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Research Article

STUDY OF AGRONOMICAL AND SOIL PARAMETERS IN PADDY FIELD FOR DEVELOPMENT OF PADDY WEEDER

BASAVARAJ[1*], SURENDRAKUMAR A.[2] AND DIVAKER DURAIRAJ C.[3]

[1]College of Agricultural Engineering, Professor Jayashankar Telangana State Agricultural University, Sangareddy, 502001
[2]Agricultural Machinery Research Centre, AEC&RI, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, 641003
[3]AEC&RI, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, 641003
*Corresponding Author: Email-basu.py009@gmail.com

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Abstract- Weed is inevitable part of farming but these become threat to crops by augmenting unfavorable condition to main crop. Weeds, instead of harbouring insects, compete with the crop for water, light, plant nutrients and adversely affect the microclimate around the plant. Weeding is an important but equally labour intensive agricultural unit operation. Weeding accounts for about 25 per cent of the total labour requirement during a cultivation season. The major weeds of paddy crop identified in the paddy field were *Echinochloa colona* (Jungle rice), *Echinochloa crus-galli* (Common barnyardgrass), *Chloris barbata* (swollen windmill grass), *Cynodon dactylon* (Bermuda Grass), *Centella asiatica* (Gotu kola) *and Cyperus difformis* (Sedge). The agronomical, soil and machine parameters were analysed for development of paddy weeder. The average soil moisture was observed 44.89 per cent and varied from 30 to 56.34 per cent. The bulk density of upper soil (20 mm to 50 mm) layer was always found to be lesser than the soil at lower layer (50 mm to 100 mm). The bulk density of upper layer showed variation this was 1.30 to 1.50 g cm^{-3}, where as in lower layer varied from 1.50 to 1.72 g cm^{-3}. The average cone index was 0.172 kg cm^{-2} up to 20 mm depth and 1.44 kg cm^{-2} from 20 to 50 mm depth and 0.75 to 1.69 kg cm^{-2} for 50 mm depth varied. The increase in cone index with increase in soil depth was found from study. The study conducted in research plots of Tamilanadu Agricultural University, Coimbatore.

Keywords- Weed, Paddy weeder, Soil moisture, Bulk density and Cone index.

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Introduction

Ever since man started growing crops, he had come up with the problems of weed. Farmers and researchers have been putting up a combined front to tackle the menace of weeds. Weeding is an essential for enhance crop growth but handling the weed nearby crop plant stem effectively is needs more attention and difficult to operate as bulk because it's along with crop. So, it's mostly achieved by manually and become labour intensive agricultural unit operation. Weeding accounts for about 25 per cent of the total labour requirement during a cultivation season [7]. In developing countries it is estimated that reduction in yield due to weeds alone is 20 to 30 per cent depending on the crops, weed infestation intensity and location, which might increase up to 50 per cent if adequate crop management practices were not observed. In developing country like India, where problem of food production will become very acute in few years due to multiplying growth of population and cultivable land decreases due to unbounded civilization. Considering above affects, proper weeding is necessary to control weed effectively to enhance production.

Materials and Methods

Agronomic Parameters

The important agronomic parameters, which influence the weeding operation, were identified as row spacing, plants spacing and height of the crop.

Row spacing and plant spacing

The main parameter that influences weeding is row spacing that helps in allowing the tool for operation. Normally recommended row to row spacing and plant to plant spacing for paddy crop ranges 25 × 25 cm.

Weeding interval

Weed is more competitive in early stages of the crops. For obtaining 95 per cent of a weed-free yield, the critical periods for weed control, were estimated between 29 to 32 days after sowing in wet seeded rice and 4 to 83 DAS in dry seeded rice [4]. In paddy cultivation, the weeding is done in three stages as furnished below [3].

1. The first weeding should be done between 15-22 DAS.
2. The second weeding may be done 10 days after first weeding.
3. The third weeding may be done 7 days after second weeding.

