDN (N_2) and absolute control (N_1) treatments. The lowest pods plant^{-1} (33.59), kernels pod^{-1} (1.63) and 100- kernel weight (35.34 g) were noted in absolute control (N_1) treatment. More pods under 100% RDN + 5 t FYM ha^{-1} (N_3) were attributed due to continuous supply of organic and inorganic source of nutrients which tends to enhance the biological nitrogen fixation along with facilitation of proper proliferation of roots and pegging. These results were in accordance with the findings of Thomas and Thenua (2010) [17]. Similarly, the highest 100-kernel weight was recorded with 100% RDN + 5 t FYM ha^{-1} (N_3). This might be due to increased transportation of sugars or photosynthates from source to storage organs *i.e*., sink, thereby resulting in more sound and weighted kernels, finally 100-kernel weight. These results were in conformity with those of Subrahmaniyan *et al*. (2001) [15] and Mohapatra and Dixit (2010) [7].

Table 1: Effect of land configuration and nutrient management on pods plant^{-1}, kernels pod^{-1} and 100- kernel weight of *kharif* groundnut

Treatment	Pods plant^{-1}			Kernels pod^{-1}			100- kernel weight (g)		
	2019	2020	Mean	2019	2020	Mean	2019	2020	Mean
Land configuration									
L_1 - Flat Bed	36.88	37.94	37.41	1.64	1.71	1.67	36.77	37.87	37.32
L_2 - Ridge and furrow	40.02	41.33	40.68	1.96	1.98	1.97	38.41	41.49	39.95
L_3 - Broad bed furrow	38.62	40.03	39.33	1.75	1.82	1.78	37.55	39.43	38.49
S Em ±	0.17	0.17	0.17	0.02	0.02	0.02	0.04	0.05	0.05
CD (5%)	0.67	0.68	0.67	0.09	0.07	0.08	0.17	0.20	0.18
Nutrient management									
N_1- Absolute control	32.97	34.21	33.59	1.59	1.67	1.63	34.41	36.27	35.34
N_2- 100% RDN	36.88	38.35	37.61	1.70	1.78	1.74	35.92	37.85	36.89
N_3- 100% RDN+ 5 t FYM ha^{-1}	42.97	44.67	43.82	1.96	1.99	1.97	40.84	43.03	41.94
N_4- 100% RDN+ foliar spray of 2% DAP at 30 DAS	40.44	41.54	40.99	1.85	1.89	1.87	39.27	41.37	40.32
N_5- 100% RDN+ foliar spray of 0.5% Zinc sulphate at 30 DAS	39.70	40.68	40.19	1.80	1.84	1.82	37.81	39.84	38.82
N_6- 100% RDN+ foliar spray of 0.2% boron at 30 DAS	38.07	39.17	38.62	1.78	1.83	1.81	37.22	39.22	38.22
S Em ±	0.37	0.20	0.29	0.02	0.03	0.03	0.17	0.20	0.19
CD (5%)	1.07	0.58	0.83	0.07	0.08	0.08	0.50	0.58	0.54

Pod and haulm yield

Table 2 provides insightful data regarding the impact of land configuration and nutrient management on pod and haulm yield in groundnut cultivation. Remarkably, the highest pod yield (34.66 q ha^{-1}) was achieved in the ridge and furrow (L2) land configuration, with broad bed furrow (L3) closely following, outperforming flat bed (L1). In comparison, flat beds (L1) exhibited the lowest pod yield at 26.3 q ha^{-1}. Ridge and furrow (L2) displayed a substantial 10.70% and 24.12% increase in pod yield over broad bed furrow (L3) and flat bed (L1), respectively. Moreover, broad bed furrow (L3) yielded 15.02% more pods than flat beds (L1). Haulm yield mirrored this pattern, with a 9.60% and 14.63% higher yield associated with ridge and furrow (L2) when compared to broad bed furrow (L3) and flat bed (L1), respectively. These improvements in pod and haulm yield under ridge and furrow (L2) were attributed to factors like increased plant height, more functional leaves, expanded leaf area, a higher number of branches, and greater dry matter production. This multifaceted enhancement in yield aligns with prior research findings by Nikam and Firake (2002) [10] and Shrinivas (2012) [13] for pod yield, as well as studies by Baskaran *et al*. (2003) [2] and Vekariya *et al*. (2015) [20] for haulm yield.

