써레질 用水에 관한 圃場實驗

Field experiment on the harrow-water requirement

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Summary

The objectives of this field experiment was to determine and recommend the water requirement for harrow considering the factors of soil class and soil moisture status. Experiment was conducted at the paddy field of the Office of Rural Development in Chungnam Province. The results of experiment were summarized as follows:

1. Continuous drought day of 10-yr return period in transplanting season was about 25 days and the water content ratios at that point were approximately 20% in clayey-loam soil and 12% in sandy-loam soil irrelevantly to the soil-depth.

2. It was recommended that harrow-water requirement for standard design were approximately 90mm in clayey-loam soil, 110mm in loamy soil and 130mm in sandy-loam soil.

Ⅰ. 緖 論

써레질用水는 一般的으로 짧은 期間에 集中的으로 많은 量의 물이 必要 하므로 用水路 斷面 決定에 重要한 要素가 되지만 計劃地區의 土性, 地下水位 狀態, 써레질前의 氣候 및 土壤水分狀態에 따라 크게 支配되므로 一律的으로 그 量을 規定하기란 대단히 어렵다. 實際로 農地改良事業計劃設計基準(1969)에서는 自然狀態의 土壤水分을 考慮할 경우에는 142mm의 써레질用水를, 農業用水開發 必要水量 基準(1972) 에서도 140mm를 써레질用水로 規定하고 있어, 그 後로 써레질用水量의 標準 設計基準으로 140mm를 一般的으로 採擇하고 있으나. 農地改良事業計劃設計基準(1983)에서는 120~180mm를, 日本의 경우[4,5]에는 土性에 따라 100~150mm를 標準 써레질用水量으로 規定하고 있다.

本 硏究에서는 써레질用水를 土性, 土壤水分狀態 土壤의 深度別 含水比, 空隙率, 飽和度 等을 測定하여 計算한 써레질 用水量과 試驗圃場에서 實測한 써레질 用水量을 比較하여 土性別로 適合한 標準設計 써레질用水量을 定하는데 目的을 둔다.

Ⅱ. 材料 및 方法

1. 試驗圃場

가. **位置** : 忠南 大田市, 農村振興院 試驗圃 2個所 및 隣近 一般農家의 논 3個所

나. **土性** : 農村振興院 試驗圃(砂壤土, 埴壤土, Fig.1), 一般農家의 논(砂壤土, 壤土, 埴壤土)

다. **灌漑用水의 計量** : 農村振興院의 試驗圃에서는 灌漑用水 pipeline에서 500l들이 물통으로 計量하고, 一般農家의 논에서는 計量치 않음.

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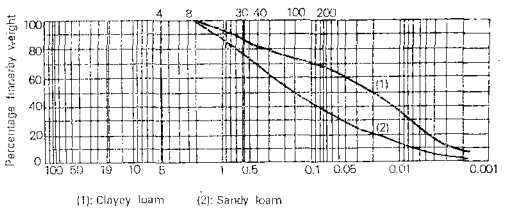

Fig. 1. Grain size accumulation curve of soils in experiment field

2. 調査 方法

써레질用水量을 實測에 의한 方法과 計算에 의한 方法으로 決定하였다.

가. 實測에 의한 方法

土壤水分狀態가 移秧期 10年頻度의 連續旱魃日數에 相當하는 時期에 計劃地區를 代表할 수 있는 土性別로 써레질用水를 供給하고 써레질用水量, 所要時間 및 日減水深을 觀測하였다.

Table-1. Experimental works on the harrowing water requirement

May 30, 1984 10 : 00AM	— Building two experiment peots with the size of 26.4m×10.0m, respectively — Laying vinylcloth to the ground to prevent horizontal seepage loss — Sampling soil specimen in dry status at each depth and soil texture — Plowing deeply to the depth of 20cm with tractor.
May 31, 1984 10 : 00AM	— Supplying the harrow water of 27.52m³ to clayey-loam soil plot for 84 minutes and 35.90m³ to sandy-loam soil plot for 110 minutes (equivalent to 5.438 *l*/sec discharge) — Harrowing with power tiller and keeping the flooding depth to 30cm
June 1, 1984 10 : 00 AM	— Checking the water loss of 18mm/day in clayey-loam soil plot and 24mm/day in sandy-loam soil plot — Supplying the supplementary water of 38mm to clayey-loam soil plot and 44mm to sandy-loam soil plot to keep the flooding depth to 50cm
June 2, 1984	— Checking the water loss of 14mm/day in clayey-loam soil plot and 18mm/day in sandy-loam soil plot — Sampling soil specimen in saturated status at each depth and soil texture
June 3, 1984 10 : 00 AM	— Checking the water loss of 14mm/day in clayey-loam soil plot and 18mm/day in sandy-loam soil plot
to June 4, 1984	— Sampling soil specimen in dry and saturated status at each depth in the ordinary farm field with soil textures of clayey-loam, loamy and sandy-loam, respectively

