Biological Forum – An International Journal 16(4): 64-69(2024)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Effect of Land Configuration and Nutrient Management on Growth and Yield of *Kharif* Groundnut (*Arachis hypogaea* L.)

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(Received: 09 February 2024; Revised: 24 February 2024; Accepted: 10 March 2024; Published: 15 April 2024)
(Published by Research Trend)

ABSTRACT: The field experiment was conducted during *kharif* season, 2021 at Post Graduate Institute Research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra). Result from this experimentation shows that the adoption of broad bed furrow planting method recorded the maximum growth attributing characters *viz.* plant height, plant spread, number of branches plant^{-1}, total dry matter plant^{-1} and yield contributing characters viz. number of pods plant^{-1} which ultimately results in increase of kernel yield (21.47 q ha^{-1}), dry pod yield (31.26 q ha^{-1}) and dry haulm yield (36.93 q ha^{-1}) of groundnut. Application of GRDF + 60 kg K_2Oha^{-1} + 60 kg S ha^{-1} recorded the maximum growth attributing characters *viz.* plant height, plant spread, number of branches plant^{-1}, total dry matter plant^{-1} and yield contributing characters viz. number of pods plant^{-1} which ultimately results in increase of kernel yield (23.62 q ha^{-1}), dry pod yield (35.06 q ha^{-1}) and dry haulm yield (35.87 q ha^{-1}) of groundnut. Based on the one-year experimental finding it can be concluded that the higher growth and yield characters were obtained with a broad bed furrow planting method with application of GRDF + 50 kg K_2O ha^{-1} + 40 S ha^{-1}.

Keywords: Groundnut, Land configuration, Nutrient management, Broad Bed Furrow.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important oilseed cum legume crop of India. Groundnut is a species in the legume family (Fabaceae) native to South America, Mexico and Central America. Groundnut is also known as earthnuts, Peanuts, goobers, goober peas, pindas, jack nuts, pinders, manila nuts, groundnuts and monkey nuts; the last of these is often used to mean the entire pod. Groundnut is an oilseed crop and it is useful for crop rotation. It is easy to grow, withstand drought to some extent and so a choice crop for dry farming. It is soil erosion resistant crops. Being a leguminous crop, it can fix atmospheric nitrogen (22 kg ha^{-1}) with the help of symbiotic relationship of bacteria in root nodules and thereby reduces fertilizer requirement of succeeding crop. Thus, maintain soil fertility. All parts of the plant can be commercially used. A large number of food products are prepared from groundnut *viz.* boiled nuts, roasted nuts, salted nut, groundnut milk, groundnut yogurt, groundnut bars, groundnut butter, groundnut cheese, bakery products etc.

Traditionally, groundnut is sown on flat bed without proper gradation and slope and the problem of waterlogging becomes severe. To overcome this, a broad bed and furrow system is suggested. The raised bed should be 1.2 m wide and 15 cm high and with two furrows of 30 cm width on either side to drain out excess water. This width of raised bed will accommodate 4 rows of groundnut at 30 cm distance between rows. The broad bed and furrow system need a graded slope of land, 0.8 to 2 per cent and it is formed across the slope. The furrows should lead to a main drain at the end of the field. The crop in the raised bed showed excellent root growth and nodulation, vigorous plant growth and greener foliage than flat bed. Raising groundnuts on a flatbed reduces the weed problem. Crops in BBF are more amenable for manual harvesting with fewer pods left in ground while pulling out. This system is recommended for all soils particularly for clayey soils in high rainfall areas.

Fertilizers are the kingpin in the present system of agriculture. Scientific uses of fertilizer assume vital importance in sustainable agriculture. Fertilizers pay back to the farmer more profit per unit investment. Judicious use of fertilizer is an important management practice to increase groundnut production. Indian soils are usually low in organic matter and nitrogen.

The optimization of the mineral nutrition is the key to optimize the production of groundnut, as it has very high nutrient requirements and the recently released high yielding groundnut varieties remove still more nutrients from the soil.

