Current Journal of Applied Science and Technology

38(6): 1-5, 2019; Article no.CJAST.54553
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Comparative Evaluation of Puddling Techniques in Sandy Loam Soil

K. Prasanthkumar[1*], M. Saravanakumar[1], J. John Gunasekar[2], S. S. Sivakumar[1] and P. Masilamani[3]

[1]Department of Farm Machinery and Power Engineering, AEC & RI, Kumulur, Trichy, Tamil Nadu, India.
[2]Department of Renewable Energy Engineering, AEC & RI, Kumulur, Trichy, Tamil Nadu, India.
[3]ADAC & RI, Navalur Kuttapattu, Trichy, Tamil Nadu, India.

Authors' contributions

This work was carried out in collaboration amongst all authors. Author KPK conducted the whole study at the field level and prepared the manuscript. Author MS advised and gave the necessary technical support throughout the study and disciplined the manuscript. Authors JJG, SSS and PM are part of advisory committee and provided necessary technical support and suggestions for this study. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2019/v38i630474
Editor(s):
(1) Dr. Md. Hossain Ali, Chief Scientific Officer and Head, Agricultural Engineering Division, Bangladesh Institute of Nuclear Agriculture (BINA), Bangladesh Agricultural University Campus, Bangladesh.
(2) Dr. Hamid El Bilali, Research Fellow, Centre for Development Research, University of Natural Resources and Life Sciences (BOKU), Vienna, Austria.
Reviewers:
(1) Md. Abdul Quddus, Bangladesh Agricultural University, Bangladesh.
(2) Naseeb Singh, ICAR Research Complex for NEH Region, India.
Complete Peer review History: http://www.sdiarticle4.com/review-history/54553

Short Research Article

Received 28 November 2019
Accepted 03 February 2020
Published 05 February 2020

ABSTRACT

Aims: Puddling is a distinct operation to provide standing water condition for paddy cultivation. There are various puddling techniques conventionally adopted by the farmers. In order to scientifically establish the performance of various puddling techniques in terms of puddling quality, they were evaluated and compared.
Study Design: The results were analyzed statistically using factorial experiment.
Place: The study was carried out in the experimental field of Agricultural Engineering College & Research Institute, Kumulur, Trichy, Tamil Nadu, India. The texture of the soil is sandy loam (Clay = 12.5%, silt = 15.6% and sand = 71.9%).
Methodology: The conventionally used puddling techniques (*viz.,* cage wheel, rotavator and

**Corresponding author: E-mail: prasanthkumar027@gmail.com;*

power tiller operated rotary tool) were evaluated in terms of puddling index and infiltration rate. The evaluation parameters were determined using standard procedure.
Results: The puddling quality was not significantly affected by increasing number of pass from single to double. The power tiller operated rotary tool registered the highest puddling index of 61.18% and the lowest infiltration rate of 17.00 mm d^{-1} and the rotavator registered the second highest of 58.29% puddling index and 21.00 mm d^{-1} of infiltration rate. Area coverage was superior in the case of puddling with rotavator due to the larger width.
Conclusion: The overall performance of the rotavator was concluded to be the best among the various puddling techniques compared in this study.

Keywords: Pudding index; quality; infiltration rate; cage wheel; rotavator; power tiller.

ABBREVIATIONS

mm d^{-1} : Millimeter per day;
KW : Kilo watt;
km h^{-1} : Kilometer per hour;
h : Hour;
ml : Millimeter.

1. INTRODUCTION

Paddy is a water loving crop and it requires huge volume of water for its growth. Paddy is cultivated under standing water condition. The water stagnation could be possible only by arresting or minimizing the infiltration. This could be achieved by creating impervious layer or by reducing the porosity of soil. Paddy cultivation is an age old technology in which the farmers adopt the practice of destructing the soil structure and churn it in the presence of water, which is called puddling. It is a process in which the size of soil particles are reduced and mixed with water. This soil particle on settlement occupies the pore space of the soil on sub surface thereby reducing the porosity and infiltration.

The puddling techniques and number of passes are the parameters mainly influencing the puddling quality assessment [1,2,3]. The float assisted tilling wheels registered puddling index of 24.3% and 6.70% in third and first pass, respectively [4]. Puddling with rotavator varied the puddling index from 78.84 to 80.63% in medium black soil [5]. The infiltration rate of 1.52, 1.99 and 3.20 mm d^{-1} for six, four and two number of passes, respectively, with rotavator puddling in silty clay soil [6]. The effect of puddling intensity on engineering properties of paddy field inferred the inverse relation between number of pass and infiltration rate [7].

To reduce the duration of land preparation, cost of production and especially providing an apt bed for mechanized transplanting, selecting appropriate machinery for puddling is quite important [8]. Many studies had been conducted in different soils; however the study had not been carried out in sandy loam soil. Hence this study is intended to evaluate different puddling techniques with single and double pass in sandy loam soil in terms of puddling index and infiltration rate.