Remarkably, the highest pod and haulm yields, reaching 37.28 and 71.06 q ha^{-1}, respectively, were achieved with the 100% Recommended Dose of Nutrients (RDN) along with 5 tons of Farm Yard Manure (FYM) ha^{-1} (N3), surpassing all other practices. The treatments, namely 100% RDN with a foliar spray of 2% Diammonium Phosphate (DAP) (N4), 100% RDN with a foliar spray of 0.5% zinc sulfate ($ZnSO4$)

(N5), and 100% RDN with a foliar spray of 0.2% boron (N6), exhibited similar and significantly superior results compared to both 100% RDN (N2) and the absolute control (N1). Moreover, 100% RDN (N2) also outperformed the absolute control (N1), signifying its positive impact. Conversely, the lowest pod and haulm yields, at 23.83 and 54.23 q ha^{-1}, respectively, were observed in the absolute control (N1) group. Notably, pod yield witnessed a remarkable 22.05% and 36.08% increase under 100% RDN + 5t FYM ha^{-1} (N3) compared to 100% RDN (N2) and the absolute control (N1), respectively. Similarly, haulm yield also saw an increase of 10.20% and 23.68% under the former treatment compared to the latter two. The heightened pod and haulm yields attributed to 100% RDN + 5t FYM ha^{-1} (N3) were the result of superior growth attributes observed in this treatment. These findings align with the research of various scholars such as Chitdeshwari *et al.* (2007) [3], Murthy *et al.* (2009) [8], and Thomas and Thenua (2010) [17] who reported similar results regarding pod yield. Furthermore, the substantial increase in haulm yield in the 100% RDN + 5t FYM ha-1 (N3) treatment was due to the enhanced growth characteristics, including plant height, leaves, branches, and dry matter production, in line with the findings of Mohapatra and Dixit (2010) [17].

Table 2: Effect of land configuration and nutrient management on pod and haulm yield of *kharif* groundnut

Treatment	Pod yield (q ha^{-1})			Haulm yield (q ha^{-1})		
	2019	2020	Mean	2019	2020	Mean
Land configuration						
L_1 - Flat Bed	25.50	27.10	26.30	58.45	62.44	60.44
L_2 - Ridge and furrow	32.99	36.34	34.66	67.68	73.93	70.80
L_3 - Broad bed furrow	29.68	32.21	30.95	61.70	66.31	64.00
S Em ±	0.60	0.57	0.59	0.64	0.71	0.68
CD (5%)	2.31	2.21	2.26	2.53	2.78	2.65
Nutrient management						
N_1- Absolute control	22.77	24.89	23.83	52.07	56.40	54.23
N_2- 100% RDN	27.87	30.25	29.06	61.20	66.42	63.81
N_3- 100% RDN+ 5 t FYM ha^{-1}	35.94	38.61	37.28	68.28	73.85	71.06
N_4- 100% RDN+ foliar spray of 2% DAP at 30 DAS	30.32	32.96	31.64	65.09	70.05	67.57
N_5- 100% RDN+ foliar spray of 0.5% Zinc sulphate at 30 DAS	29.78	32.39	31.09	64.65	69.57	67.11
N_6- 100% RDN+ foliar spray of 0.2% Boron at 30 DAS	29.66	32.19	30.92	64.36	69.07	66.71
S CD (5%)Em ±	0.72	0.68	0.70	0.95	1.04	0.99
	2.09	1.98	2.03	2.74	3.00	2.87

RDN: Recommended dose of nutrients (30, 60 and 30 kg of N, P2O5 and K2O ha-1, respectively)