나. 計算에 의한 方法

써레질用水量=湛水深+表土層의 置換空氣量+心土層의 置換空氣量+水面蒸發量+浸透量 ……(1)

湛水深은 30~50mm를 取하지만 本 硏究에서는 30mm를 適用하였으며, 湛水後 表土層의 空氣量은 約 3%로 取하였다.

써레질用水量은 土壤水分狀態에 따라 달라지므로 供給時의 土壤含水比에 基準이 必要하다. 따라서 移秧時期別로 10年 頻度 旱魃日數를 求하고, 그 때의 土壤含水比 變化[3]를 旱魃 經過日數에 따라 土性別로 調査하였다. 또한 土壤의 深度別, 土性別로 試驗圃와 一般農家의 논에서 써레질前의 乾燥狀態와 써레整地後 湛水狀態에서의 試料를 採取하여 比重 空隙率, 飽和度等을 調査하여 써레질用水量을 計算하였다.

Ⅲ. 結果 및 考察

1. 試驗期間의 主要氣象

試驗圃에서 約 300m 떨어진 大田測候所 儒城分室에서 主要 氣象資料를 取得하였다.

2. 移秧期 連續旱魃日數

가. 10年頻度 連續旱魃日數

忠南의 10個 降雨觀測所(大田, 儒城, 牙山, 保寧 扶餘, 錦山, 瑞山, 洪城, 唐津, 論山)의 1965~1982年(18年間) 日 降雨資料로 부터 計算한 結果는 Table-3와 같다.

Table-2. Major climatic factor at Yuseong station during experiment period

Date	Unit	May 12	13	14	15	16	17	18	19	20	21	22	23	24	25
Temperature	°C	23.1	16.6	17.4	17.1	17.5	17.5	17.9	18.5	18.8	17.1	17.0	18.8	20.4	19.4
Precipitation	mm	—	44.0	—	—	—	—	—	—	—	—	—	—	—	—
Pan-evaporation	mm	4.3	0.3	5.4	3.7	6.7	5.4	5.7	6.8	8.3	5.7	7.2	7.2	5.1	3.0
Relative-humidity	%	73	94	71	73	70	71	69	68	53	57	61	63	63	82

Date	Unit	May 26	27	28	29	30	31	Jun. 1	2	3	4	5	6	7	8
Temperature	°C	20.6	21.7	21.2	21.0	22.0	22.8	21.7	23.1	24.5	22.1	24.6	24.2	20.1	20.2
Precipitation	mm	—	—	—	—	—	—	—	—	0.3	5.5	—	10.5	27.2	0.0
Pan-evaporation	mm	5.5	6.4	4.6	6.3	5.0	7.2	6.2	8.6	7.1	5.4	6.4	1.5	1.9	5.1
Relative-humidity	%	69	70	82	81	82	72	73	63	68	83	75	85	90	80

Table-3. Continuous drought day in each transplanting date

Transplanting Date	May 11	May 21	Jun. 1	Jun. 11
Mean(day)	13.5	14.2	14.6	13.7
0-yr return eriod (day)	20	25	21	26

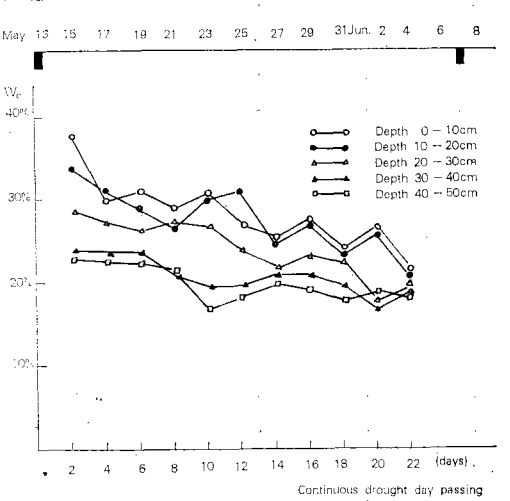

Fig. 2. Variation of water content ratio on continuous drought days passing in clayey loam soil