2. MATERIALS AND METHODS

Conventionally, farmers use several techniques for puddling, either as single implement or multiple implements or combination of implements. Therefore it was intended to analyze the difference in the formation of impervious layer in terms of puddling index, which is the ratio of volume of the soil particles to the volume of total sample of puddled soil, containing soil particles and water [1,2,3]. Though there are several puddling techniques, conventionally and commercially, available, the following are predominantly used.

i. Cage wheel (I_1) (Fig. 1a)
ii. Rotavator / Rotary tiller (I_2) (Fig. 1b)
iii. Power tiller operated rotary tool (I_3) (Fig. 1c)

Fig. 1a. Cage wheel

Fig. 1b. Rotavator

Fig. 1c. Power tiller operated rotary tool

The power tiller was operated at the speed of 1.6 to 1.9 km h^{-1} and the tractor was operated at the speed 2.1 to 2.4 km h^{-1}. Number of pass influences the degree of churning. When the puddling intensity is not up to the required level, puddling is exercised one more time. To understand its influence, it was decided to evaluate the puddling techniques in single (P_1) and double pass (P_2). Depth of water was maintained at 5 to 10 cm from the ground level throughout the field. After secondary tillage the fields were leveled to maintain uniform water level during the puddling process. The influence of pertinent parameter on the quality attributes was evaluated with three puddling techniques and two number of pass. The treatment details are detailed below. Each treatment was replicated thrice to reduce the experimental error.

Puddling techniques	= 3
Number of pass	= 2
Replication	= 3
Total number of treatments	= 3 x 2 x 3 = 18

The study was carried out in the research field of Agricultural Engineering College & Research Institute, Kumulur, Trichy, Tamil Nadu, India. The texture of the soil is sandy loam (Clay = 12.5%, silt = 15.6% and sand = 71.9%) in nature. The results were analyzed statistically using factorial experiment.

2.1 Puddling Index

The puddling index was measured by adopting the Indian standard procedure [9]. The test sample from the puddled soil was collected by inserting a hollow pipe vertically into the puddled soil (Fig. 2). After insertion, top of the hollow pipe was closed and the pipe along with the soil sample was removed from the puddled field. The collected sample was poured into a measuring cylinder and allowed for settle to a period of 48h.

The total volume of the sample and volume of the soil was noted on the measuring cylinder and recorded. The puddling index is the ratio of soil particles to the total volume and was computed using the formula (1).

$$\text{Puddling index (PI)} = \frac{V_s}{V_t} \times 100 \qquad (1)$$

Where,

PI	=	Puddling index (%)
Vs	=	Volume of soil after 48h (ml),
Vt	=	Total volume of sample (ml)

2.2 Infiltration Rate

The infiltration is an indicator of the creation of impervious layer on the soil subsurface [1,7]. A pipe of diameter 15 cm was inserted into the soil until the hard surface is reached (Fig. 2). A graduated scale was inserted vertically along the inner diameter of pipe, so that the scale is vertically stable. The pipe was filled with water to its top level, and it was noted on the graduated scale and recorded. The water level inside the pipe was recorded during every 3h interval and the relation between the infiltration rate and duration was found out.

Fig. 2. Infiltration rate measurement

3. RESULTS AND DISCUSSION

3.1 Puddling Index

Analysis of variance for puddling index in sandy loam soil is presented Table 1. The puddling technique was significant at 1% (*P = .000)* level and the number of pass was not significant (*P = 0.094*).

It could be observed from the Table 2 that the highest puddling index of 61.18% was registered by power tiller operated rotary tool (I_3) and the lowest puddling index of 48.46% was recorded for cage wheel, in single pass (P_1). The registration of highest puddling index by power tiller operated rotary tool might be due to the rotary action with thin layer of soil cutting, and subjecting to more disintegration during operation. The above results were in close agreement with the findings of Behera, et al. [1], Chinna [2] and Prasanthkumar et al. [10].

The number of pass did not produced any significant results with puddling index. It might be due to the highest degree of disintegration on first pass compared to second pass. When the number of pass was increased from single to double, the puddling index increased by 5.92, 0.30 and 2.98% for cage wheel, rotavator and power tiller operated rotary tool, respectively.

3.2 Infiltration Rate

Analysis of variance for infiltration rate in sandy loam soil is presented Table 3. The puddling technique was significant at 1% (*P = .000*) level and the number of pass did not have significant (*P = .747*) effect on infiltration rate.

After single pass (P_1), the lowest infiltration rate of 17.00 mm d^{-1} and the highest infiltration rate of 30.00 mm d^{-1} was recorded for puddling with power tiller operated rotary tool (I_3) and cage wheel (I_1), respectively. The puddling techniques of power tiller operated rotary tool (I_3), rotavator (I_2) and cage wheel (I_1) was noticed to have first to third ranking in terms of infiltration rate sandy loam soil.

