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Growth Response and Yield of Groundnut (*Arachis hypogaea* L.) to Various Amendments in Surface Crusting Alfisol under Different Land Configuration

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ABSTRACT

Background: In some of Alfisol areas of Tamil Nadu, surface crusting seems to be a major constraint in the districts namely Pudukkottai, Trichy, Thanjavur, Cuddalore and Sivagangai where Alfisols accounts for 4,51,584 ha (4.49% TGA) in which groundnut is cultivated as a major crop. However, amid the above constraint, the area under groundnut is getting declined.

Methods: With an aim to overcome the above constraint, a field experiment was conducted at Agricultural College and Research Institute, Tamil Nadu Agricultural University, Kudumiyanmalai during 2016-2017 and 2017-2018 in surface crusting Alfisol to investigate the response of Groundnut to various amendments under different land configuration. The experiment was laid out in Split plot design.

Result: The results of the experiment revealed that among the main plot treatments, the land configuration of raised bed (M_1) has influenced the growth attributes such as plant height, LAI, dry matter production, root length, root spread besides yield during 2016-2017 and 2017-2018 and this was closely followed by ridges and furrow system. Under sub plot treatments, there was remarkable increase in all the growth parameters and yield at Bio-char @ 5 t ha^{-1} (S_1) during 2016-2017 and 2017-2018. There was no significant effect between main and sub plots.

Key words: Alfisol, Amendments, Groundnut, Land configuration, Soil surface crusting.

INTRODUCTION

Peanuts or “groundnuts” as they are known in some parts of the world are the edible seeds of a legume. India is second largest producer of peanuts in world, with total production of approximately 7.131 million metric tons per year (USDA, PS and D database 1996-2000). Among the groundnut producing countries in the world, India ranks first with respect to area (5.47 million ha, 22.7% of world average) (FAOSTAT, FAO. ORG 2009). In India, productivity of groundnut is low (1,007 kg ha^{-1}) as compared to world average productivity of 1,522 kg ha^{-1}. Groundnut accounts for 22.79% of area and 19.67% of production of total oil seeds in India. In Tamil Nadu, it is cultivated in an area of 0.54 million ha with production of 1.05 million tonnes and productivity of 880 kg ha^{-1} (Economic Survey, Government of India, 2010-11). Though, there are many constraints which reduce the production and productivity of groundnut in India, soil related problem of surface crusting is also one which seems to be a major constraint in areas where Alfisol is predominant. For instance, there are districts in Tamil Nadu which include Trichy, Thanjavur, Pudukkottai, Cuddalore and Sivagangai covering an area of 4,51,584 ha (4.49% TGA) in which Groundnut is cultivated as a major crop. As for surface crusting, the colloidal oxides of Fe and Al present in the soil binds the soil particles while wet and forms hard mass while dry that prevents the emerging seedlings. The surface crusting is also formed due to precipitation of Mn, Fe and Al and fixation of phosphates due to acidity in soil. It becomes, difficult in doing intercultural operations like weeding, earthing-up *etc.* irrespective of crops that too in groundnut like crops which produce its economic part in sub-terrain soil. Owing to above constraint, the cultivated area under groundnut is getting declined drastically that warrants an effective measure to overcome the same. Taking into consideration of the above situation, the present investigation was undertaken with the objectives which are to study the effect of various amendments in reducing the surface crusting under different land configuration; to determine the amendment suitable for the land configuration and

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to study the growth and development of groundnut to various amendments under different land configuration in surface crusting alfisol.

