

Mechanized crop care in non-flooded rice production in Malaysia

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Abstract

A research on the mechanization of fertilizer and pesticide application in non-flooded rice was conducted in the Muda area in the state of Kedah in Malaysia. The soil cone index values were higher, and the insect infestation was lesser, in non-flooded rice compared to the flooded rice. Boom-cum-spot sprayer and fertilizer broadcaster, attached to the 45-hp tractor, fitted with narrow steel wheels, were appropriate machines for crop care and maintenance, in non-flooded rice cultivation. The width of the narrow steel wheel should preferably be lesser than 10 cm, so that the width of the tracts made in the non-flooded rice field can be small. This narrow steel wheel tractor mounted with applicators can be used during the rice growing period, but only until the heading stage. An area of 7 hectare per day can be sprayed by the boom sprayer, while the inverted cone shaped fertilizer broadcaster can broadcast an area of 6 hectares per day. The soil should have a cone index value of above 3.0 kg/cm² at 25 cm depth. These results have significant implications for moving towards mechanization of fertilizer and pesticide applications in non-flooded rice in Malaysia.

Media summary

Fitting the tractor with narrow steel wheels enabled the usage of tractor mounted applicators during the rice growing period for crop care in non-flooded rice.

Key Words

Steel wheel, non-flooded, boom sprayer, broadcaster, rice

Introduction

Crop environment will change when rice is grown from flooded to non-flooded condition. Non-flooded rice cultivation is defined as the cultivation of rice in an environment whereby there is no standing water in more than 50% of the crop-growing period. In the non-flooded rice cultivation, the pest situation may be different and the method of fertilizer application may need reinvestigation. The land preparation technique will be the same for both flooded and non-flooded conditions, but for mechanization for non-flooded rice, appropriate machines and applicators for pesticide and fertilizer application need to be selected and modified to suit to the non-flooded rice culture. Before selection of the appropriate machines and applicators, the pest population, cone index value, and method of fertilizer application needs to be understood. Once the machines are selected, preliminary testing should be done, and modifications to the machines and improvement to the traction device will be needed to suit to the non-flooded rice culture. The objective of the study was (i) to investigate changes in pest occurrence and fertilizer application, and cone index value from flooded to non-flooded system, and (ii) to select and test appropriate machines for crop care and maintenance for non-flooded rice production system.

Methods and materials

A field trial was conducted during off season in 1996, at Kg Gulau, in the Muda area, involving flooded and non-flooded rice (each with plot size of 30m x 18m) to investigate into changes in crop environment, with respect to pest occurrence and fertilizer application. Another field trial was conducted at Buluh Lima,

in the Muda area, during main season 1996/1997, to record the cone index value of non-flooded and flooded direct seeded rice. The main season is from September to January while the off season is from March to July. Cone index value is defined as the penetration force (kg) over the cone base area (cm²). Then the selection of appropriate machine and applicators for non-flooded rice cultivation was made. The performance of the tractor and the fertilizer and pest applicators were then tested at four locations in the Muda area (Buluh Lima, Sungai Korok, Alor Senibong and Alor Serdang) during main season 1996/1997, main season 1997/1998 and off season 1998. Of importance was to study the field requirements of non-flooded rice that may result into large scale mechanization. Verification of research results were carried out in farmers' fields prior to field demonstrations.

Results and discussion

Changes in crop environment with respect to pest occurrence and fertilizer application.

The time of insect infestation was found to be similar for both flooded and non-flooded rice culture. However in the non-flooded rice, there appeared to be slightly less insect population compared to the flooded rice. In the non-flooded plot, the application of granular NPK fertilizers on the soil surface resulted in uneven green appearance of the rice crop (Table 1).

Table 1. Insect* population over the growing season in the non-flooded (NF) and flooded (F), direct seeded rice, at Kg Gulau, MADA, off season 1996.