Economics of groundnut cultivation (₹ ha^{-1}): The economic analysis of groundnut cultivation, encompassing cultivation cost, gross return, net return, and benefit-cost ratio, is presented in Table-3. On average, the cost of cultivation amounted to ₹35,424 ha^{-1}, with a gross return of ₹1,52,344 ha^{-1}, resulting in a net return of ₹1,16,921 ha^{-1}. The mean benefit-cost ratio stood at a commendable 4.28. Among the various land configurations, ridge and furrow (L2) stood out, recording the highest gross return (₹1,70,800 ha^{-1}), net return (₹1,33,784 ha^{-1}), and benefit-cost ratio (4.61). Broad bed furrow (L3) followed closely, with respective values of ₹1,52,225 ha^{-1}, ₹1,18,544 ha^{-1}, and a benefit-cost ratio of 4.51, securing the second position. In contrast, flat bed (L1) reported the lowest values for these parameters. The cost of cultivation ha^{-1} was highest (₹37,016.50) in ridge and furrow (L2), followed by broad bed furrow (L3) and flat bed (L1). These findings align with previous research by Dhadage *et al.* (2008) [4] and Kamble *et al.* (2017) [5], reinforcing the economic advantages of ridge and furrow land configuration in groundnut cultivation.

Nutrient management 100% RDN + 5 t FYM ha^{-1} (N_3) recorded the highest gross return (₹186375 ha^{-1}), net return (₹144895 ha^{-1}) and benefit cost ratio (4.49). The respective values under 100% RDN + foliar spray of 2% DAP (N_4) were ₹ 158200, ₹ 122054 and 4.38 which stood second in position. Further, in respect of remunerative point of view, 100% RDN + foliar spray of 0.5% zinc sulphate (N_5), 100% RDN + foliar spray of 0.2% boron (N_6), 100% RDN (N_2) and absolute control (N_1) were in descending order after 100% RDN + 5 t FYM ha^{-1} (N_3) and 100% RDN + foliar spray of 2% DAP (N_4) treatments. However, absolute control (N_1) expressed the lowest value of these three economic parameters. Regarding cost of cultivation, value was maximum (₹41480 ha^{-1}) in 100% RDN + 5 t FYM ha^{-1} (N_3) due to application of farm yard manure and minimum (₹30876 ha^{-1}) was in absolute control (N_1). The highest gross returns, net returns and benefit cost ratio with 100% RDN + 5 t FYM ha^{-1} (N_3) might be due to highest pod yield which has even compensated the highest cost of cultivation. These results are in conformity with the findings of Mohapatra and Dixit (2010) [7] and Wani *et al.* (2015) [21].

Table 3: Effect of land configuration and nutrient management on economics of *kharif* groundnut

Treatment	Cultivation cost (₹ ha^{-1})	Gross return (₹ ha^{-1})			Net return (₹ ha^{-1})			Benefit cost ratio		
	2019 and 2020	2019	2020	Mean	2019	2020	Mean	2019	2020	Mean
Land configuration										
L_1 - Flat Bed	32411	125000	133000	129000	92588	100588	96588	3.85	4.10	3.97
L_2 - Ridge and furrow	37016	162450	179150	170800	125433	142133	133783	4.39	4.84	4.61
L_3 - Broad bed furrow	33681	145900	158550	152225	112218	124868	118543	4.33	4.70	4.51

Nutrient management										
N_1- Absolute control	30876	113850	124450	119150	82973	93573	88273	3.69	4.03	3.86
N_2- 100% RDN	35252	139350	151250	145300	104097	115997	110047	3.95	4.29	4.12
N_3- 100% RDN+ 5 t FYM ha^{-1}	41480	179700	193050	186375	138219	151569	144894	4.33	4.65	4.49
N_4- 100% RDN+ foliar spray of 2% DAP at 30 DAS	36146	151600	164800	158200	115453	128653	122053	4.19	4.56	4.38
N_5- 100% RDN+ foliar spray of 0.5% Zinc sulphate at 30 DAS	35883	148900	161950	155425	113016	126066	119541	4.15	4.51	4.33
N_6- 100% RDN+ foliar spray of 0.2% boron at 30 DAS	36066	148300	160950	154625	112233	124883	118558	4.11	4.46	4.29
General mean	35423	146116	158572	152344	110692	123148	116920	4.11	4.46	4.28

Conclusions

The land configuration practice *viz.,* ridge and furrow (L_2) produced the highest pods plant^{-1}, kernels pod^{-1}, 100-kernel weight, pod yield, haulm yield and benefit cost ratio. Nutrient management practices, 100% RDN + 5t FYM ha^{-1} (N_3) recorded the maximum values of yield attributes, yields and benefit cost ratio of groundnut.

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