MATERIALS AND METHODS

A. Site of Experiment

Geographically, the Central Campus Farm of Mahatma Phule Krishi Vidyapeeth, Rahuri is situated between the 74° 35′E and 74°19′East longitude and 19°18′N and 19°57′ North latitude. The altitude of the field varies from 495 to 556 m above mean sea level. The tract lies on the eastern side of the Western Ghats and falls in the rain shadow area receiving more than 80 per cent of the rainfall from the South West monsoon. Agro-climatologically, this area falls in the scarcity zone (drought prone area) of Maharashtra state. The annual rainfall ranges from 307 to 619 mm with an average of 520 mm. Out of which 80 per cent rain is received from the South-West monsoon from June to October with 45 rainy days. Agro-climatically location is in drought-prone areas of Maharashtra state, characterized by the low and erratic rainfall with less rainy days and long dry spell.

B. Soil characteristics

The topography of the experimental field was uniform level and well drained. The soil of the experimental site was sandy clay loam in texture, low in available nitrogen (120.30 kg ha^{-1}), moderate phosphorus (15.5 kg ha^{-1}) high in potassium (320.30 kg ha^{-1}). The soil was moderately alkaline in reaction (pH 7.1) with EC 0.35 dSm^{-1} and organic carbon 0.43 %.

C. Experimental design

The field experiment consists of 15 treatment combinations laid out in split plot design with three replications. The allocation of main and sub plot treatments to the representative plot was done by random method. The main plot treatments consisted of three land configurations *viz*., Broad bed Furrow (30 cm × 7.5 cm), Ridges and furrow (30 cm × 10 cm) and Flat bed furrow (30 cm × 10 cm). The sub plot treatments involved of different nutrient management *viz*., Absolute control, GRDF (25:50:0 N:P_2O_5 : K_2O_5 kg ha^{-1} + FYM 10 t ha^{-1}), GRDF + 40 kg K_2O ha^{-1} + 20 kg S ha^{-1}, GRDF + 50 kg K_2O ha^{-1} + 40 kg S ha^{-1} and GRDF + 60 kg K_2O ha^{-1} + 60 kg S ha^{-1}. The seeds of groundnut variety RHRG-6083 (Phule Unnati) were procured from the AICRP groundnut scheme MPKV, Rahuri (M.S.) for the experiment. Sowing was done by hand dibbling. For this, the lines were first marked out with the help of markers at 30 cm distance on BBF as well as in flat bed treatments. Seeds were then dibbled in these lines at a distance of 7.5 cm in broad bed furrow and at 10 cm in flat bed furrow and ridges and furrow treatment land configuration with recommended seed rate 120 kg ha^{-1}. The groundnut kernels were treated with biofertilizers like *Rhizobium* and PSB culture @ 250 g / 10 kg seeds. Application organic manure through well rotted farmyard manure 10 ton ha^{-1} was done well before 15 days of dibbling except in absolute control. The recommended dose of fertilizer *i.e.,* 25 kg N through urea, 50 kg P_2O_5 ha^{-1} through DAP was applied as a basal dose. Variable rate of potassium is applied through MOP and Sulphur (SO_4) is applied through Bensulf (90% S).

RESULTS AND DISCUSSION

A. Plant height

The plant height was significantly influenced due to effects of land configurations. Broad bed furrow recorded significantly maximum plant height than rest of land configurations. Better plant growth in broad bed furrow could be attributed to loose and porous seed bed which helps in maintaining soil water relationship and it influences the growth characteristics of the plant. Application of GRDF + 60 kg K_2O + 60 kg S ha^{-1} recorded significantly higher plant height than rest of nutrient levels and it was at par with the application GRDF + 50 kg K_2O + 40 kg ha^{-1}. The increase in plant height with application of higher levels of nutrients results in enhanced activities of meristematic tissues, increase in number and size of the cell and the efficient utilization of nutrient uptake. The interaction between land configurations and nutrient management levels found to be non significant on plant height.