MATERIALS AND METHODS

A study was undertaken during Margazhipattam (*i.e.*) Winter (Dec-Jan) season of 2016-2017 and 2017-2018 at Agricultural College and Research Institute, Kudumiyanmalai, Pudukkottai, Tamil Nadu, India to investigate the response of groundnut to various amendments in surface crusting alfisol under different land configuration. The soil of the experiment field is iron rich alfisol belonging to Vayalogam Series that has Fe content varied from 2.60-4.35 ppm and Mn content of 3.54 ppm. The pH of the soil ranged from 7.58 to 8.0 and EC of 0.30 dSm^{-1} with low in N content (162 kg ha^{-1}), medium in phosphorus (13.0 kg ha^{-1}) and high in potassium (322.0 kg ha^{-1}). The experiment laid out in split plot design and replicated thrice. Main plot treatments consisted of three land configuration *viz.* M_1-Raised bed, M_2-Ridges and furrow system and M_3-Farmers practice of flat bed system. Whereas, sub pot consisted of four amendments *viz.,* S_1-Bio-char @ 5 t ha^{-1}, S_2-Tank silt @ 25 t ha^{-1} with FYM @ 12.5 t ha^{-1}, S_3-Lime @ 2 t ha^{-1} with FYM @ 12.5 t ha^{-1} and S_4-Control. Observations on growth parameters *viz*., plant height (cm), LAI, dry matter production (g $plant^{-1}$), root length (cm) and root spread (cm) were recorded on 40 DAS during 2016-2017 and 2017-2018. At harvest, the observations were recorded on the yield and yield attributes which include haulm yield (kg ha^{-1}), no. of pods $plant^{-1}$ and dry pod yield (kg ha^{-1}). Groundnut variety TMV (Gn)-13 having the duration of 105 days was taken as test crop of the experiment. All the inputs like Fertilizers, gypsum, seeds *etc.* were used as per the blanket recommendation besides giving management practices like weed control and irrigation on need basis. The collected data of above experiment were statistically analyzed with split plot design and discussed below.

RESULTS AND DISCUSSION

Plant growth characters

Plant height (cm)

There was significant effect noticed among the treatments as for the plant height of the Groundnut during both the years of investigation (Table 1). As observed, the plant height was found higher (17.60 and 10.93 cm) in the treatment land configuration with raised bed (M_1) under main plot treatments during 2016-2017 and 2017-2018 respectively at 40 DAS. However, this was closely followed by ridges and furrow system during both the years. Under sub plot treatments, Bio-char @ 5 t ha^{-1} (S_1) had registered with remarkable increase in plant height to the tune of 17.96 and 12.08 cm during 2016-2017 and 2017-2018 respectively at 40 DAS. There was no significant effect between main and sub plot treatments in influencing the plant height of groundnut during both the years.

All the growth parameters at Bio-char @ 5 t ha^{-1} (S_1) registering the plant height to the tune of 17.96 and 12.08 cm, LAI of 6.95 and 5.07, Plant dry matter production of 12.80 and 7.97 g $plant^{-1}$, root length of 17.99 and 12.98cm and root spread of 11.88 and 11.98 cm during 2016-2017 and 2017-2018 respectively at 40 DAS (Table 1). With regard to growth parameters, under main plot treatments, the land configuration of raised bed (M_1) has influenced the growth attributes such as plant height (17.60 and 10.93 cm), LAI (6.02 and 4.63), dry matter production (13.30 and 7.87 g $plant^{-1}$), root length (17.13 and 12.99 cm) and root spread (11.93 and 11.61 cm) during 2016-2017 and 2017-2018 respectively at 40 DAS. However, this was closely followed by ridges and furrow system during both the years. Under sub plot treatments, there was remarkable increase in all the growth parameters at Bio-char @ 5 t ha^{-1} (S_1) registering the plant height to the tune of 17.96 and 12.08 cm, LAI of 6.95 and 5.07, plant dry matter production of 12.80 and 7.97 g $plant^{-1}$, root length of 17.99 and 12.98 cm and root spread of 11.88 and 11.98 cm during 2016-2017 and 2017-2018 respectively at 40 DAS.There is no significant effect between main and sub plot treatments in influencing the growth attributes of groundnut during both the years.

LAI

There was makeable variation in registering the LAI between the treatments (Table 1). On observing the data of the LAI, the land configuration of raised bed (M_1) has influenced LAI (6.02 and 4.63) under main plot treatment during 2016-2017 and 2017-2018 respectively at 40 DAS. This was closely followed by ridges and furrow system (M_2) during both the years. Meanwhile, under sub plot treatment the LAI was found to be higher at Bio-char @ 5 t ha^{-1} (S_1) registering the LAI to the tune of 6.95 and 5.07 during 2016-2017 and 2017-2018 respectively at 40 DAS. There is no significant effect between main and sub plot treatments in influencing the LAI of groundnut during both the years.

Dry matter production (g $plant^{-1}$)

Under main plot treatments, the land configuration of raised bed (M_1) has influenced dry matter production (13.30 and 7.87 g $plant^{-1}$) during 2016-2017 and 2017-2018 respectively at 40 DAS (Table 1). However, this was closely followed by ridges and furrow system during both the years.