12 Tapping 3 Sweep				
DAS	NF	F	NF	F
30	7	10	23	26
43	17	11	15	19
55	104	82	43	23
69	109	214	248	426
83	173	207	154	187
97	738	312	49	62
110	328	536	198	216

*Stem borer, leaf eater, Bph, GLH, WBph, Z/Z, rice bug, and natural enemies.

DAS – Days after sowing.

In the field trial at Buluh Lima, in the Muda area, during main season 1996/1997, the cone index value of the non-flooded plot, at 34 days after sowing, was higher than that of the flooded plot (Table 2).

Table 2. Cone index value (kg/cm²), in non-flooded (NF) and flooded (F), direct seeded rice, at 34 DAS, at Buluh Lima, MADA, main season 1996/1997.

Depth (cm)	0	5	10	15	20	25	30	35
NF	0	0.14	0.23	1.09	2.73	3.53	3.65	3.30
F	0	0.0	0.0	0.37	1.81	3.35	3.47	3.11

Selection of appropriate machines and applicators

Since the soil cone index values were higher in the non-flooded rice, and the insect infestation was lesser in non-flooded rice compared to the flooded rice, it was decided to test the boom-cum- spot sprayer and fertilizer broadcaster, attached to the 45-hp tractor, fitted with narrow steel wheels, as was used in flooded rice culture (Azizul, 1995), as appropriate machines and applicators for crop care and maintenance, in non-flooded rice cultivation. For the narrow steel wheels, the front wheel diameter was 133 cm while the back wheel diameter was 176 cm. Both wheels were of 12.5 cm width and have sprockets with iron bar over it. The boom-cum-spot sprayer was a 400 liter tank with 9.5 m sprayer arm having 24 nozzles. The inverted cone shaped fertilizer broadcaster, with a capacity of 400 kg has a single rotating plate, at the bottom, for broadcasting the fertilizers.

Testing of appropriate machines and applicators

The 45-hp tractor fitted with narrow steel wheels, tested at four locations in the Muda area, during

main season 1996/1997, main season 1997/1998 and off season 1998, was found to leave behind in the non-flooded rice plots, the tracts of 15-20 cm width and 18-26 cm depth. When this narrow steel wheel followed the same path, for a second time in the season, in the non-flooded rice fields, the tract depth became deeper by more than 2 cm. A tract depth of 25-30 cm and a width of 19-24 cm, for the second passing of the tractor, has been recorded. Although the tracts left behind were covered by the growing rice plants, after 10-14 days, the damage done to the rice crop was still visible. If possible the width of the narrow steel wheel should be further reduced (lesser than 10 cm) so that the width of the tracks will be smaller than 15-20 cm and there will be less visible damage done to the rice crop. One problem with this tractor fitted with narrow steel wheels was when it got bogged down in the soft area of the non-flooded rice field, and with the rice crop around, it was difficult to handle this problem. Another problem was the difficulty in moving along farm roads and bunds due to much vibrations of the tractor caused by the narrow steel wheel. The wheel sprockets with iron bar over it will also leave marks on the roads and bunds.

When attached to the 45-hp narrow steel wheel tractor, in the non-flooded rice plots, the work rate of the boom-cum-spot sprayer for the 4 locations was in the range of 40-55 min/ha. On a per day basis, with six hour working time, the boom sprayer can cover an area of about 7 hectares. This boom sprayer can also be used for herbicide application in the field. When attached to the 45-hp narrow steel wheel tractor, in the non-flooded rice plot, the work rate of the inverted cone shaped fertilizer broadcaster for those 4 locations was in the range of 55-70 min/ha. For the same working time, the fertilizer broadcaster can cover an area of about 6 hectares. With the single rotating plate, it could broadcast the fertilizer with a spread of 6-8 m, with work rate increasing when the fertilizer gets stuck at the rotating plate. This inverted cone shaped fertilizer broadcaster can also be used for seed sowing. This narrow steel wheeled tractor with applicators can be used only until before the heading stage. Crop care and maintenance after the heading stage needs to be carried out using the conventional method. This is because the height of the narrow steel wheeled tractor does not permit it to enter the rice field after the heading stage. To mechanize after the heading stage necessitates adjustment to be made to the height of the tractor. A 1.0 m ground clearance will be necessary.

