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Effect of land configuration and microbial consortium on growth and yield of groundnut (*Arachis hypogaea* L.)

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Abstract
The productivity of groundnut is important for the farmers to get a higher yield in different season. Growing of groundnut in summer, increase the productivity through the different management practices. A field experiment was conducted at Dryland Agricultural Research Station, Chettinad, Karaikudi, Sivagangai Disctrcit, Tamil Nadu during summer, 2022 to study on the influence of seed bed preparation and microbial consortium on the growth and yied of groundnut. The experiment was laid out in factorial randomized block design replicated thrice. The treatments consisted of three land configuration methods *viz*., L_1- Flat bed, L_2- Ridges and furrow, L_3- Raised bed and five microbial consortium levels *viz*., M_1- RDF (25:50:75 kg NPK ha^{-1}), M_2- RDF + Seed treatment with *Rhizobium*, M_3- RDF + Seed treatment of *Rhizobium* + soil application of AMF, M_4- RDF + Seed treatment of *Rhizobium* + soil application of AMF + foliar spraying of PPFM + seed treatment with *Bacillus altitudinis* (FD 48) and M_5- RDF + Seed treatment with *Rhizobium* + soil application of AMF + foliar spraying of PPFM and *Bacillus altitudinis* (FD 48). Among the land configuration, ridges and furrow registered the higher plant height, LAI, DMP and yield attributes. In microbial consortium application of RDF + seed treatment of *Rhizobium* + soil application of AMF + foliar spraying of PPFM and *Bacillus altitudinis* (FD 48) recorded the maximum plant height, LAI, DMP and yield attributes. Sowing of groundnut in ridges and furrow and application of microbial consortium; seed treatment of *rhizobium* + soil application of AMF + foliar spraying of PPFM and *Bacillus altitudinis* (FD 48) has enhanced the growth and yield attributes.

Keywords: Configuration, microbial, consortium, groundnut, *Arachis hypogaea* L.

Introduction
Groundnut (*Arachis hypogaea* L.) belongs to genus *Arachis* of family Fabaceae is the “King of oilseed” in our country. It is grown all over the world because of its value for oil, protein, food, medicinal, and industrial application. Adoption of improved technology is most important to meet the ever-increasing demand of vegetable oil, production improvement of major oilseed crops through area expansion, and productivity enhancement. Groundnut is cultivated in both rainfed and irrigated conditions. The productivity of groundnut is low because of monsoon uncertainty and disease epidemics in the *kharif* season, which restricts its cultivation in the rainy season. This has led to economic losses to the farmers due to the partial or total failure of groundnut crop discouraging the farmers from further cultivation. Summer yields are higher and more stable due to the bright sunlight and lower incidence of insects, pests, and diseases. 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 consumptive pan evaporation, land configurations and others must be prioritized. The effectiveness of crop management techniques like irrigation, nitrogen application, and weed control, among others, is highly dependent on the land configuration. Because groundnut has a distinct mechanism, namely geotropism, a loose and well-aerated soil surface has a favourable impact on pod penetration and development.

The primary component of the bio fertilizer is a microbe, which supports soil nutrients for effective plant growth and elevated food production. Although there are many different microorganisms, they all effectively contribute to the soil's nutrients and play a key part in nutrient mineralization and productivity. Beneficial bacteria-containing bio fertilizers were both economically feasible and widely accessible in nature (Dhayalan and Sudalaimuthu. 2021) [4].

Plants that consume mineral nutrients with the help of bio fertlizers produce better results in terms of long-term crop productivity (Malusa *et al*., 2012). All bacterial bio fertlizers play a vital role in nitrogen (N) fixing, phosphorus (P), potassium (K), zinc, and silica solubilization, which aids in fixing various micro and macro nutrients to the soil (Narendra *et al*., 2017) [5]. Additionally, bio fertilizers promote plant growth by improving soil fertility through the release of plant growth hormones, the creation of antibiotics, and the biodegradation of organic materials (Sinha *et al*., 2010) [9]. Under the right circumstances, microorganisms added to the soil release metabolites, acids, and enzymes that provide plants with assailable forms of lacking nutrients.

To improve the nutrient mobilization and use efficiency the beneficial microbial inoculants are used. Using microbes solely or in a consortium could enhance the productivity of most farming systems significantly as the microbes and plants have been evolutionarily interacting in nature. Therefore the present investigation was carried out to study the influence of seed bed preaparation and microbial consortium in groundnut.