B. Plant spread

The plant spread was significantly influenced due to effects of land configurations. Broad bed furrow recorded significantly maximum plant spread than rest of land configurations. These results are in close conformation with those reported by Hamakareem *et al.* (2016); Kalavathi *et al.* (2018). Application of GRDF + 60 kg K_2O + 60 kg S ha^{-1} recorded significantly higher plant spread than rest of nutrient levels and it was at par with the application GRDF + 50 kg K_2O + 40 kg S ha^{-1}. The increase in vegetative growth of plants due to higher inorganic fertilizers might have increased nutrient uptake, resulting in increased plant spread. These results are in close conformation with results recorded by Salke *et al.* (2011). The interaction effect between different land configurations and nutrient management was non-significant in respect of plant spread.

C. Number of branches plant^{-1}

The number of branches $plant^{-1}$ was significantly influenced due to effects of land configurations. Broad bed furrow recorded significantly maximum number of branches $plant^{-1}$. The results are in close conformity with the findings of Sathiya *et al.* (2020). Number branches $plant^{-1}$ was significantly influenced with increased levels of nutrients. Application of GRDF + 60 kg K_2O + 60 kg S ha^{-1} recorded significantly higher number branches $plant^{-1}$ than rest of nutrient levels and it was at par with the application GRDF + 50 kg K_2O + 40 kg S ha^{-1}. Similar results were reported by Yadav *et al.* (2014); Patel *et al.* (2018). The interaction effect between different land configurations and nutrient management levels was non-significant in respect to the number of branches $plant^{-1}$.

D. Total root nodules plant^{-1}

The number of total root nodules $plant^{-1}$ was significantly influenced due to effects of land configurations. Broad bed furrow recorded significantly maximum number of total root nodules plant^{-1} than rest of land configurations. Broad bed furrow helps to conserve moisture, increases infiltration, good aeration and reduces runoff and soil erosion due to this increasing total root nodules plant^{-1}. The total root nodules plant^{-1} were influenced significantly due to different nutrient management levels. The total root nodules plant^{-1} were recorded significantly higher in GRDF + 60 kg K_20 + 60 kg S ha^{-1} than rest of nutrient management treatments. However, it was at par with the treatment GRDF + 50 kg K_2O ha^{-1} + 40 kg S ha^{-1}. Plant required more potassium and sulphur for growth and development of groundnut plants. The secretion of organic acids might improve soil conditions for better root proliferation, proteins metabolism leading to a greater number of nodules per plant. Similar results were reported by Yadav *et al.* (2014). The interaction effect between land configuration and nutrient management level was found non significant in respect of total root nodules plant^{-1}.

E. Total dry matter plant^{-1}

The mean total dry matter plant^{-1} was influenced significantly by different land configurations. The significantly highest total dry matter plant^{-1} was recorded higher in broad bed furrow than rest of land configurations. This might be due to porous media providing a proper proportion of air and water for the development of groundnut crop as compared to the other land configurations. These findings confirm the results of Bharade *et al.* (2019). The significantly higher total dry matter plant^{-1} were recorded in GRDF + 60 kg K_2O + 60 kg S ha^{-1} than rest of nutrient management treatments. However, it was at par with the treatment GRDF + 50 kg K_2O + 40 kg S ha^{-1}. The main reason for increase in dry matter production by groundnut plants might be due to increased uptake of major nutrients with higher levels of fertilizer application which improved plant growth and accumulated greater biomass which lead to increased dry matter production of plants. These results were in conformity with the results of Devi *et al.* (2022). The interaction effect between land configurations and nutrient management level was non significant in respect of total dry matter plant^{-1}.

