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IMPACT OF WEATHER ON YIELD AND YIELD COMPONENTS IN SOME ELITE *HEVEA* CLONES

The influence of weather on the yield of *Hevea* is well recognised. The ultimate effect of weather parameters on yield is mediated through their effects on various yield components. The composite effect of environmental variables influences the yield of rubber more than any of the individual effect (Rao *et al.*, 1990). Moreover the variations in the meteorological parameters such as irradiance, temperature and vapour pressure deficit when exceeding a given threshold may cause stress in *Hevea*. A better understanding of the role of individual environmental factors on yield through their influence on yield components would be useful to evaluate the performance of different *Hevea* clones.

Observations were made in a clone evaluation trial laid out at the Rubber Research Institute of India Farm, Kottayam (Latitude 9° 32'N, Longitude 76° 36'E and altitude 73m above msl). Four hybrid *Hevea* clones (14/82, 17/82, 22/82 and 30/82) in an eleven year old plantation were selected for this study. These clones were developed from the crosses between RRII 105 and RRIC 100. The hybrids were comparable in yield to RRII 105 (Licy, 1997). The trees were maintained under uniform cultural practices and the same system of tapping. Six trees of uniform girth were selected from each clone for recording observations. Yield (g/tree/tap) and the yield components initial flow (IF) rate (ml/cm/min), dry rubber content (DRC) (% W/v) and plugging index (PI) were measured using standard methods (Milford *et al.*, 1969). Observations were made at weekly intervals from January to July 1996.

The soil moisture and weather data were also recorded on the days on which the yield components were recorded. Soil moisture was determined gravimetrically from samples collected from depths of 0 to 15 and 15 to 30 cm on the previous and the same day of the yield data analysis. Weather data like maximum and minimum temperature, relative humidity, wind speed, soil temperature, sunshine hours and rainfall from the RRII agrometeorological observatory were collected. Rainfall was recorded only for dry months 'extending from January to May.

Path coefficient analysis (Williams *et al.*, 1990) was used to understand the direct and indirect effects of environmental factors on yield through yield components. The correlation between the meteorological factors and yield were worked out. The data on the path coefficient analysis for each *Hevea* clone are shown separately in Tables 1 to 5. Results indicated that the direct negative influence of maximum temperature is high for the hybrid 14/82. Wind speed and soil temperature had significant negative association influencing the yield indirectly. Sunshine hours positively influenced the yield, both directly and indirectly through maximum temperature. Cumulative rainfall had significant positive influence on the yield through yield components. The results indicate that the clone 14/82 is very sensitive to weather in general and to temperature in particular.

Table 1. **Direct and indirect effects of the meteorological parameters on yield and its components for clone 14/82**

Meteorological parameter	Direct effects	Indirect effects											
		IF	DRC	PI	ST(M)	WS (pd)	RH(E)	Max T (pd)	Min T (same day)	Pan (pd)	Min T (pd)	Sun shine	Total correlation
ST(M)	-0.1272	-0.1073	-0.05539	-0.3078	—	-0.0106	0.0439	-0.3833	0.1832	0.07560	-0.04696	0.1455	-0.5943
WS (pd)	-0.02119	-0.0664	-0.03837	-0.2811	0.0675	—	0.0675	-0.4144	0.1338	0.05166	0.0224	0.1855	-0.4244
RH(E)	-0.2193	-0.0357	-0.02156	-0.0900	0.0255	0.00652	—	0.4399	-0.0196	-0.620	0.0147	-0.3175	-0.255
Max T (pd)	-0.6046	-0.0345	-0.0168	-0.1156	-0.0815	-0.145	0.1596	—	0.1378	0.0857	-0.0327	0.3430	-0.1743
Min T(same day)	0.2339	-0.0851	-0.0570	-0.3875	-0.0997	-0.0121	0.0184	-0.3556	—	0.0638	-0.468	0.1329	-0.7244
Pan(E) (pd)	0.1303	-0.0218	-0.0319	-0.23211	-0.0738	-0.00839	0.1043	-0.3975	0.1144	—	-0.0334	0.2064	-0.2435
Min T (pd)	-0.05865	-0.0723	-0.0395	-0.2556	-0.1019	-0.00811	0.0552	-0.3311	0.1866	0.0743	—	0.1348	-0.13095
Sunshine	0.4486	0.0316	0.00376	0.02966	-0.04167	-0.00884	0.1565	0.4564	0.0699	0.0605	-0.0177	—	0.2639

ST(M) : Soil temperature morning; WS(pd) : Wind speed previous day; RH(E) : Relative humidity evening; Max T (pd) : Maximum temperature previous day; Min T (pd) : Minimum temperature (previous day)

