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Short Communication

STUDIES ON DIFFERENT DRAINAGE SYSTEMS FOR CULTIVATION OF PAPAYA IN NON CALCIC BROWN SOILS IN SRI LANKA

W.A.WIJITHAWARNA [1], S.H.S.A. DE SILVA [2], I.K. WARSHAMANNA [3], A.G. CHANDRAPALA [4], INDIKA GUNATHILAKA [2], N.D. RANAWAKA [5]

[1] *Grain Legumes and Oil Crops Research and Development Centre, Angunakolapelessa, Sri Lanka*
[2] *Regional Agricultural Research and Development Centre, Aralaganwila, Sri Lanka*
[3] *National Plant Quarantine Centre, Katunayaka, Sri Lanka*
[4] *Natural Resources Management Centre, Peradeniya, Sri Lanka*
[5] *In Service Training Centre, Gannoruwa, Peradeniya, Sri Lanka.*

INTRODUCTION

Papaya is a major commercial fruit crop in Sri Lanka with a year round production. The crop is mainly cultivated in highlands of the dry and intermediate zones under rain fed condition and with supplementary irrigation. Due to its profitability farmers are now using abandoned paddy fields and lands in the lower terrains for cultivation of papaya. In papaya cultivation root systems of the crop is severely affected during rainy seasons due to the saturation of water in the soil space causing splitting of roots and infection by the fungi *Phytophthera* spp. *and Phythium* spp. This results in a basal and root rot diseases which is a major problem of papaya cultivation in poorly drained soils of Sri Lanka. The recovery rate of the infected plants is very slow with the application of fungicides leading to a reduction in yield and quality. Therefore, this study was carried out to identify a possible drainage network and to identify a remedy to prevent the basal and foot rot of papaya grown in lowlands.

MATERIAL AND METHODS

The experiment was conducted by establishing 3 crops, during *yala* 2004 to *maha* 2009/2010 and at the Regional Agricultural Research and Development Centre, Aralaganwila. The soil was a poorly drained non calcic brown (NCB) soil. The location falls in to the Low Country Dry Zone (DL_{2b}) having mean monthly rainfall of 158 mm. The initial observational trials were carried out from *maha* 2002/2003 to *maha* 2003/2004 to obtain an idea about the designing the drainage canals for easy management. These studies showed that the raised bed system is more effective than the planting hole system for removing excess water through drainage. It also showed that the main drain canal and basal canals between beds should be connected with lateral canals where these laterals collect excess water and direct to the main canal effectively. The study also showed that

the depth of main canal should be100-150 cm and distance between main canals has to be 50 m. The suitable depth of basal canals between raised beds was around 30 cm.

Based on the initial study the six different drainage systems; namely flat beds without drainage system (DS1), 20 cm basal canals (between the planting beds) with 30 cm laterals (to connect basal canals and direct water to main canal) and 40-60 cm main drainage canal (DS2), 30cm basal canal with 35 cm lateral and 60-80 cm main canal (DS3), 30cm basal canal with 40cm laterals and 80-100 cm main canal (DS4), 30cm basal with 45cm laterals and 100-150cm main canal (DS5) and 30cm basal canal with 50 cm laterals and 150-200 cm main canal (DS6) were developed within Randomized Complete Block Design with three replicates.

Spacing in each treatment was 3 m x 3 m (1,100 plants/ha). Thirty seedlings were planted in each replicate. Except the zero canal treatment, raised beds were formed in all the treatments. Six weeks old seedlings of variety Rathna were planted in May 2004 (first crop) October 2006 (second crop), December 2008 (third crop). Chemical fertilizers were applied according to the DOA recommendations and cow dung was added as organic manure. Weed control was done manually. Irrigation method was surface by filling of canals and drain out after 8-10 hours to maintain field capacity of the root zone. Incidence of papaya root and basal rot, survival after infection with the treatment by fungicides (systemic), survival after flowering (3 to 4 months after establishment), depth of the ground water level after heavy rain or irrigation and fruit yield were recorded and analyzed using the SAS statistical procedure.

RESULTS AND DISCUSSION

Survival of plants from establishment to flowering

Survival of plants after the establishment in the soil showed significant difference between different drainage systems (Table 1). The crop survival at establishment was better in all the treatments when compared to the control. The survival rate was higher in deeper drainage system and lower in shallow drainage system. According to Table 1 there was no significant difference in plant survival at flowering between the drainage systems 5 and 6 due to effective drainage of excess moisture within the root zone area.