It could be inferred from the Table 4 that the increase in number of passes decreased the

Table 1. Analysis of variance (ANOVA) for puddling index in sandy loam soil

S. no.	Source	Df	SS	MS	F	Probability
1.	Tot	17	520.857	30.639	8.849	
2.	Rep	2	0.039	0.019	0.006	
3.	Trt	5	486.197	97.239	28.087	.000
4.	I	2	468.828	234.414	67.708	.000
5.	P	1	11.826	11.826	3.416	.094
6.	IP	2	5.543	2.772	0.801	.476
7.	Err	10	34.621	3.462	1.000	

Table 2. Effect of puddling techniques (I) and number of passes (P) on puddling index

Treatment	Mean values of Puddling index (%)
I_1P_1	48.46
I_1P_2	51.33
I_2P_1	58.29
I_2P_2	58.46
I_3P_1	61.18
I_3P_2	63.00

Table 3. Analysis of variance (ANOVA) for infiltration rate in sandy loam soil

S. no.	Source	Df	SS	MS	F	Probability
1.	Tot	17	649.125	38.184	3.747	
2.	Rep	2	0.583	0.292	0.029	
3.	Trt	5	546.625	109.325	10.727	.000
4.	I	2	544.750	272.375	26.725	.001
5.	P	1	1.125	1.125	0.110	.747
6.	IP	2	0.750	0.375	0.037	.964
7.	Err	10	101.917	10.192	1.000	

infiltration rate in all puddling techniques. When the number of passes increased from single to double the infiltration rate was decreased by 1.69, 0.00 and 6.25% for cage wheel (I_1), rotavator (I_2) and power tiller operated rotary tool (I_3), respectively. Reduction in infiltration rate compared to single pass might be due to the higher level of churning in soil that creates more suspended material and covers the soil pore space, on settlement. While puddling with rotavator (I_2), double pass produced any effect on infiltration rate, since the puddling index had not raised to significant level in double pass for rotavator puddling. The above results were in corroborated with the findings of Kankal, et al. [5].

Table 4. Effect of puddling techniques (I) and number of passes (P) on infiltration rate

Treatment	Mean values of infiltration rate (mm d^{-1})
I_1P_1	30.00
I_1P_2	29.50
I_2P_1	21.00
I_2P_2	21.00
I_3P_1	17.00
I_3P_2	16.00

4. CONCLUSION

Increasing number of pass increased the puddling index and reduced the infiltration rate, for different puddling techniques. Reduced infiltration rate leads to water saving in paddy field. The power tiller operated rotary tiller registered the highest puddling index and lowest infiltration rate. The rotavator puddling was recorded second in terms of highest puddling index and lowest infiltration rate. Puddling with rotavator had the more area coverage compared to power tiller operated rotary tool. Hence it is concluded that the rotavator puddling is suitable for puddling the sandy loam soil among the different puddling techniques.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Behera BK, Varshney BP, Goel AK. Effect of puddling on puddled soil characteristics and performance of self-propelled transplanter in rice crop. CIGR E Journal. 2009;9:1-18.
2. Chhina RS. Comparative performance of different puddling equipments. Int. J. of Agrl. Engg. 2015;8(2):210-214.
3. Pradhan P, Verma A, Kiran K, Ragesh KT. Performance of power tiller with different cage wheels in wet land. Int. J. of Agrl. Sci. and Res. 2015;5(5):23-32.
4. Fajardo AL, Suministrado DC, Peralta EK, Bato PM, Paningbatan EP. Force and puddling characteristics of the tilling wheel of float-assisted tillers at different lug angle and shaft speed. Soil and Tillage Res. 2014;140:118-125.
5. Kankal US, Karale DS, Thakare SH, Khamballkar VP. Performance evaluation of tractor operated rotavator in dry land and wet land field condition. Int. J. of Agril. Sci. Res. 2016;6(1):137-146.
6. Mousavi SF, Yousefi-Moghadam S, Mostafazadeh-Fard B, Hemmat A, Yazdani MR. Effect of puddling intensity on physical properties of a silty clay soil under laboratory and field conditions. Paddy Water Environ. 2009;7:45–54.
7. Rezaei M, Tabatabaekoloor R, Seyedi SRM, Nategh AN. Effects of puddling intensity on the in-situ engineering properties of paddy field soil. Australian J. of Agrl. Engg. 2012;3(1):22-26.
8. Alizadeh MR, Allameh A. Field performance of two and four wheeled tractors in paddy field preparation. Tech. J. Engg and App. Sci. 2013;3(4): 298-305.
9. IS: 11534. Test code for puddler. Bureau of Indian Standards. 1985;1-22.
10. Prasanthkumar K, Saravanakumar M, Gunasekar JJ. Water management through puddling techniques. J. of Krishi Vigyan Kendra. 2019;8(1):297-300.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/54553