Table 2. **Direct and indirect effects of the meteorological parameters on yield and its components for clone 17/82**

Meteorological parameter	Direct effects	Indirect effects											
		IF	DRC	PI	ST(M)	WS (pd)	RH(E)	Max T (pd)	Min T (same day)	Pan (pd)	Min T (pd)	Sun shine	Total correlation
ST(M)	-0.0847	-0.0182	0.1450	-0.4903	—	0.00096	0.03120	-0.1821	-0.1038	0.0227	0.01948	0.04175	-0.0170
WS (pd)	0.000135	0.01389	0.1635	-0.4832	-0.04245	—	0.04803	-0.1948	-0.0758	0.0155	0.000931	0.05319	-0.4726
RH(E)	-0.1560	0.02438	0.01766	-0.00841	0.01696	-0.00041	—	0.2068	0.0111	-0.0186	-0.00612	-0.0910	-0.00332
Max T(pd)	-0.2842	-0.0257	-0.0895	-0.3227	-0.0543	0.000093	0.1135	—	-0.07703	0.02575	0.0135	0.09838	-0.424
Min T (same day)	-0.1325	-0.0622	0.0945	-0.5112	-0.663	0.000077	0.01311	-0.1672	—	0.01916	0.0194	0.0381	-0.75505
Pan(E) (pd)	0.0392	0.0705	0.1950	-0.3766	-0.0491	0.0000540	0.0747	-0.1869	-0.0648	—	0.01387	0.05919	-0.2248
Min T (pd)	0.2433	-0.04277	0.09195	-0.3903	-0.0678	0.00085	0.0393	-0.1584	-0.1057	0.02233	—	0.0387	-0.5483
Sunshine	0.1275	-0.0732	-0.0469	-0.5812	-0.0277	0.00005	0.111	-0.2192	-0.0395	0.01817	0.00737	—	-0.2005

ST(M) : Soil temperature morning; WS(pd) : Wind speed previous day; RH(E) : Relative humidity evening; Max T (pd) : Maximum temperature previous day; Min T (pd) : Minimum temperature (previous day)

Table 3. **Direct and indirect effects of the meteorological parameters on yield and its components for clone 22/82**

Meteorological parameter	Direct effects	Indirect effects											
		IF	DRC	PI	ST(M)	WS (pd)	RH(E)	Max T (pd)	Min T (same day)	Pan (pd)	Min T (pd)	Sun shine	Total correlation
ST(M)	-0.02812	-0.11073	0.07282	-0.43233	—	0.03622	0.02063	-0.05724	-0.04173	-0.06569	0.02058	0.04850	-0.5370
WS (pd)	0.0723	0.03800	0.00202	-0.4420	-0.01410	—	0.0317	-0.06126	-0.03047	-0.04490	-0.00984	0.06179	-0.3848
RH(E)	-0.10301	-0.16942	0.09299	-0.20897	0.00563	-0.02234	—	0.00501	0.00447	0.05389	-0.00647	-0.10577	-0.3939
Max T(pd)	-0.08936	0.08857	-0.02706	-0.18387	-0.01802	0.04953	0.07494	—	-0.03133	-0.08449	0.01432	0.1143	-0.0822
Min T (same)	-0.05326	-0.09044	0.09831	-0.5354	-0.02204	0.04133	0.00865	-0.05256	—	-0.05544	0.02051	0.04426	-0.5960
Pan(E) (pd)	-0.1132	0.0793	0.005621	-0.2909	-0.01631	0.02863	0.049014	-0.05876	-0.02607	—	0.01465	0.08876	-0.2592
Min T (pd)	0.02569	-0.06482	0.06406	-0.35011	-0.02252	0.02767	0.02595	-0.04981	-0.04251	-0.0646	—	0.04491	-0.4060
Sunshine	0.14814	0.11823	-0.04764	0.1023	-0.009200	0.03014	0.07355	-0.06893	-0.0159	-0.05258	0.007791	—	0.2858

ST(M) : Soil temperature morning; WS(pd) : Wind speed previous day; RH(E) : Relative humidity evening; Max T (pd) : Maximum temperature previous day; Min T (pd) : Minimum temperature (previous day)

Table 4. **Direct and indirect effects of the meteorological parameters on yield and its components for clone 30/82**