F. Number of pods plant^{-1}

The mean total number of pods plant^{-1} was influenced significantly by different land configurations. The mean total numbers of pods plant-1 were recorded significantly higher in broad bed furrow than rest of land configurations. Broad Bed Furrows provide favourable soil atmosphere by lowering the bulk density in the surface layer with low soil strength. Groundnut pods grow underground, therefore the loose and well aerated seed bed is important as loose soil surface is useful for penetration of pegs and development of pods. The mean total number of pods plant^{-1} was influenced significantly due to different nutrient management levels. The mean total number of pods plant^{-1} at harvest was recorded significantly higher in GRDF + 60 kg K_2O + 60 kg S ha^{-1} than rest of nutrient management treatments. However, it was at par with the treatment GRDF + 50 kg K_2O ha^{-1} + 40 kg S ha^{-1}. The application of GRDF + 60 kg K_2O + 60 kg S ha^{-1} higher number of dry pod plant^{-1} was obtained due to better growth as well as higher uptake of nutrients might have produced and converted more photosynthetic into numerous metabolites needed for such yield attribute. Similar results were reported by Devi *et al.* (2022). The interaction effect between land configurations and nutrient management levels found to be significant in respect of the number of pods plant^{-1}. The interaction combination between broad bed furrow and GRDF + 60 kg K_2O + 60 kg S ha^{-1}recorded a significantly higher number of pod plant^{-1} than the rest of the combination.

G. Kernel yield

The mean kernel yield q ha^{-1} was influenced significantly by different land configurations. The mean kernel yield was recorded significantly higher in broad bed furrow than rest of land configurations. The mean kernel yield q ha^{-1} was influenced significantly due to different nutrient management levels. The mean kernel yield q ha^{-1} at harvest was recorded significantly higher in GRDF + 60 kg K_2O + 60 kg S ha^{-1} than rest of nutrient management treatments. Similar findings were reported by Yadav *et al.* (2019). The interaction effect between land configurations and nutrient management levels found to be significant in respect of kernel yield q ha^{-1}. The interaction combination between broad bed furrow and GRDF + 60 kg K_2O + 60 kg S ha^{-1} recorded a significantly higher number of kernel yield q ha^{-1} than the rest of the combination. However, it was at par with BBF and GRDF + 50 kg K_2O + 40 kg S ha^{-1}.

H. Dry pod yield

The mean dry pod yield q ha^{-1} was influenced significantly by different land configurations. The mean dry pod yield was recorded significantly higher in broad bed furrow than rest of land configurations. This might be due to the environmental conditions in respect of soil water-plant relationships largely influenced the pod formation and its development in case of groundnut. The above findings indicated that modified land configurations with modification of soil helped in significantly increasing the plant growth. The broad bed furrow provided a loose soil mass with adequate soil moisture. The results confirmed the findings of Bharade *et al.* (2019). The mean dry pod yield q ha^{-1} was influenced significantly due to different nutrient management levels. The dry pod yield q ha^{-1} at harvest was recorded significantly higher in GRDF + 60 kg K_2O + 60 kg S ha^{-1} than rest of nutrient management treatments. The application of GRDF + 60 kg K_2O + 60 kg S ha^{-1} higher number of dry pod yield q ha^{-1} was obtained due to better growth as well as higher uptake of nutrients might have produced and converted more photosynthetic into numerous metabolites needed for such yield attribute. Similar findings were reported by Yadav *et al.* (2019); Srikanth and Singh (2021); Devi *et al.* (2022). The interaction effect between land configurations and nutrient management levels found to be significant in respect of dry pod yield. The interaction combination between broad bed furrow and GRDF + 60 kg K_2O + 60 kg S ha^{-1} recorded a significantly higher number of dry pod yield than the rest of combination which is at par with BBF and GRDF + 50 kg K_2O + 40 kg S ha^{-1}.