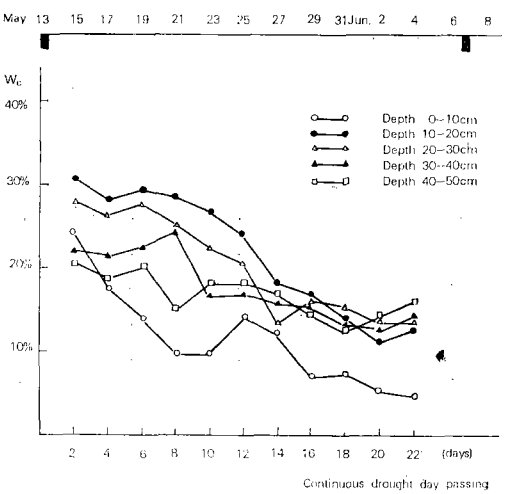

Fig. 3. Variation of water content ratio on continuous drought days passing in sandy loam soil

移秧期 最大連續旱魃日數는 6月 1日 基準으로 1978年의 80日間이 1位値이고 1965年의 27日이 2位値였다. 以上의 結果에 따라 10年頻度 連續旱魃日數를 25日로 定하였다.

나. 旱魃 經過日數에 따른 含水比變化

試驗圃의 土性別, 深度別로 旱魃 經過日數에 따른 含水比 變化를 調査하였으며 結果는 Fig. 2, 3

과 같다.

壤土에서는 深度別로 고르게 變化하는데 比하여 砂壤土에서는 比較的 고르지못 하였다. 10年頻度 連續旱魃日數인 25日 經過時의 含水比는 깊이에 關係없이 이 壤土에서 20%, 砂壤土에서 12%를 나타내고 있다.

3. 써레질用水量의 計算値와 實測値比較

試驗圃 2個所에서는 前記 計量方法에 依하여 써레질用水를 實測하고, 써레질前 乾燥狀態와 整地後 湛水狀態에서의 比重 含水比, 空隙比, 飽和度 等을 深度別로 調査하여 써레질用水量을 計算하였다. (Table-4,5) 一般農家의 논에서는 水量實測을 하지않고 計算에 의한 方法만을 擇하였으며 結果는 各各 Table-6,7,8과 같다.

Table-4. Harrow-water requirement in clayey-loam soil at the experiment paddy-field

Depth(cm)	Specific weight	Water content ratio		Porocity		Degre of Saturation		Harrow-water requirement(mm)	
		before harrowing	after leveling	before harrowing	after leveling	before harrowing	after leveling	calcul-ated	observed
Flooding								30.0	
0—10	2.57	.220	.460	.502	.555	.560	.950	24.6	
10—20	2.67	.210	.410	.468	.535	.637	.950	21.0	
20—30	2.63	.200	.240	.408	.430	.762	.837	4.9	
30—40	2.63	.180	.200	.408	.410	.686	.762	3.2	
40—50	2.55	.170	.150	.394	.390	.667	.588	—	
Total		.196		.435	.464			83.7	104.0

Table-5. Harrow-water requirement in sandy-loam soil at the experiment paddy-field

Depth(cm)	Specifc weight	Water content ratio		Porocity		Degre of Saturation		Harrow-water requirement	
		before harrowing	after leveling	before harrowing	after leveling	before harrowing	after leveling	calcul-ated	observed
Flooding								30.0	
0—10	2.63	.036	.360	.474	.500	.105	.950	42.5	
10—20	2.62	.120	.320	.415	.469	.443	.950	26.2	
20—30	2.58	.160	.250	.415	.420	.581	.890	13.3	
30—40	2.58	.140	.170	.398	.400	.547	.665	4.8	
40—50	2.61	.130	.128	.359	.360	.606	.606	—	
Total		.117		.412	.430			116.8	136.0

Table-6. Harrow-water requirement in clayey-loam soil at the ordinary farm-field

Depth(cm)	Specific weight	Water content ratio		Porocity		Degre of Saturation		Harrow-water requirement	
		before harrowing	after leveling	before harrowing	after leveling	before harrowing	after leveling	calcul-ated	observed
Flooding								30.0	
0—10	2.63	.250	.600	.545	.624	.540	.950	29.4	—
10—20	2.58	.219	.410	.517	.528	.506	.950	24.0	—
20—30	2.60	.200	.260	.456	.444	.619	.845	9.3	—
30—40	2.60	.180	.180	.390	.398	.731	.709	—	—
40—50	2.60	.180	.180	.375	.375	.780	.780	—	—
Total		.204		.456	.474			—	92.7