The common type of weeds which affects yield are shown in [Table-1]. It is categorized as grassy weeds, broad leaved weeds and sledges.

Since all the above mentioned weeds are getting matured within a period of 15 to 45 days, the weeding has to be done before the critical period for efficient control is preferred.

Soil parameters

The soil parameters influencing performance of weeding and design of weeder

were identified and measured *viz.,* soil type, soil moisture, bulk density, cone index. The manners of measurement and characterization of these properties are discussed in the following sections.

Table-1 *Different weeds in paddy field*

Sl. No.	Types of weeds	6.	Eclipta prostrata
I.	**Grassy weeds**	7.	Marselia quadrifolia
1.	Enchinochlona colona	8.	Monochoria vaginalis
2.	Chloris barbata	9.	Nastridium indicum
3.	Enchinochloa crus-galli	10.	Phyla nodiflora
4.	Paricum Sp.	11.	Phyllanthes niruri
5.	Cynodon dactylon	12.	Rotala densiflora
II.	**Broad leaved weeds**	13.	Ruellia tuberose
1.	Ammania baccifera	14.	Sonchus oleraceus
2.	Asteracantha longifolia	15.	Sphaeranthus indicus
3.	Centella asiatica	**III**	**Sedges**
4.	Commelina benghalensis	1.	Cyperus difformis
5.	Cyanotis axillaris	2.	Cyperus iria
		3.	Fimbristylis milliacea

Table-2 *Soil resistance for various soils*

S. No.	Type of soil	Soil resistance(kg/cm²)
1.	Sandy soil	0.2
2.	Sandy loam	0.3
3.	Silt loam	0.35-0.5
4.	Clay	0.4-0.56
5.	Heavy loam	0.5-0.7

Soil moisture

Moisture content of soil will affect draft of implement and slip. Soils having more moisture content give more slip and hence increase the draft.

Moisture content of soil plays an important role for the growth of the crop and optimum soil moisture is needed at the time of weeding to minimize the field losses and energy input. The soil samples were collected from the rice fields with standing rice stubble. The fields after harvest were flooded to saturate the soil profile and soil samples were collected 24 hours after saturation. Soil samples were collected at depths of 10 cm and 20 cm from paddy field. These samples were weighed and then oven dried at oven at 105 °C for about 24 hours. After the specified time, the oven-dried samples were weighed. The moisture content on wet basis was calculated [8],

$$MC_{db} = \frac{Ww\text{-}Wd}{Ww} \times 100$$

Where,

MC_{db} = moisture content (dry basis)
Ww = weight of water
Wd = weight of dry matter

Bulk Density

Bulk density is the mass per unit volume of soil including pore space. Measurement of bulk density was carried out in all the experimental sites. Since the soil is saturated clay bulk density is affected by sampling process. Since bulk density varies with depth, samples were taken at two different depths of 10 cm and 10 20 cm. Soil sample was manually filled in cylindrical aluminium cups to measure the bulk density. The volume of container was around 100 cm^3, whenever bulk density was measured. Measurement of moisture content was also made simultaneously.

$$\text{Bulk density } (kg/m^3) = \frac{\text{Mass of soil sample(kg)}}{\text{Volume of container(m3)}} \times 1000$$

Cone index

Cone index is a measure of the resistance of soil to the penetration of cross circular cone. The cone index was measured using manually operated hand held CPM-84 digital cone penetrometer. The measurement was taken at random in the experimental field with and without weeds.

Soil type

Soil resistance of different soil types were referred for determination power requirement. Soil resistance for different soils is given in [Table-2] [4].