Materials and Methods

A experiment was conducted at Dryland Agricultural Research Station, Chettinad, Karaikudi, Sivagangai district of Tamil Nadu during summer, 2022. The experimental site is located at 10°16'N latitude and 78°78' E longitude at an elevation of 115 m above Mean Sea Level. The soil of the experimental plot is sandy loam in texture. The experiment was laid out in Factorial randomized block design with three replications. The treatments consisted of three land configuration methods *viz*., L_1- Flat bed, L_2- Ridges and furrow, L_3- Raised bed and five microbial consortium levels *viz*., M_1- RDF (25:50:75 kg NPK ha^{-1}), M_2- RDF + Seed treatment with *Rhizobium*, M_3- RDF + Seed treatment of *Rhizobium* + soil application of AMF, M_4- RDF + Seed treatment of *Rhizobium* + soil application of AMF + foliar spraying of PPFM + seed treatment with *Bacillus altitudinis* (FD 48) and M_5- RDF + Seed treatment with *Rhizobium* + soil application of AMF + foliar spraying of PPFM and *Bacillus altitudinis* (FD 48). Seed treatment of Rhizobium and *Bacillus sp* (FD 48) was done @ 100 ml ha^{-1}. AMF was basally applied @ 2000 g ha^{-1}before sowing. Foliar application of PPFM and *Bacillus sp* (FD 48) @ 500 ml ha^{-1} was done on 45 DAS. The sowing was done at 30 cm × 10 cm spacing in flat bed, ridges and furrow and rasised bed. The gross and net plot sizes were adopted 8.00 × 5.0 m^2 and 7.60 x 3.80 m^2 respectively. The periodical observations were taken with tagged plants. The plot vice plants were harvested and stripped manually and the yield attributes were recorded.

Results and Discussion

Effect of land configuration and microbial consortium on growth (Table 1)

The maximum plant height (79.5 cm), LAI (3.78) and DMP (4151 kg ha^{-1}) of ground nut were recorded under ridges and furrow (L_2). The maximum growth in ridges and furrow might be due to ridges and furrow have loose soil, more aeration and drainage which is less compacted (Bakht *et al*., 2011) [1]. Ridges have loose soil which promotes root penetration and growth of crops. Similar results was obtained by (C. Mvumi *et al*., 2018) [8]. The minimum plant height (47.8 cm), LAI (3.43) and DMP (3710 kg ha^{-1}) were recorded under flat bed (L_1). This might be due to dense surface soil layer in flat surface is limiting factor for the root growth (Chassot and Richner, 2002) [2]. Among the microbial consortium the treatment (M_5) had the maximum plant height (69.5 cm), LAI (4.01) and DMP (4433 kg ha^{-1}). This could be due to beneficial microorganisms involved in cellulose decomposition, the production of antibiotics, vitamins and hormones, all of which contribute to the positive impact of producing larger cells with thinner cell walls and influencing cell division and cell elongation, which improved vegetative growth and eventually increased plant height. The fact that groundnut, like other legumes, forms symbiotic relationships with rhizobia, which fixes nitrogen and plays an important role in crop productivity. Use of bioinoculant with RDF increased the plant growth and development and it might be due to the balanced nutrition along with the beneficial effects of bio-inoculant, and impact on morphological and photosynthetic components, which ultimately led to profuse root growth and nutrient uptake of the crop. The combined application of inorganic fertilizers with biofertilizers enhance the growth (Vigneshvarraj *et al*., 2020) [12]. The similar results were observed by Mohapatra and Dixit (2010).

The minimum plant height (58 cm), LAI (3.27) and DMP (3568 kg ha^{-1}) were recorded in the application of recommend dose of fertilizer (M_1). It may be due to nutrient uptake and the benefial bio-inoculant are not involved in the plant growth and development. In interaction between the land configuration and microbial consortium the treatment combination (L_2M_5) had significantly maximum plant height (86 cm), LAI (4.17) and DMP (4800 kg ha^{-1}). It may be due to the better aeration and moisture availability in the ridges and furrow along with beneficial bio-inoculant involved in the plant growth and development. The minimum plant height (42.6 cm), LAI (2.97) and DMP (3279 kg ha^{-1}) were recorded in the treatment combination of (L_1M_1). It may be due to the compact of the flat surface and the beneficial bio-inoculants are not involved in the plant growth and development.

Effect of land configuration and microbial consortium on yield attributes

The yield attributes namely pod weight per plant (39.54 g), number of pods per plant (47.32) and 100 kernel weight (37.24 g) were found to be maximum under ridges and furrow (L_2). Where as the flat bed (L_1) registered the minimum pod weight per plant (35.84 g), number of pods per plant (42.16) and 100 kernel weight (35.16 g). Among the microbial consortium the treatment (M_5) had registered the maximum yield attributes; pod weight per plant (41.06 g), number of pods per plant (40.3) and 100 kernel weight (38.66 g) compared to the (M_1). It might be due to the application fertilizer along with the bio inoculants leads to favourable source to sink translocation translated to the pods and increase the yield. Similar results were earlier reported by Sharma *et al*., 2017. The treatment combination L_2M_5 had significant effect on the pod weight per plant (44.20 g) and number of pods per plant (42.67). It may be due to the favourable soil moisture availability in the ridges and furrow along with the bio inoculants enhanced the soure to sink translocation that lead to increase in the yield.

