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LIGHT TRANSMISSION, HEAT RETENTION AND MECHANICAL STRENGTH PROPERTY EVALUATION OF FILM PLASTIC CLADDING MATERIALS AVAILABLE IN NEW ZEALAND

A thesis
submitted in partial fulfilment
of the requirement for the degree
of

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in

Horticultural Engineering

at
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Philip Reeve Heatley
1990

ABSTRACT

This study was conducted on film plastic cladding materials commercially available from distributors in New Zealand. Laboratory scale experiments were applied to test and evaluate the optical, thermal and mechanical properties of each of the film plastics.

Optical properties tested included PAR transmissivity and the degree of UV radiation transmission through the film plastics. The radiant heat retention property of each product was evaluated through thermal transmission tests. Mechanical property evaluation required application of tear resistance, tensile strength, impact resistance and water vapour permeance tests.

It was recognised that an evaluation and comparison of each of the film plastics as a full functional cladding material would be useful to both greenhouse designers and growers. Consequently, each of the products were ranked according to specific optical, thermal or mechanical properties. Upon combining these rankings, recommendations on the best film plastic cladding material, for specific applications, were supported and presented in tabular form.

Experimental data and analysis consistently indicated that a PVC film plastic, a double layer co-extruded film plastic, woven PE and reinforced EVA film materials and a specific EVA type film plastic, available in New Zealand at the time of this research, will perform particularly well as greenhouse cladding materials. Purchasing evaluation, of any of the film plastics tested in this study, should further involve the cost and the susceptibility of each product to UV degradation as selection criteria.

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LIST OF SYMBOLS AND ABBREVIATIONS

λ	=	wavelength
α	=	absorptivity
A	=	surface area
°C	=	degrees Celsius
C	=	cost; radiation constant
CO_2	=	carbon dioxide
cos	=	cosine
Σ	=	sum
ϵ	=	emissivity
E	=	emissive power
EVA	=	ethylene vinyl acetate
FRP	=	fibre reinforced plastic
g	=	gram
Gm	=	Gigametre
h	=	convective heat transfer coefficient
HALS	=	hindered amine light stabilizer
I	=	intensity
IR	=	infra-red
IREVA	=	infra-red ethylene vinyl acetate
IRPE	=	infra-red polyethylene
IR	=	impact resistance
J	=	joule
k	=	thermal conductivity; extinction coefficient
kg	=	kilogram
l	=	path length

m = metre

mm = millimetre

MS = combined mechanical strength

MW = Megawatt

n = refractive indicae

nm = nanometre

N = newton

θ = degree angle

σ = Stephan Boltzmann constant

ρ = reflectivity

Pa = Pascal

PAR = photosynthetically active radiation

PE = polyethylene

PEST = polyester

PETh = thermal polyethylene

PVF = polyvinyl fluoride

PT = PAR transmissivity

Q = rate of heat flow; radiation

r = component of reflection

s = second

sin = sine

τ = transmissivity

T = temperature

tan = tangent

TR = tear resistance

TS = tensile strength

TT = thermal transmissivity

μm = micrometre

um = micrometre

UV = ultra-violet radiation

UVB = ultra-violet 'B' radiation

UVC = ultra-violet 'C' radiation

VA = vinyl acetate

WVP = water vapour permeance

WVT = water vapour transmission

x = distance

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