Description of cone penetrometer

The resistance offered by the penetration of the cone was sensed by the load cell and transmitted to the load indicator and recorder. The ultrasonic sensor helps to measure the distance between the device and the soil surface. The equipment has provision for continuous recording of soil strength profile and can store up to 3000 sets of reading (100 replication × 30 sets of reading per location). The data labels include date; the recorded data can be transferred to a personal computer using data acquisition software and stored as Excel files. Weight of the equipment excluding penetrometer probe is 1.04 kg. For proper functioning of this instrument, the ultrasonic beam should be reflected back from the ground to the receiver. To ensure this, target plate of 300 mm × 300 mm with a central hole was first placed on the ground before penetration of the cone into the soil. The specifications of hand held CPM-84 digital cone penetrometer is given in [Table-3]. The unit is shown in [Fig-1].

Table-3 *Specifications of hand held CPM-84 digital cone penetrometer*

S. No.	Particulars	Values
1.	Make	Indus (Indus Electronics India(p).Ltd)
2.	Model	CPM-84
3.	Load Capacity	0 to 200 kg
4.	Distance measurement	0 to 400 mm with incremental depth of 5 to 10 mm adjustable
5.	Number of readings per penetration	Maximum 50
6.	Number of data sets	100×30 sets of readings per location
7.	Communication	USB port
8.	Data Retrieval and Processing Software	Penetrometer 4.1

Measurement of cone index (6)

i) Type B (ASBE S313.3 FEB04) probe was attached to penetrometer
ii) The target platform was placed in location where measurement has to be made
iii) The penetrometer was positioned with the apex of the cone at the ground level and the start button was pressed. This signals beginning of recording. As the probe was pushed into the soil, the depth and force readings were continuously recorded in the penetrometer display.
iv) The force values were recorded at every incremental depth of approximately 10 mm. when the maximum depth or maximum penetration resistance for manual pushing was reached, the start button was pressed again signal the end of the measurement. The penetrometer is gently pulled out by holding the cone penetrometer rod to prevent damage to the instrument.
v) Cone index was calculated using the equation

$$CI = \frac{F}{A}$$

Where,
CI = cone index, kg/mm^2
F = penetration resistance, kg
A = cone base area, mm^2
= 129 mm^2

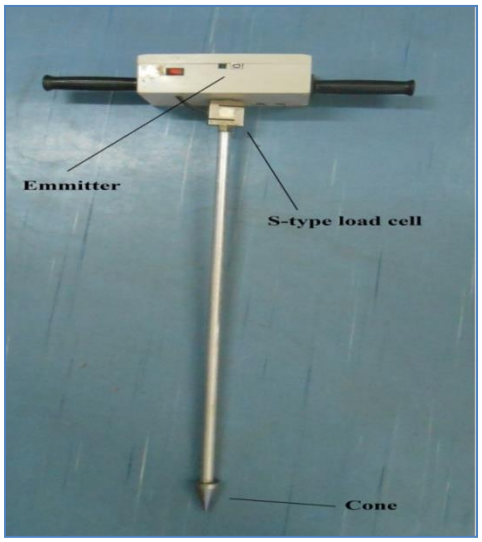

Fig-1 Cone penetrometer for cone index measurement

Results and Discussions

Crop parameter

i) Spacing between rows and plants

The row spacing and plant spacing of paddy was identified as 25×25 cm according to the SRI method.

Weed parameter

The major weeds of paddy crop identified in the paddy field were *Echinochloa colona* (Jungle rice), *Echinochloa crus-galli* (Common barnyardgrass), *Chloris barbata*(swollen windmill grass), *Cynodon dactylon*(Bermuda Grass), *Centella asiatica* (Gotu kola) *and Cyperus difformis* (Sedge). The images of identified weeds are shown in [Fig-2].

(a)Asteracanthalongifolia *(b) Echinochloacolona*

(c) Echinochloa crus-galli (d) Centellaasiatica

Fig-2 Different types of weeds identified in paddy field

i) Weeding interval

In paddy cultivation, the weeding is done in three stages *viz.,* first weeding between 15-22 DAS, second weeding 10 days after first weeding and third weeding 7 days after second weeding.