I. Dry haulm yield

The mean dry haulm yield was influenced significantly by different land configurations. The mean dry haulm yield was recorded significantly higher in broad bed furrow than rest of land configurations. This might be due to the environmental conditions in respect of soil water-plant relationships which largely influenced the biomass production and its development in case of groundnut. These findings are in conformity with those reported by Kamble *et al.* (2016). The mean dry haulm yield was influenced significantly due to different nutrient management levels. The dry haulm yield at harvest was recorded significantly higher in GRDF + 60 kg K_2O + 60 kg S ha^{-1} than rest of nutrient management treatments. The reason for higher pods and haulm yield obtained with recommended dose of NPK, Ca, S along with organic manure could be due to adequate supply of essential nutrients that might have helped in steady supply of nutrients because favourable soil properties maintained throughout the crop growth period (Rajanikannt *et al.*, 2008). Similar findings were supported by Thorave and Dhonde (2007); Yadav *et al.* (2015) ; Devi *et al.* (2022). The interaction effect between land configurations and nutrient management levels found to be significant in respect of dry haulm yield q ha^{-1}. The interaction combination between broad bed furrow and GRDF + 60 kg K_2O + 60 kg S ha^{-1} recorded significantly higher dry haulm yield than the rest of the combination.

Table 1: Growth attributes of groundnut as influenced by different treatments.

No.	Treatment	Plant height (cm)	Plant spread (cm)	Number of branches $plant^{-1}$	Total root nodules $plant^{-1}$	Total dry matter $plant^{-1}$ (g)
A.	**Land configuration (Main plot)**					
M_1	Broad bed furrow	32.47	39.51	10.58	67.36	46.85
M_2	Ridges and furrows	30.86	38.56	10.06	65.74	44.14
M_3	Flat bed furrow	29.94	38.17	9.92	64.43	42.09
	SEm ±	0.04	0.10	0.05	0.05	0.05
	CD (P=0.05)	0.19	0.36	0.19	0.23	0.17
B.	**Nutrient management (Sub plot)**					
N_1	Absolute control	29.62	37.35	9.32	64.19	42.59
N_2	GRDF (25:50:0 N:P_2O_5 : K_2Okg ha^{-1} + FYM 10 t ha^{-1})	30.72	38.09	9.39	64.58	44.01
N_3	GRDF + 40 kg K_2O ha^{-1} + 20 kg S ha^{-1}	31.07	38.66	10.03	65.50	44.41
N_4	GRDF + 50 kg K_2O ha^{-1} + 40 kg S ha^{-1}	31.90	39.78	11.07	67.38	45.03
N_5	GRDF + 60 kg K_2O ha^{-1} + 60 kg S ha^{-1}	32.13	39.84	11.25	67.57	45.79
	SEm ±	0.08	0.13	0.13	0.07	0.07
	CD (P=0.05)	0.25	0.38	0.40	0.22	0.20
C.	**Interaction**					
	SEm ±	0.22	0.39	0.40	0.23	0.27
	CD (P=0.05)	NS	NS	NS	NS	NS
	General Mean	31.02	38.75	10.31	65.84	44.36

Table 2: Yield attributes and yield of groundnut as influenced by different treatments.

	Treatment	Number of pods $plant^{-1}$	Kernal yield (q ha^{-1})	Dry pod yield (q ha^{-1})	Dry haulm yield (q ha^{-1})
A.	**Land configuration (Main plot)**				
M_1	Broad bed furrow	28.42	21.47	31.26	36.93
M_2	Ridges and furrows	26.20	18.91	28.64	34.38
M_3	Flat bed furrow	25.40	16.77	26.68	29.51
	SEm ±	0.05	0.06	0.11	0.02
	CD (P=0.05)	0.19	0.22	0.39	0.07
B.	**Nutrient management (Sub plot)**				
N_1	Absolute control	23.64	10.71	16.58	28.99
N_2	GRDF (25:50:0 N:P_2O_5 : K_2Okg ha^{-1} + FYM 10 t ha^{-1})	25.55	17.98	27.62	33.97
N_3	GRDF + 40 kg K_2O ha^{-1} + 20 kg S ha^{-1}	26.57	19.81	30.26	34.41
N_4	GRDF + 50 kg K_2O ha^{-1} + 40 kg S ha^{-1}	28.73	23.15	34.76	34.98
N_5	GRDF + 60 kg K_2O ha^{-1} + 60 kg S ha^{-1}	28.92	23.62	35.06	35.87
	SEm ±	0.10	0.15	0.13	0.07
	CD (P=0.05)	0.31	0.51	0.44	0.25
C.	**Interaction**				
	SEm ±	0.32	0.28	0.35	0.05
	CD (P=0.05)	1.06	0.89	1.14	0.17
	General Mean	26.68	19.05	28.86	33.61

Table 3: Interaction effect between land configuration and nutrient management level on number of pod plant^{-1} and kernel yield (q ha^{-1}) groundnut as influenced by different treatments.