Meteorological parameter	Direct effects	Indirect effects											
		IF	DRC	PI	ST(M)	WS (pd)	RH(E)	Max T (pd)	Min T (same day)	Pan (pd)	Min T (pd)	Sun shine	Total correlation
ST(M)	-0.1272	-0.1073	-0.05539	-0.3078	—	-0.0106	0.0439	-0.3833	0.1832	0.07560	-0.04696	0.1455	-0.5943
WS (pd)	0.1309	0.19815	0.09809	-0.14459	-0.03739	—	0.03053	0.03556	-0.11505	-0.05281	0.05281	0.09665	0.2872
RH(E)	-0.099241	0.03203	0.1119	-0.19353	0.01494	-0.04027	—	-0.03774	0.01687	0.07013	-0.03474	-0.1655	-0.3251
Max T(pd)	0.05188	0.09225	-0.02314	-0.00943	-0.04779	0.08971	0.07219	—	-0.11832	-0.09692	0.07688	0.17876	0.26807
Min T (same)	-0.20114	0.11371	0.09705	-0.24405	-0.05844	0.07486	0.008326	0.03052	—	-0.07213	0.11007	0.06924	-0.0819
Pan (E) (pd)	-0.14739	0.15958	0.08142	-0.09156	-0.04326	0.05187	0.04722	0.03412	-0.09844	—	0.07866	0.10757	0.17979
Min T (pd)	0.13792	0.1275	0.08428	-0.15289	-0.05973	0.05011	0.02499	0.02892	-0.16052	-0.08405	—	0.07026	0.06679
Sunshine	0.23173	0.02774	-0.13736	0.14818	-0.02442	0.05458	0.07086	0.04002	-0.06009	-0.06842	0.04182	—	0.3246

ST(M) : Soil temperature morning; WS(pd) : Wind speed previous day; RH(E) : Relative humidity evening; Max T (pd) : Maximum temperature previous day; Min T (pd) : Minimum temperature (previous day)

Table 5. **Path analysis using rainfall from January to May**

Clone	Cumulative effect of rainfall upto 3 months			
	Direct effect	Indirect effect thourgh yield components		
		IF	DRC	PI
14/82	0.2219	0.2065	0.0142	0.3562
17/82	0.0675	-0.0420	-0.2468	0.7384
22/82	0.1022	0.0522	-0.0419	-0.0753
30/82	-0.1002	-0.3130	-0.2811	0.5378

For the clone 17/82, indirect effects of meteorological parameters were more relevant as compared to that of direct effects. Direct association of the environmental parameters was significantly low except that of maximum temperature. Indirect negative influence of soil temperature and wind speed through PI were high, even though their direct effects were negligible. While sunshine has only low direct influence, rainfall indirectly influenced yield through PI.

The direct influence of minimum temperature on yield was high and the influence of other meteorological variables was practically nil for the clone 30/82. On the whole, the clone 30/82 can be regarded as a hardy clone next to 22/82.

There was no direct and indirect influence of meteorological parameters on the clone 22/82. In the case of other *Hevea* clones studied there was either the direct or the indirect influence. Hence 22/82 can be regarded as a *Hevea* clone which is not influenced by the environment. Other clones were found to be influenced by various environmental factors. The percentage reduction in yield in summer was minimum for 22/82 and the CV of yield in two seasons was also minimum (Table 6).

On the whole, the result of the path coefficient analysis indicated that temperature is the most important single climatic factor directly influencing the day-to-day variations in yield of *Hevea*. On the contrary, indirect influence through yield components is more for soil temperature (morning) and wind speed (previous day). In the case of rainfall, indirect influence through PI was more pronounced. Results are in agreement with the data of Milford *et al.* (1969). Saraswathyamma and Sethuraj (1975) reported that though a strong clonal character, plugging index is easily influenced by environmental factors and noted a relationship between variations in yield and initial flow rate. Similar positive correlations with latex yield and initial flow

Table 6. **Stability of yield over seasons**

Clone	Mean summer yield (g/tree/tap)	Annual mean yield (g/tree/tap)	Reduction of mean summer yield from annual mean yield (%)	CV of yield between two seasons (peak and lean)
14/82	67.53	96.31	29.88	38
17/82	35.08	70.69	50.37	63
22/82	59.74	75.88	21.27	29
30/82	51.53	82.99	37.91	45

rate were reported earlier by several investigators (Sethuraj *et al.*, 1974; Yeang and Paranjothy, 1982; Mydin *et al.*, 1992). The significant influence of morning soil temperature on yield (Sethuraj, 1977) was observed to be through its effect on the PI.

The indirect influence of wind speed through other environmental parameters was also evident from the path coefficient analysis. The influence of pan evaporation and RH on yield, on the whole, was not direct but through other factors and therefore did not show significant association as reported earlier on the basis of simple correlation analysis (Sailajadevi *et al.*, 1998). A longer period of sunshine and adequate amount of summer rainfall have moderate positive effect on yield. Summer rainfall also contributed to the yield indirectly through PI. The residual value 0.21 obtained shows that unaccounted variability other than the environmental parameters was negligible.

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