Soil parameter

The soil parameter namely soil moisture, bulk density, cone index were measured.

a) Soil type

The different soils sandy clay loam, clay loam and clay were identified.

b) Soil moisture

The moisture content of the soil was determined at experimental field during the weeding stage in the paddy field. It was observed that the average soil moisture was 44. 89 per cent and varied from 30 to 56.34 per cent.

Bulk density

All the experiments were done under saturated soil conditions. The fields were flooded with standing water and after 24 hours the experiments were conducted. The undisturbed soil sample was scooped up and free water was allowed to drain and samples were collected in containers used for measurement of moisture content and bulk density.

The bulk density of upper soil layer was always found to be less than the lower layer. The bulk density of upper layer showed wide variation and varied between 1.30 to 1.50 g cm^{-3} for the field. The bulk density in the lower layer varied from 1.50 to 1.72 g cm^{-3}.

Table-4 *Bulk density and Moisture content of C-WL field*

Location	Field No.	Depth (0 to 10 cm)	
		Bulk Density (g/cm3)	Moisture content (wet basis, %)
C-WL	M4	1.54	35.6
		1.56	35.1
		1.56	36.5
		1.52	34.7
	Average	**1.53**	**35.5**
	M2	1.37	43.5
		1.36	37.8
		1.34	38.5
		1.37	39
	Average	**1.36**	**39.4**

Table-5 *Bulk density and Moisture content for BSR field*

Location BSR	Field No.	Depth (0 to 10 cm)	
		Upper Bulk Density (g/cm^3)	Moisture content (wet basis, %)
	F1	1.66	34.2
		1.65	34.6
		1.69	36.7
		1.68	37.1
	Average	**1.66**	**35.5**
	F2	1.69	35.6
		1.6	35.8
		1.66	35.2
		1.67	35.4
	Average	**1.68**	**35.5**

Cone index

The penetration resistance of a cone into the soil is expressed in terms of force per unit base area of the cone and extensively used in tillage and traction study. In present study in order to measure the penetration resistance of the soft wet clay soil of the rice field, a penetration cone with base area of 7.8 cm^2 was used, as against the standard ASTM cone of 3.22 and 1.29 cm^2 base areas. The large cone enabled measurement of the penetration resistance of weak clay soil especially in the upper layer. Cone index values are given in the [Table-6 and 7].

Table-6 *Cone index of soil at different depths in wetland field*

S.No.	Cone index (kg cm^{-2})	
	20 mm depth	50 mm depth
1.	0.146	1.34
2.	0.176	1.24
3.	0.178	1.45
4.	0.205	1.65
5.	0.152	1.53

Table-7 *Cone index of soil at 50 mm depths in BSR field*

S.No.	Cone index (kg cm^{-2})	
	Field	50 mm depth
1.	F1-BSR	0.912
2.		1.14
3.		1.058
4.		1.065
5.		1.36
1.	F2-BSR	1.69
2.		1.29
3.		0.75
4.		1.15
5.		0.89

The cone index at different depths of soil is shown in [Fig-3-6]. From [Table-6 and 7] it was observed that cone index values increased with increase in depth. The average cone index was 0.172 kg cm^{-2} up to 20 mm depth and 1.44 kg cm^{-2} from 20 to 50 mm depth in C-Wetland and 0.75 to 1.69 kg cm^{-2} for 50 mm depth varied in BSR paddy field. The increase in cone index with increase in soil depth may be due to soil compaction.

