Journal of Agroecology and Natural Resource Management
p-ISSN: 2394-0786, e-ISSN: 2394-0794, Volume 4, Issue 4; July-September 2017, pp. 325-330

http://www.krishisanskriti.org

Charred Rice Husk to Improve the Soil Moisture Retention and Nutrient Management under Rainfed Groundnut (*Arachis hypogaea* L.)

Balasubramanian P[1] and C.R. Chinnamuthu[2]

[1,2]AC&RI, TNAU, Madurai, Tamil Nadu, India
E-mail: [1]agribalatnau1991@gmail.com, [2]crchinnamuthu@yahoo.com

Abstract—*A field experiment was conducted at the Department of Agronomy, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, Tamil Nadu during 2014-2015 rabi season to find out the effect of charred rice husk and other organic materials enriched with or without fertilizer nutrient on the moisture retention and nutrient supply during the deficit period of crop growth. The field experiment was conducted with ten treatments, replicated thrice laid out in randomized block design. Groundnut variety, VRI 2, a Spanish bunch type was selected for the study and raised under sandy clay loam textured soil. The treatment includes application of charred rice husk, biochar, lignite and farm yard manure alone and enriched with the recommended dose of nitrogen (10 kg ha^{-1}) and phosphorus (10 kg ha^{-1}) fertilizer and compared with the absolute control and recommended dose of fertilizer (10:10:45 kg NPK ha^{-1}).*

The structural morphology of organic materials were studied using Scanning Electron Microscope (SEM) showed that the particles of charred rice husk were uneven and the diameter varied from 3-4 µm with clod and block appearance. The particles of biochar were irregular in shape, uneven sized and diameter varied from 2-3 µm with block appearance and the lignite particles found spherical and aggregated. The chemical composition of intercalated manure with nutrient examined under SEM-EDAX revealed that the charred rice husk contains 64.31 per cent carbon 28.42 per cent oxygen and 5.96 per cent silica. Whereas the biochar composed of Carbon 66.65 per cent, nitrogen 6.58 per cent, oxygen 24.55 per cent and silica 0.26 per cent and lignite comprised of carbon (63.64 per cent), nitrogen (2.56 per cent), oxygen (24.96 per cent) and silica (1.25 per cent).

The different organic manures at the rate of 5 tons/ ha^{-1} was mixed with the calculated quantities of urea and single super phosphate and incubated for 45 days. The nutrient loaded organic manures were incorporated into the dry soil during land preparation. Total amount of rainfall received during the entire crop growth period was 179 mm in 2014-2015. Data on crop growth characteristics revealed that, among various treatments; enriched farm yard manure recorded higher values when compared to other treatments. Application of enriched biochar and charred rice husk closely followed the best treatment with respect to biometric parameters at all stages of crop growth. Incorporation of enriched FYM at 5 t ha^{-1} recorded significantly higher pod yield (2190 kg ha^{-1}). The enriched biochar and charred rice husk produced comparable pod yield of 2010 kg ha^{-1} and 1983 kg ha^{-1}, respectively.

Keywords*: Groundnut, Rainfed, enriched charred rice husk, FYM, Lignite, SEM-EDAX and water retention capacity*

1. INTRODUCTION

Groundnut (*Arachis hypogaea* L.), the 'King of oilseeds' is an unpredictable legume, may continue to be an important commercial crop in rainfed areas. About 69 per cent of the groundnut area is under rainfed generating 53.42 per cent of the total production (Directorate of Economics and Statistics, Department of Agriculture and Cooperation, 2009-10). The uncertainty of groundnut productivity in the rainfed areas could be minimized by *in situ* conserving the soil moisture received through precipitation during the cropping period and improving the nutrient status.

Rice husk is the natural sheath or productive cover, which forms the cover of rice grains during their growth. Rice husk represents about 20 per cent by the weight of the rice harvested. About 80 per cent by weight of the raw husk is made of organic components (Anonymous, 1979) and incorporation of rice husk into soil mixture was found to affect many crops (Sharma *et al.,* 1988).