Land configurations / Nutrient Management		Number of pod plant^{-1}			Kernel yield (q ha^{-1})		
		M_1-Broad bed furrow	M_2-Ridges and furrow	M_3- Flat bed	M_1- Broad bed furrow	M_2-Ridges and furrow	M_3-Flat bed
N_1	Absolute control	24.96	25.15	24.55	13.64	9.99	8.46
N_2	GRDF (25:50:0 N:P_2O_5 : K_2Okg ha^{-1} + FYM 10 t ha^{-1})	26.54	25.28	24.83	19.28	18.71	15.96
N_3	GRDF + 40 kg K_2O ha^{-1} + 20 kg S ha^{-1}	28.05	25.98	25.69	22.99	20.14	16.30
N_4	GRDF + 50 kg K_2O ha^{-1} + 40 kg S ha^{-1}	30.17	26.29	25.91	25.55	22.60	21.31
N_5	GRDF + 60 kg K_2O ha^{-1} + 60 kg S ha^{-1}	32.40	28.33	26.05	25.91	23.11	21.84
	SEm ±	0.32			0.28		
	CD (P=0.05)	1.06			0.89		

Table 4: Interaction effect between land configuration and nutrient management level on dry pod yield (q ha^{-1}) and dry haulm yield (q ha^{-1}) of groundnut as influenced by different treatments.

Land configurations / Nutrient Management		Dry pod yield (q ha^{-1})			Dry haulm yield (q ha^{-1})		
		M_1-Broad bed furrow	M_2-Ridges and furrow	M_3- Flat bed	M_1- Broad bed furrow	M_2-Ridges and furrow	M_3-Flat bed
N_1	Absolute control	20.49	15.67	13.58	34.29	30.48	22.21
N_2	GRDF (25:50:0 N:P_2O_5 : K_2Okg ha^{-1} + FYM 10 t ha^{-1})	28.84	28.69	25.35	36.72	34.60	30.60
N_3	GRDF + 40 kg K_2O ha^{-1} + 20 kg S ha^{-1}	33.56	30.61	26.61	37.25	35.01	30.98
N_4	GRDF + 50 kg K_2O ha^{-1} + 40 kg S ha^{-1}	36.66	33.91	33.70	37.36	35.69	31.28
N_5	GRDF + 60 kg K_2O ha^{-1} + 60 kg S ha^{-1}	36.75	34.34	34.15	39.01	36.12	32.49
	SEm ±	0.35			0.05		
	CD (P=0.05)	1.14			0.16		

CONCLUSIONS

Based on the one year experimental finding it can be concluded that the higher growth and yield characters obtained by application of broad bed furrow land configuration with GRDF + 50 kg K_2O ha^{-1} + 40 S ha^{-1} was found appropriate and beneficial for achieving higher productivity.

FUTURE SCOPE

The promising combination of land configuration and nutrient management level can be exploited in different crops for better moisture conservation and nutrient saving.

Acknowledgement. The authors are thankful to Post Graduate Institute, MPKV, Rahuri for their contribution to conduct the experiment.
Conflict of interest. None.

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How to cite this article: Suryavanshi K.R., Kolse R.H., Danawale N.J., Pawar R.A., Deshmukh P.H. and Shelke S.R. (2024). Effect of Land Configuration and Nutrient Management on Growth and Yield of *Kharif* Groundnut (*Arachis hypogaea* L.). *Biological Forum – An International Journal, 16*(4): 64-69.