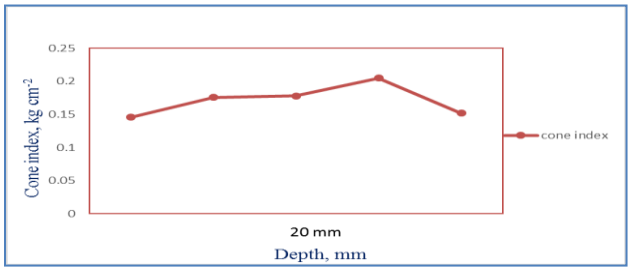

Fig-3 Variation of cone index at 20 mm depth in Wetlands

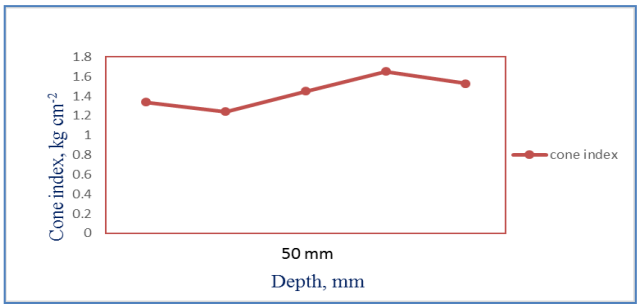

Fig-4 Variation of cone index at 50 mm depth in Wetlands

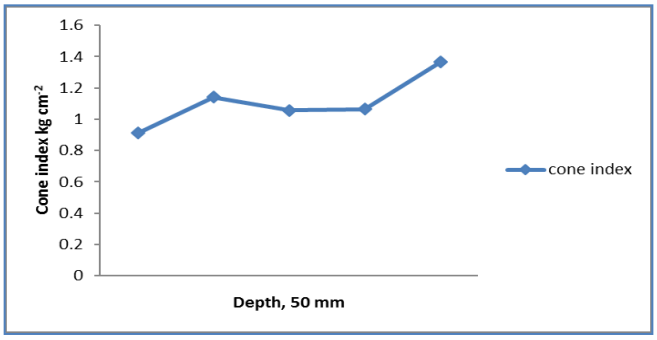

Fig-5 Variation of cone index at 50 mm depth in BSR field

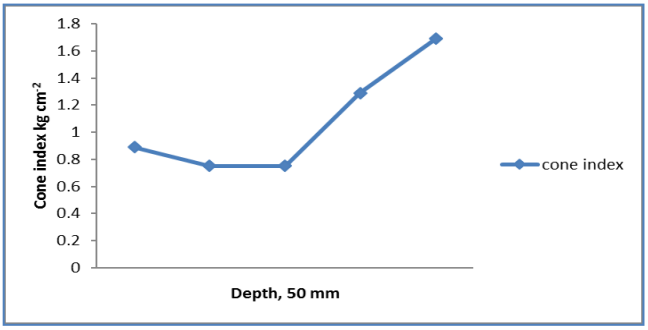

Fig-6 Variation of cone index at 50 mm depth in BSR field

Conclusion

Different agronomical and soil parameters are summarized and concluded below,

The major weeds of paddy crop identified in the paddy field were *Echinochloa colona, Echinochloa crus-galli, Chloris barbata, Cynodon dactylon, Centella asiatica and Cyperus difformis*.

In paddy cultivation, the weeding is done in three stages *viz.*, first weeding between 15-22 DAS, second weeding 10 days after first weeding and third weeding 7 days after second weeding. The different soils sandy clay loam, clay loam and clay were identified.

In paddy field, the moisture content was observed that the average soil moisture was 44. 89 per cent and varied from 30 to 56.34 per cent. The bulk density of upper soil layer was always found to be less than the lower layer. The bulk density of upper layer showed wide variation and varied between 1.30 to 1.50 g cm^{-3} for the field. The bulk density in the lower layer varied from 1.50 to 1.72 g cm^{-3}. The average cone index was 0.172 kg cm^{-2} up to 20 mm depth and 1.44 kg cm^{-2} from 20 to 50 mm depth in C-Wetland and 0.75 to 1.69 kg cm^{-2} for 5mm depth varied in BSR paddy field. The increase in cone index with increase in soil depth may be due to soil compaction. All the agronomic characteristics are useful in the design and development of paddy weeder.

Conflict of Interest: None declared

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