Incidence of root rot and basal rot and ground water level

The incidence of foot rot and root rot was significantly different between all drainage systems. Incidence of root rot was well controled in the drainage systems 5 and 6 due to the improvement of drainage within the root zone depth. The results demonstrated that the occurrence of root rot disease declined with gradual increase of

drainage canals (Table 1). According to Irwin (1997) incidence of *Phytophthora* root rot of mature trees of papaya in waterlogged areas during the rainy periods can be greatly reduced by improving drainage in the orchards. This study also showed that increasing canal depths from treatment 1 to 6, reduced the incidence of papaya root and basal rot.

Table 1. **Plants survival after the establishment and at flowering of papaya plants as affected by drainage systems.**

Treatment	Number of plants		
	Crop 1	Crop 2	Crop 3
Control(1)	30.0^{a}	30.0^{a}	30.0^{a}
D S 2	29.333^{a}	30.0^{a}	20.0^{b}
D S 3	24.333^{b}	27.667^{a}	12.0^{c}
D S 4	20.0^{b}	22.33^{ab}	7.33^{d}
D S 5	10.0^{c}	15.0^{b}	1.66^{e}
D S 6	1.0^{c}	4.33^{b}	0.66^{e}

Note: Mean values within a column with the same letters are not significantly different at $p \geq 0.05$.

Table 2. **Number of plants infected by root and foot rot and ground water levels as affected by drainage systems.**

Treatment	Number of plants		
	Crop 1	Crop 2	Crop 3
Control(1)	30.0^{a}	30.0^{a}	30.0^{a}
D S 2	24.0^{b}	22.33^{b}	20.0^{b}
D S 3	14.0^{c}	11.33^{c}	12.0^{c}
D S 4	5.66^{d}	5.33^{d}	7.33^{d}
D S 5	0.66^{e}	0.0^{e}	1.66^{e}
D S 6	0.0^{e}	0.0^{e}	0.66^{e}

Note: Mean values within a column with the same letters are not significantly different at $p \geq 0.05$.

Ground water level

Deeper ground water levels were observed in treatment 5 and 6 and lowest was in plots without drainage canals (control). To maintain the desired level of water table (below 45 cm) drainage canals should be prepared as in treatments 3 to 6. The best plant survival was recorded in treatment DS 5 and DS 6.

Total fruit yield per treatment

Total fruit yield in individual plot was recorded from the first harvest (7 months to 19 months period) of the three cropping seasons. Yield of individual plot was depended on number of plants that survived irrigation and drainage conditions and climatic parameters. The highest yield was recorded in drainage system 5 and the lowest

yield in drainage system 2. In the control there were no any fruit because none of the plants survived with flood irrigation under ill drained conditions.

Table 3. Ground water level as affected by drainage systems.

Treatment	Distance from soil surface to ground water level (cm)		
	Crop 1	Crop 2	Crop 3
D S 6	108.54[a]	105.76[a]	109.9[a]
D S 5	90.36[b]	80.45[b]	82.6[b]
D S 4	71.59[c]	61.72[c]	64.29[c]
D S 3	54.71[d]	49.06[d]	45.9[d]
D S 2	32.85[e]	24.66[e]	23.72[e]
Control	20.32[f]	7.69[f]	12.16[f]

Note: Mean values within a column with the same letters are not significantly different at $p \geq 0.05$.

Table 4. Total yield per plot in the established three crops as affected by drainage systems.

Treatment	Crop 1 kg/trt/year	Crop 2 kg/trt/year	Crop 3 kg/trt/year
D S 6	894.07[d]	886.1[c]	1,070.6[c]
D S 5	2334.5[a]	2,276.9[a]	2,253.1[a]
D S 4	1,275.07[b]	1,464.5[b]	1,450.3[b]
D S 3	1,044.87[c]	1,031[c]	1,138.1[c]
D S 2	497.33[e]	539.4[d]	643.7[d]
Control	0.0[f]	0.0[e]	0.0[f]

Note: Mean values within a column with the same letters are not significantly different at $p \geq 0.05$.

CONCLUSIONS

The results revealed that the use of a canal depth of 30cm basal and 45cm lateral with 100-150 cm main canal is the most effective drainage system for papaya cultivation for poorly drained NCB soils. Deep main canal with dimension of 150-200 cm induces higher survival of plants but reduces total yields by drying off the root zone. Raised beds are the most suitable for papaya cultivation in ill drained soils.

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