Now days, Soil organic matter content is gradually declining due to high cropping intensity which causes quick decomposition of organic matter. Use of rice husk as an organic manure, might be play a vital role not only in improving soil physical condition but also in improving the plant nutrients. Incorporation of rice husk can significantly improve soil properties by decreasing soil bulk density, enhancing soil pH, adding organic carbon, increasing available nutrients and removing heavy metals from the system, ultimately increasing crop yields (Williams *et al*., 1972). Rice husk under different irrigation intervals can give good rice stand, better grain yield and higher water use efficiency (Abo-Soliman *et al.* 1990). The present investigation was aimed to study the role of enriched rice husk as an organic manure on groundnut pod yield and water retention capacity under rainfed condition.

2. MATERIALS AND METHODS

Field experiment was conducted during *rabi* 2014-2015 under rainfed condition at the Central Farm, Department of Agronomy, Agriculture College and Research Institute, Madurai, Tamil Nadu. The site was located at 9^0. 54' N latitude and 78^0.80' E longitude at an altitude of 147 m above mean sea level. The region falls under the southern zone of Tamil Nadu. Field experiment was conducted with ten treatments (Figure.2) replicated thrice laid out in randomized block design. The treatment includes application of charred rice husk, biochar, lignite and farm yard manure alone and enriched with the recommended dose of nitrogen (10 kg ha^{-1}) and phosphorus (10 kg ha^{-1}) fertilizer and compared with the absolute control and recommended dose of fertilizer (10:10:45 kg NPK ha^{-1}). The enriched organic manures were prepared by taking each at the rate of 5 tons/ ha^{-1} and mixed thoroughly with the recommended dose of urea and phosphorus. The mixture was incubated for 45 days in dark room. The procedure for loading nutrient in the organic material is detailed below (Figure.1).

Groundnut variety, VRI 2, was selected for the study and sown at 30 x 10 cm spacing to maintain the uniform plant population of 40 plants per m^2 area. Seeds were uniformly coated with *Trichoderma viride* at the rate of 4g kg^{-1} and dried in shade before sowing. Soil samples, from the experimental sites, as well as enriched organic manures were collected and analyzed for chemical composition. The results, for both soil and enriched organic manures, were presented in Table (1). Total amount of rainfall received during the entire crop growth period (November 2014 to January 2015) was 179 mm.

Figure 1. Procedure for enriched organic manures:

Charred rice husk loaded with urea at the recommended dose and mixed thoroughly

↓

Further the single super phosphate at the recommended dose mixed with Charred rice husk

↓

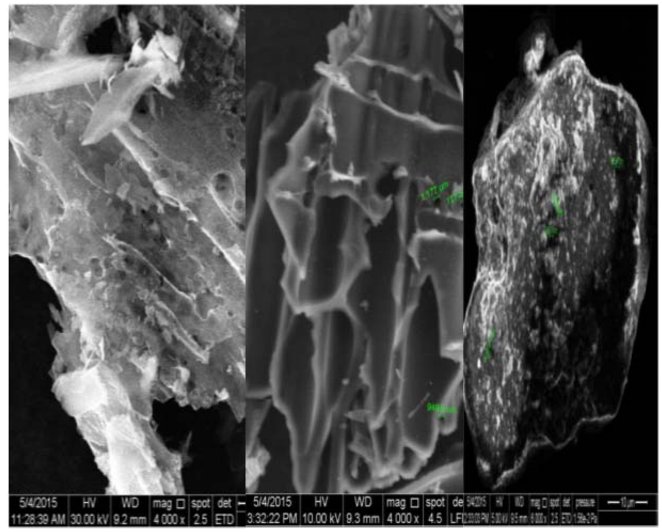
Covered with Tar paulin and incubated for 45 days at room temperature

↓

Resulted in enriched manure with nitrogen and phosphorus

3. RESULTS AND DISCUSSION

Figure. 2: Scanning Electron Microscope (SEM) of the size reduced charred rice husk a) 30 µm b) 10 µm resolution (SEM)



A. Growth characters

Concerning, application of organic manures, results in Table (2) clearly showed that a significant positive effect was observed on all traits at rates of 5 tons ha^{-1} which increased vegetative growth traits. The results in Table (2) showed that plant height (cm) and number of branches plant^{-1} and leaf area index were significantly affected by the absolute control plot. The highest values were recorded under enriched farm yard manure 5 tons ha^{-1} followed by enriched charred rice husk 5 tons ha^{-1}. However, no significant difference was found between the enriched bio char and enriched lignite at 5 tons ha^{-1} on plant height (cm) and number of branches/plant on this traits. The same trend was observed on leaf area index. Aliyu *et al*. (2011) reported that application of rice husk as a manures two weeks before planting also produced the highest number of leaves in cowpea Chandrasekaran *et al*. (2007).