In the field trials, many researchers reported that biochar application improved soil quality, increased crop production and promoted plant growth (Major *et al.* 2010); Zhang *et al.* (2010). It was further evidenced with the present study, wherein the dry matter production of groundnut was increased tremendously at Biochar @ 5 t ha^{-1} (S_1) by registering it 12.80 and 7.97 g $plant^{-1}$ during 2016-2017 and 2017-2018 respectively at 40 DAS (Table 1). It might be largely affirmed with the improved soil properties like bulk density, particle density and reduced soil penetration resistance achieved in the above treatment during both the years. This result was in agreement with the Ding *et al.* (2016) who reported that the increased pH of soils should be attributed to the plenty of liming contained in biochar.

Therefore, improvements of soil physical properties promote the productivity of plant through increasing the amount of nutrient elements and reducing nutrient leaching. The above treatment was however nearest to the Lime @5 t ha^{-1} with FYM @ 12.5 t ha^{-1} (S_3) which has recorded the dry matter production of 12.56 and 6.72 g $plant^{-1}$ during 2016-2017 and 2017-2018 respectively at 40 DAS. There was no significant influence on the dry matter production at Control (S_4) which has given no amendments.

Root length and root spread (cm)

As noticed with the various main plot treatments, raised bed has given significantly higher root length (17.13 and 12.99 cm) and root spread (11.93 and 11.61 cm) during 2016-2017 and 2017-2018 respectively at 40 DAS (Table 2). However, this was closely followed by ridges and furrow system during both the years. Under various amendments in sub plot treatments, Biochar @ 5 t ha^{-1} had greater effect in recording the root length to the tune of 17.99 and 12.98 cm during 2016-2017 and 2017-2018 respectively at 40 DAS as that of rest of the treatments. As for sub plot treatments, Biochar @ 5 t ha^{-1} (S_1) performed better in recording root spread which were 11.88 and 11.98 cm during 2016-2017 and 2017-2018 respectively at 40 DAS. It could be following reduced crustation as observed from the reduced penetration resistance resulting in easy penetration of roots at which possible increase in movement of moisture and air around roots is more that would help increase the root length. It has been further proven as observed by Ding *et al.* (2016) who stated that Biochar has great water holding capacity because of the large surface area, which could promote the growth of microorganisms. He has further stated that the well-developed pore structure of biochar may not only enhance the capacity of water retention but also provide a

Table 1: Effect of various amendments on plant height, LAI and plant DMP in groundnut under different land configuration at 40 DAS during 2016-17 and 2017-18.

Treatments	Plant height (cm)		LAI		Plant DMP (g. $plant^{-1}$)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Main plot (Land configurations)						
M_1- Raised bed	17.60	10.93	6.02	4.63	13.30	7.87
M_2- Ridges and furrow	17.20	10.84	5.16	3.67	10.58	6.23
M_3- Flat bed (Farmers practice)	16.83	8.75	5.09	3.66	10.35	5.92
SEd	0.3591	0.4 537	0.3682	0.3507	0.3930	0.4353
CD (0.05)	0.530	0.706	0.632	0.351	0.691	0.786
Sub plot (Soil amendments)						
S_1- Biochar @ 5 t ha^{-1}	17.96	12.08	6.95	5.07	12.80	7.97
S_2- Tank silt @ 25 t ha^{-1} with FYM @ 12.5 t ha^{-1}	16.18	10.81	5.26	3.71	11.49	6.58
S_3- Lime @ 2 t ha^{-1} with FYM @ 12.5 t ha^{-1}	17.18	10.83	5.27	4.82	12.56	6.72
S_4-Control	14.59	10.66	5.22	3.68	10.80	5.01
SEd	0.4551	0.4638	0.3421	0.2889	0.4629	0.4442
CD (0.05)	0.701	0.704	0.619	0.607	0.792	0.886

Interaction was not significant.

Table 2: Effect of various amendments on root length, root at 40 DAS in groundnut under different land configuration during 2016-17 and 2017-18.