Field requirements for non-flooded rice mechanization

For ease in mechanization, the non-flooded rice field needs to be properly leveled at land preparation stage. Sufficient in-field drains should be provided. The soil should have a cone index value of above 3.0 kg/cm² at 25 cm depth. However the hardpan should be further improved, to increase the soil bearing capacity to beyond 3.0 kg/cm². The non-flooded rice field also should have an access path for the entry and exit of the tractor/applicator. Length of the field plots should be sufficient enough (preferably more than 100 m) for the tractor operator to set his working speed and applicator performance.

Large scale verification and field demonstration

The large scale verification of this mechanization package for crop care and maintenance in non-flooded rice was conducted at Hutan Putus in the Muda area, during main season 1998/1999. The 45-hp tractor fitted with narrow steel wheel and applicator was tested on a 1.9 ha non-flooded rice plot. With the boom-cum-spot sprayer attached to the tractor, at 55 days after sowing, the work rate was 40 min/ha, and this left behind a tract width of 17-22 cm and a tract depth of 10-22 cm. When the tractor with the fertilizer broadcaster (with single rotating plate) attached to it moved along the same path, at 63 days after sowing, the tract width was 21-25 cm and the tract depth was 20-30 cm. The work rate of the fertilizer broadcaster was 45 min/ha (Table 3).

Table 3. Large scale verification of narrow steel wheel 45-hp tractor with applicator, at Hutan Putus, MADA, during main season 1998/1999 (Area 1.9 ha).

Applicator	Field tracts (cm)		Work rate Cost	
	Width	Depth	(min/ha)	(RM/ha)
Boom sprayer attached (at 55 DAS), 1 st passing	17-22	10-22	40	29
Fertilizer broadcaster attached (at 63 DAS), 2 nd passing along the same path	21-25	20-30	45	30

The mean yield of the non-flooded rice was 4213 kg/ha and that of flooded rice was 4701 kg/ha, thus the yield of non-flooded rice was about 10% lower than that of flooded rice.

Farmers' response and cost comparison

It appears that farmers can accept this mechanization package for crop care and maintenance in non-flooded rice. However they expressed uncertainty on the usage of this tractor with applicator in soft paddy soil or soft spots in the field. The expected contractual cost for usage of the fertilizer broadcaster/boom sprayer attached to the narrow steel wheel tractor is RM 29-30/ha, which is cheaper than using the knapsack blower (RM 34/ha) (Table 4).

Table 4. Cost comparison in rice mechanization for pesticide and fertilizer application.

	Work rate (hr/ha)	Cost (RM/ha)
Pesticide		

Knapsack (manual)	4.0	45
Knapsack blower	1.3	34
Boom sprayer – narrow wheel tractor	0.75	29
Fertilizer application		
Manual	6.0	45
Knapsack blower	2.0	34
Fertilizer broadcaster – narrow wheel tractor	0.86	30

1 US\$=RM3.80

Conclusion

The boom-cum-spot sprayer and the inverted cone fertilizer broadcaster (with single rotating plate), attached to the tractor, fitted with narrow steel wheels, were found to be appropriate machines and applicators for crop care and maintenance, in non-flooded rice cultivation. When attached to the 45-hp narrow steel wheel tractor the boom sprayer can spray an area of 7 ha per day. The inverted cone shaped fertilizer broadcaster attached to the 45-hp narrow steel wheel tractor can cover an area of 6 ha per day. The 45-hp narrow steel wheel tractor, left behind in the non-flooded rice field, forms tracks of 15-20 cm width and 18-26cm depths. The width of the narrow steel wheel should be lesser than 10 cm, so that the width of the tracks will be smaller than 15-20 cm and there will be less visible damage to the rice crop. For mechanization in non-flooded rice fields, the soil cone index value should be above 3.0 kg/cm² at 25 cm depth.

References

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