Table-7. Harrow-water requirement in loamy soil at the ordinary farm-field

Depth(cm)	Specific weight	Water content ratio		Porocity		Degre of Saturation		Harrow-water requirement(mm)	
		before harrowing	after leveling	before harrowing	after leveling	before harrowing	after leveling	calculated	observed
Flooding								30.0	
0—10	2.67	.126	.490	.441	.579	.426	.950	36.2	—
10—20	2.66	.143	.310	.438	.465	.488	.950	22.8	—
20—30	2.58	.185	.240	.422	.429	.654	.826	7.8	—
30—40	2.58	.219	.230	.441	.441	.715	.751	1·6	—
40—50	2.62	.249	.250	.451	.451	.795	.795	—	—
Total		.185	.438	.473				98.4	—

Table-8. Harrow-water requirement in sandy-loam soil at the ordinary farm-field

Depth(cm)	Specific weight	Water content ratio		Porocity		Degre of Saturation		Harrow-water requirement(mm)	
		before harrowing	after leveling	before harrowing	after leveling	before harrowing	after leveling	calculated	observed
Flooding								30.0	
0—10	2.69	.100	.450	.444	.524	.336	.950	34.9	—
10—20	2.69	.140	.400	.415	.531	.530	.950	28.9	—
20—30	2.63	.170	.240	.415	.412	.629	.900	11.0	—
30—40	2.63	.180	.200	.358	.358	.845	.940	3.4	—
40—50	2.67	.190	.200	.359	.300	.906	.950	—	—
Total		.156		.398	.432			108.2	—

Table-9. Observed-calculated harrow-water requirement

Site	Soil texture	Three phase composition						Harrow-water requirement		Area (m^2)	Water supply time (min.)		Discharge (l/sec)	Water loss (mm/day)
		top-soil			sub-soil									
		air	water	solids	air	water	solids	cal.	obs.					
Experiment	—1 clayey-loam	.195	.290	.515	.113	.295	592	84mm	104mm	264	84	5.438		14
paddy-field	—2 sandy-loam	.322	.123	.555	.177	.229	.594	117	136	264	84	5.438		18
Ordinary	—1 clayey-loam	.251	.279	.469	.137	.285	.577	98	—	—	—	—		—
farm-field	—2 loamy	.238	.172	.559	.136	.296	.568	93	—	—	—	—		—
	—3 sandy-loam	.243	.187	.570	.102	.285	.613	108	—	—	—	—		—

試驗圃의 空隙率은 砂壤土에서 39%, 埴壤土에서 46%程度이었으며 耕耘과 써레질로 表土層의 空隙率은 約 6%정도 增加하였다.

試驗圃에서의 實測 써레질用水量은 埴壤土에서 04mm, 砂壤土에서 136mm였으나, 計算値는 84mm와 117mm로서 各各 24%, 16%의 誤差를 나타내고 있으며, 一般農家 논의 計算 써레질用水量은 埴壤土 93mm, 壤土 98mm, 砂壤土 108mm로서 대체로 實測値보다 計算値가 작은 傾向이었다.

綜合하면 10年頻度標準設計 써레질用水量은 埴

壤土에서 90mm, 壤土에서 110mm, 砂壤土에서 130 mm 정도가 適合할 것으로 判斷되며, 이는 이제까지의 一律的인 140mm의 써레질用水보다는 다소 작아 用水를 節約할 수 있을 것으로 여겨진다.

Ⅳ. 結 論

土性, 土壤水分狀態를 考慮하여 計算한 써레질用水量과 試驗圃場에서 實測한 써레질用水量을 比較하여 標準設計를 위한 써레질用水量의 基準을 定하기 위하여 忠南 農村振興院 試驗圃場과 隣近 一般農家의 논에서 試驗한 結果를 要約하면 다음과 같다.

1. 移秧期의 10年頻度 連續旱魃日數는 約 25日이며, 그때의 土壤含水比는 깊이에 큰差없이 埴壤土에서 20%, 砂壤土에서 12% 정도였다.

2. 標準設計를 위한 써레질用水量은 埴壤土에서 90mm, 壤土에서 110mm, 砂壤土에서 130mm를 추천한다.

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