However, absolute control plots significantly reduced the values of all the studied growth attributes. This may be due to the decreasing moisture content in root zone for a long period, which adversely affected cell division, elongation and vegetative growth. The increase in branch number was attributed to the gradual release of nutrients during decomposition of manures (Budhar and Palaniappan, 1994 and Budhar, 2003).

Table 1: Effect of enriched charred rice husk and other organic materials on Growth characters

Treatments	Plant height (cm)	No. of branches/ plant^{-1}	Leaf Area Index
T_1 (CRH+NP)	48.59	11.84	4.60
T_2 (BC+NP)	46.62	11.94	4.38
T_3 (LN+NP)	43.16	11.07	4.16
T_4 (FYM+NP)	52.49	13.15	4.89
T_5 (CRH)	41.97	10.16	3.43
T_6 (BC)	41.56	10.27	3.55

T_7 (FYM)	42.98	10.53	4.01
T_8 (LN)	39.00	10.04	3.23
T_9 (Control)	36.04	7.92	2.87
T_{10} (RDF NPK)	44.34	11.24	4.66
SEd	**1.08**	**0.18**	-
CD (p=0.05)	**2.27**	**0.39**	-

B. Pod yield and yield components:

`With respect of yield and yield components such as, flowering percentage, number of pegs, number of pods, number of matured pods, single seeded pods and double seeded pods and hundred pod weight were different organic manures application plots Table (3).

The results indicated that highly significant reduction was found in all the yield components with respect to without organic manures (absolute control plot), compared to the different enriched organic manures treatments Table (3). The results indicated that, application of enriched farm yard manure and enriched charred rice husk 5 tons ha^{-1} yielded the highest biological and pod yields respectively. Consequently, the increase in pod yield components can be due to the fact that available more water enhanced nutrient availability which improved nitrogen and other macro and micro elements absorption as well as enhancing the production and translocation of the dry matter content from source to sink. Similar results were reported by Abd El Hafez (1997), respectively. Okon *et al*. (2005) stated that the optimum level of rice husk plus 0.05 ton urea ha^{-1} can sustain rapid growth and better yield of okra even faster than NPK, because rice husk ash contains almost all other essential plant nutrients and the presence of nitrogen will boost their uptake. The increase in both biological and yields indicates that, rice husk already decomposed and its nitrogen as well as other nutrients was released to the plant, furthermore, improved physical and chemical soil properties could enhance the absorption of native nutrients in the soil. Similar results were found by Ebaid *et al*. (2005). The increase in biological yield could be due to the increase in yield attributes (plant height, number of branches, leaf area index and hundred pod weight) were stated El Refaee . (2007). However, no significant difference were found between enriched bio char and enriched lignite at 5 tons ha^{-1}.

On the other hand, without organic manures recorded the lowest biological and pod yields. These results revealed that the reduction in yield components can be expected as plants are exposed to water deficit. Besides, available\ water enhanced the production and transporting of dry matter content to the pod yield resulting in more pod yield. This is in agreement with results reported by Naidu. (1992).