Effect of land configuration and microbial consortium on pod and haulm yield

The maximum pod (2451 kg ha^{-1}) and haulm (4412 kg ha^{-1}) yield of groundnut were recorded in the ridges and furrow

(L_2) compared to the falt bed (L_1) which recoreed the lowest pod (2129 kg ha^{-1}) and haulm (3821 kg ha^{-1}) yield. It may be due to optimum soil moisture with uniform flow of water, lesser weed competition because of lesser area of wetter periphery and enhanced the yield attributes (Malik *et al.*, 2003) [6]. Among the microbial consortium, M_5-application of RDF + Seed treatment with *Rhizobium* + soil application of AMF + foliar spraying of PPFM and *Bacillus altitudinis* (FD 48) resulted in the maximum pod (2702 kg ha^{-1}) and haulm (4865 kg ha^{-1}) yield of groundnut. It may be due to the increased availability of nutrients due to balanced nutrition and microbial inoculum played an important role in rapid cell division and elongation in meristematic tissues, root development and proliferation and enhancing flowering, pod setting and seed formation (Singh and Singh, 2014). The treatment combination L_2M_5 out yielded other combinations by recording the maximum pod (3000 kg ha^{-1}) and haulm (5400 kg ha^{-1}) whereas L_1M_1 resulted in the minimum pod (1830 kg ha^{-1}) and haulm (3237 kg ha^{-1}) yield. It may be due to the moisture availability in the ridges and furrow and also the microbial inoculants might have favoured the nutrient uptake and promoted the yield attributes of the crop.

Table 1: Effect of land configuration and microbial consortium application on plant height (cm) of groundnut

Treatments	Plant height at harvest (cm)						LAI at 60 DAS						DMP at harvest (kg/ha)					
	M_1	M_2	M_3	M_4	M_5	MEAN	M_1	M_2	M_3	M_4	M_5	MEAN	M_1	M_2	M_3	M_4	M_5	MEAN
L_1	42.6	47.4	48.4	47.6	53.1	47.8	3.36	3.91	3.90	3.62	4.16	3.79	3279	3717	3919	3487	4150	3710
L_2	73.7	77.9	82.0	78.1	86	79.5	3.89	3.87	4.39	4.15	4.60	4.18	3715	3713	4400	4130	4800	4151
L_3	57.7	62.2	65.0	62.4	69.4	63.3	3.62	3.85	4.14	3.61	4.38	3.96	3710	3700	4120	3497	4350	3875
MEAN	58.0	62.5	65.1	62.7	69.5		3.54	3.87	4.14	3.79	4.38		3568	3710	4146	3704	4433	
	L		M		L×M		L		M		L×M		L		M		L×M	
S.Ed	0.82		1.09		1.87		0.09		0.11		0.20		41		53		91	
CD (p=0.05)	1.72		2.27		3.98		0.16		0.23		0.41		84		108		187	

Table 2: Effect of land configuration and microbial consortium application on yield attributes of groundnut

Treatments	100 kernel weight						Pod weight/plant(g)						No of pods / plant					
	M_1	M_2	M_3	M_4	M_5	MEAN	M_1	M_2	M_3	M_4	M_5	MEAN	M_1	M_2	M_3	M_4	M_5	MEAN
L_1	32.30	35.00	36.30	34.90	37.30	35.16	33.10	36.70	36.60	34.70	38.10	35.84	35.53	42.4	45.53	42.53	43.97	42.16
L_2	35.20	36.20	38.70	36.10	40.00	37.24	36.50	36.40	41.00	39.60	44.20	39.54	35.97	38.83	45.97	40.83	42.67	47.32
L_3	34.80	34.70	38.10	34.60	38.70	36.18	36.40	36.30	39.50	36.10	40.90	37.84	34.4	38.07	42.27	39.1	34.4	44.76
MEAN	34.10	35.30	37.70	35.20	38.66		35.33	36.46	39.03	36.80	41.06		35.3	39.8	44.6	40.8	40.3	
	L		M		L×M		L		M		L×M		L		M		L×M	
S.Ed	0.27		0.35		0.62		0.35		0.46		0.80		0.47		0.61		1.06	
CD(p=0.05)	0.56		0.73		NS		0.73		0.94		1.64		0.97		1.26		2.18	

Table 3: Effect of land configuration and microbial consortium application on the pod and haulm yield

Treatment	Pod yield (kg/ha)						Haulm yield (kg/ha)					
	M_1	M_2	M_3	M_4	M_5	MEAN	M_1	M_2	M_3	M_4	M_5	MEAN
L_1	1830	2125	2233	2042	2416	2129	3237	3825	4020	3675	4350	3821
L_2	2103	2203	2667	2283	3000	2451	3786	3966	4800	4110	5400	4412
L_3	2092	2103	2458	2050	2691	2279	3767	3786	4425	3690	4845	4102
MEAN	2008	2143	2452	2125	2702		3596	3859	4415	3825	4865	
	L		M		L×M		L		M		L×M	
S.Ed	43.73		56.45		97.87		94		121		210	
CD(p=0.05)	89.58		115.65		200.31		192		247		428	

Conclusion

From the above study it can be concluded that sowing of ground nut under ridges and furrow combined with application of microbial consortium (rhizobium, AMF, PPFM and *Bacillus altitudinis* - FD48) lead to higher growth and yield of groundnut.

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