Treatments	Root length (cm)		Root spread (cm)	
	2016-17	2017-18	2016-17	2017-18
Main plot (Land configuration)				
M_1- Raised bed	17.13	12.99	11.93	11.61
M_2- Ridges and furrow	15.94	11.60	10.10	9.60
M_3- Flat bed (Farmers practice)	14.88	10.74	9.01	8.51
SEd	0.5133	0.4438	0.4975	0.4641
CD (0.05)	1.201	0.817	0.891	0.821
Sub plot (Soil amendments)				
S_1- Bio-char @ 5 t ha^{-1}	17.99	12.98	11.88	11.98
S_2- Tank silt @ 25 t ha^{-1} with FYM @ 12.5 t ha^{-1}	16.01	11.61	10.36	8.68
S_3- Lime @ 2 t ha^{-1} with FYM @ 12.5 t ha^{-1}	16.98	11.94	10.54	9.69
S_4- Control	14.61	10.24	9.04	7.61
SEd	0.4215	0.4439	0.4922	0.4209
CD (0.05)	0.885	0.785	0.854	0.844

Interaction was not significant.

Table 3: Effect of various amendments on haulm yield, No. of pods plant^{-1} and pod yield in groundnut under different Land configurations during 2016-17 and 2017-18.

Treatments	Haulm yield (kg ha^{-1})		No. of pods plant^{-1}		Pod yield (kg ha^{-1})	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Main plot (Land configurations)						
M_1- Raised bed	5877	2750	24.43	43.88	1921	1566
M_2- Ridges and furrowsystem	4159	2343	22.02	34.88	1302	1175
M_3- Flat bed (Farmers practice)	3680	2206	16.93	34.13	1104	922
SEd	508	151	1.0374	3.8493	83	95
CD (0.05)	1412	319	2.991	6.687	183	198
Sub plot (Soil amendments)						
S_1- Bio-char @ 5 t ha^{-1}	5753	2741	24.29	42.72	1903	1397
S_2- Tank silt @ 25 t ha^{-1} with FYM @ 12.5 t ha^{-1}	4884	2294	22.93	41.22	1560	1314
S_3- Lime @ 2 t ha^{-1} with FYM @ 12.5 t ha^{-1}	4273	2075	20.16	34.50	1382	1238
S_4- Control	3777	2089	19.93	32.06	924	934
SEd	272	144	1.0258	3.0970	95	103
CD (0.05)	572	314	2.415	6.607	214	208

Interaction was not significant.

shelter for soil's microorganisms, thus nutrient retention and cycling could be improved. Similar trend was noticed in root spread also as for as soil amendments are concerned.

Yield and yield attributes of groundnut

Yield attributing characters like No. of pods plant^{-1}, Haulm yield and pod yield of groundnut showed remarkable improvement by adopting different land configuration in main plot in surface crusting Alfisol (Table 3). Among the three combinations of land configuration, raising groundnut on raised bed (M_1) was most efficient in giving the highest values of yield attributes *viz.* Haulm yield of 5877 and 2750 kg ha^{-1} and no. of pods of 24.43 and 43.88 plant^{-1} besides recording maximum pod yield to the tune of 1921 and 1566 kg ha^{-1} during 2016-2017 and 2017-2018 respectively. Similar results were obtained by Liu *et al.* (2016) in a pot experiment, in which co-composted biochar increased the total C and CEC at an application rate of 1.5% and enhanced the crop yield by 70.8-309% as compared to the control. The treatment in order of superiority followed this treatment was planting groundnut in ridges and furrow system (M_2). Significantly lower values of yield attributing characters and pod yield were associated with flat bed (M_3) planting of groundnut in surface crusting Alfisol. These results were in line with those reported by Sakthivel *et al.* (2003) in soybean. Whereas, under sub plot treatments, the yield attributes were found to be significant in Bio-char @ 5 t ha^{-1} which recorded the haulm yield of 5753 and 2741 kg ha^{-1}, no. of pods of 24.29 and 42.72 plant^{-1} and pod yield of 1903 and 1397 kg ha^{-1} during 2016-2017 and 2017-2018 respectively. As for interaction, there is no significant effect observed between land configuration and amendments on yield and yield attributes during both the years.

CONCLUSION

The land configuration of raised bed (M_1) in combination with soil amendment Bio-char @ 5.0 t ha^{-1} (S_1) was found to be the better practice in influencing the plant growth parameters *viz*., plant height, LAI, plant DMP, root length and root spread besides recording higher yield and yield attributes in groundnut in surface crust Alfisol. Raised bed combined with Lime @ 2 t ha^{-1} with FYM @ 12.5 t ha^{-1} is the next best practice to achieve the above parameters.

Conflict of interest

All authors declared that there is no conflict of interest.

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