Table 2: Effect of enriched charred rice husk and other organic materials on yield characters

Treatments	Flowering percentage plant^{-1}	Number of pegs plant^{-1}	Number of pods plant^{-1}	Number of matured pods plant^{-1}	Single seeded pods plant^{-1}	Double seeded pods plant^{-1}	Hundred pod weight (g)
T_1 (CRH+NP)	8.50	28.81	23.19	19.78	3.10	16.79	101.27
T_2 (BC+NP)	8.47	29.47	23.26	20.14	2.99	17.45	101.54
T_3 (LN+NP)	7.84	26.67	20.08	17.09	2.13	14.51	100.03
T_4 (FYM+NP)	9.16	31.78	25.77	22.97	3.11	20.22	102.95
T_5 (CRH)	6.20	22.87	18.03	14.02	4.20	10.54	99.78
T_6 (BC)	6.88	23.42	19.21	14.86	3.14	11.46	99.81
T_7 (FYM)	7.24	24.16	20.48	16.24	4.01	11.78	100.01
T_8 (LN)	6.16	21.84	16.94	12.40	4.00	8.27	98.83
T_9 (Control)	5.16	15.70	11.41	9.56	4.65	5.84	97.23
T_{10} (RDF NPK)	7.60	27.48	21.48	16.21	3.57	13.72	100.48
SEd	**0.17**	**0.41**	**0.47**	**2.40**	**0.07**	**0.22**	**NS**
CD (p=0.05)	**0.36**	**0.87**	**0.99**	**5.05**	**0.15**	**0.47**	

Table (3): Biological and pod yields as well as harvest index as affected by enriched charred rice husk and other organic materials

Treatments	Pod yield kg/ ha^{-1})	Haulm yield (kg ha^{-1})	Harvest Index
T_1 (CRH+NP)	2010	5115	62.81
T_2 (BC+NP)	1983	5118	62.17
T_3 (LN+NP)	1800	4897	60.30
T_4 (FYM+NP)	2190	5304	63.62
T_5 (CRH)	1500	4389	57.84
T_6 (BC)	1559	4399	57.17
T_7 (FYM)	1681	4628	58.64
T_8 (LN)	1486	4125	55.01
T_9 (Control)	1250	3849	51.46
T_{10} (RDF NPK)	1900	5018	62.30
SEd	**84.58**	**112.64**	-
CD (p=0.05)	**177.70**	**236.66**	-

C. Nutrient uptake by crops

Increased trend in nutrient uptake of NPK from 30, 60, 90 DAS and harvest stage of crops Table (5) were found higher due to the incorporation of enriched FYM at 5 tons ha^{-1} which was followed by enriched biochar and charred rice husk at 5 tons ha^{-1}. This could be due to the role of different organic manures as organic fertilizer on better holding the water in the root zone. The reason might be due to the increased root length and root volume which might have tapped the available nutrients from rhizosphere at the increased soil moisture level than non-application of organic manure plots. The other reason could be that the applied organics might have created favorable physical, chemical and microbial environment. Furthermore, improved physical and chemical soil properties could enhance the absorption of native nutrients in the soil. (Ebaid *et al.*, 2005). Gupta *et al.* (1988) reported that available N content of the soil increased significantly with increasing application of FYM.

D. Available soil moisture (Per cent)

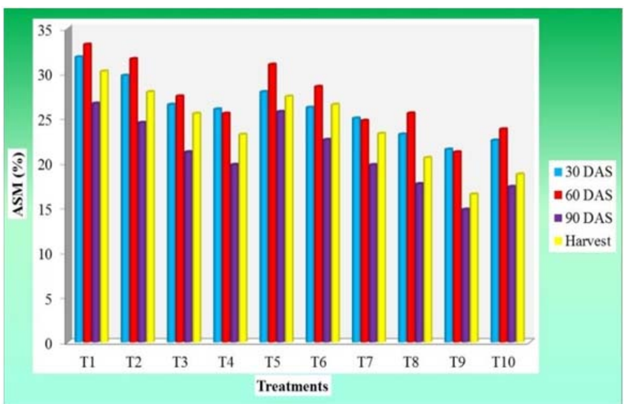
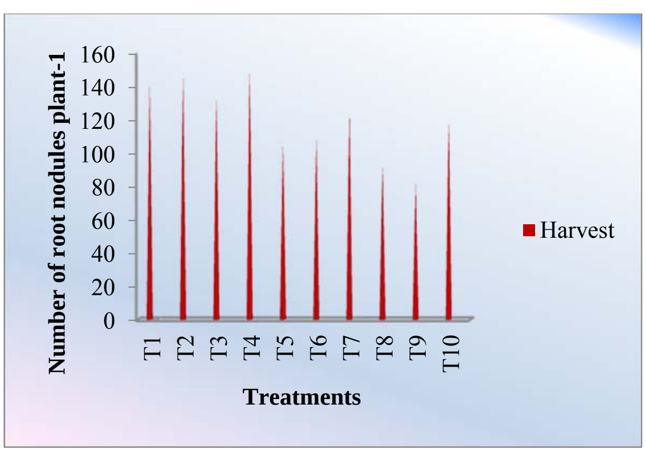


Fig. 3. Effect of enriched charred rice husk and other organic materials on available soil moisture of rainfed groundnut during various crop stages

E. Number of root nodules (Fig. 4.)



F. Water uptake by different organic manures application

The release of water from organic manures is presented in Table (7). The release of water from charred rice husk, biochar, lignite and farm yard manure ceased to exist within 3 days of experiment. The higher water leachate was observed in absolute control treatment, while charred rice husk was lower one. The leachate of water collected on the first day was observed in charred rice husk, biochar, lignite and farm yard manure with 179.33, 185.10, 207.50 and 270.67 ml respectively from the initial addition of 500 ml of water in the column.

On second day, it was observed the lower water release (179.33 ml from 500 ml) from enriched charred rice husk. It was followed by enriched biochar and enriched lignite with 185.10 and 207.50 ml respectively. The same trend was observed in third day also. The control treatment without mixing of organic manures recorded higher release of water (270.67 ml). The lowest leachate of water that may be due to absorbed water molecule in the microspores of the charred rice husk are held very strongly and released only upon the force exerted by the roots of groundnut which come into contact with organic material. Water held in the organic material utilized by the plants when it is in stress which will help to tide over the drought stress and sustain growing activity of plant. The slow release of water from charred rice husk might be due to enhanced uptake and utilization of more water. Ghanem and Ebaid (2001) reported that increasing irrigation intervals from 4 days consequently water was saved by 8.2 per cent.

Table 4: Effect of enriched charred rice husk and other organic materials on water uptake of rainfed groundnut ml/500ml

Treatments	Soil + organic manure 1.67(g)			Soil + 100% organic manure 167(g)		
	First day (ml)	Second day (ml)	Third day (ml)	First day (ml)	Second day (ml)	Third day (ml)
T_1 (CRH+NP)	179.3	397.3	418.6	55.6	508.0	419.3
T_2 (BC+NP)	185.1	425.3	442.0	128.6	331.3	442.6
T_3 (LN+NP)	207.5	458.3	470.2	172.6	321.6	459.0
T_4 (FYM+NP)	222.6	4780	472.0	262.6	381.3	471.3
T_9 (Control)	270.6	485.0	478.0	-	-	-
SEd	2.9	40.10	9.2	3.4	2.6	7.9
CD(p=0.05)	5.9	82.45	18.	7.0	5.4	16.4

4. CONCLUSION

From the experimental findings it can be concluded that, among the ten treatments, application of enriched farm yard manure at the rate of 5 tons ha^{-1} as basal resulted in higher yield and yield attributes, followed by the enriched bio char and enriched charred rice husk applied at rate of at 5 tons ha^{-1}. With respect to economics, among the organic manure treatments, the charred rice husk recorded the maximum net returns and income per rupee invested due to the cheaper material cost. Therefore, it would be concluded that application of enriched charred rice husk as a source of potassium at a rate of 5 tons ha^{-1} is favorable for yield advancements in groundnut. In India charred rice husk is a highly available and cheap manures in large quantities. Hence, application of charred rice husk is best suited to small farming in red soil conditions.

5. RESEARCH RECOMMENDATIONS:

Biochar can add value to non-harvested agricultural products (major et al.2005) and can promote plant growth (Oguntunde et al. 2004). Lahmann et al (2006) estimated that a total of 9.5 billion tons of carbon could potentially be stored in soils by the year 2100 using a wide variety of biochar application programs. Once furnished with a better understanding of this potential synergism and mechanisms that drive it, we would utilize charred rice husk (Biochar)/ nutrients interactions for sequestrations of carbon in soils to contribute to climate change mitigation. This interaction could also harnessed for restoration of distributed ecosystems, increasing fertilizer use efficiencies and the development of methods for attaining increased yields from sustainable agricultural activities.

6. FUTURE LINE OF WORK

- Optimization of charred rice husk for different agriculture crops should be standardized under different ecosystems.
- Long term carbon sequestration potential of charred rice husk in different ecosystem should be studied in detail through long term experiment.
- Charred rice husk induced microbial dynamics and its role in nutrient availability mechanism may be studied in detail.

7. ABBREVIATIONS:

Note: CRH-Charred Rice Husk 5 t ha^{-1},

BC- Biochar 5 t ha^{-1}, LN-Lignite 5 t ha^{-1},

FYM- Farmyard Manure 5 t ha^{-1},

N-Nitrogen 10 kg ha^{-1},

P-Phosphorus 10 kg ha^{-1},

K-Potash 45 kg ha-^{1},

RDF-Recommended dose of Fertilizer 10:10:45 kg NPK ha^{-1}

8. ACKNOWLEDGEMENT

The author would like to thanks Dr. C.R. Chimmanuthu and Dr. P. Venkadachalam, for his opinion and suggestion. The assistance of technician, farm labour and friends in performing some laboratory and field testing are also acknowledged.

Conflict of interests

The author declare that there is no conflict of interests regarding the publication of this paper.

REFERENCES

[1] Abo-Soliman, M.S., S.A. Ghanem, S.A. Abd El-Hafezand and N. El-Mowelhi. 1990. Effect of irrigation regimes and nitrogen levels on rice production and nitrogen losses under tile drainage. **Ministry of Agriculture and Land Reclamation Res., 1:**14-15.

[2] Aliyu, T.H., O.S. Balogun and O.O. Alade. 2011. Assessment of the effect of rate and time of application of rice-husk powder as an organic manures on cowpea (Vigna unguiculata L.) inoculated with cowpea mottle virus. Agric. and Biolo. J. of North America, 2151-7525.

[3] Anonymons. 1979. Rice situation, Economics and cooperative service.US **Department of Agriculture, Washington**, D.C.20250.

[4] Budhar, M.N. and S.P.Palaniappan. 1994. Effect of incorporation of proceeding cotton on succeeding rice. Indian J. agron., 39(3):461-463.

[5] Chandrasekaran, R., E. Somasundaram, Mohamed Amanullah, K. Nalini, K. Thirukkumaran and K. Sathyamoorthi. 2007. Response of confectionery groundnut (Arachis hypogaea L.) varieties to farm yard manure. J. of Applied Sci. Res., 3(10):1097-1099.

[6] Directorate of Economics and Statistics. 2009-10. Department of Agriculture and Corporation, Ministry of Agriculture, Government of India.

[7] Ebaid, R. A., A. A. El-Hessiwy and M. El-Dalil. 2005. Preliminary study on utilization of rice husk in rice cultivation. Egypt . J. Agric. Res., **83(58):** 369 – 376.

[8] El-Refaee. 2007. Utilization of rice husk as an organic fertilizer to improve productivity and water use efficiency in rice fields. African Crop Science Conference Proceedings, African Crop Science Society, Rice Research & Training Center, Field Crops Research Institute, Agricultural Research Center, Sakha - Kafr El-Sheikh, Egypt, 1923-1928.

[9] Ghanem, S.A. and R.A. Ebaid. 2001. Effect of farm yard manure and water regimes on productivity of rice and succeeding clover crop, Egypt J. Appil. Sci., 16 (16):115-128.

[10] Gupta, A. P., R.S. Patil and Narwal. 1988. Effect of Farmyard manure on Organic carbon, available N and P content of soil during different periods of wheat growth. **J. Indian Soc. of Soil Sci., 36(2):** 269-273.

[11] Naidu. 1992. Response of Groundnut varieties to irrigation levels in summer, **Ph.D. Thesis.**

[12] Sharma, S. K., C. M. Sharma, and I. S. Shakor. 1988. Effect of industrial organic wastes and lantana incorporation on soil properties and yield of rice. **Indian J. of Agronomy. 33:** 225-226.

[13] Williams, N.A., N.D. Morse and J.F. Buckman. 1972. Burning vs. incorporation of rice crop residues. **Agron. J., 64:** 467 – 468.

****