Model II:

The second thesis was written by JUN CHEN, KOMI MESSAN, MARISABEL RODRIGUEZ MESSAN, GLORIA DEGRANDI-HOFFMAN, DINGYONG BAI, AND YUN KANG, in June, 2020, aim to model honeybee population dynamics: stage structure and seasonality.

(2.1)

(2.4)

B(t) is the population of brood bees in a given hive at time t

H(t) is the population of adult bees in a given hive at time t

*K = the population of adult bee needed for half of the maximum brood survival rate*

*a = the regulation effects from brood population B*

r = *Daily egg-laying rate of queen (Estimated)*

a = *the regulation effects of brood (Estimated)*

*(Estimated)*

= *Death rate of the adult bees (Estimated)*

*γ = The length of seasonality (Estimated)*

*√K = Colony size at which brood survival rate is half maximum (Estimated)*

*τ= Time spent in brood (Khoury 2013)*

*Ψ= the time of the maximum laying rate (Harris 1980)*

*⇒* (3.1)

*-*

*Which gives*

*And*

*0=*

*Sloving the equation (3.4) gives*

*(3.4)*

*（3.5）*

*(3.6)*

3.7,3.8 is the characteristic equation of the interior equilibrium (B\*,H\*) of model (2.4)

3.7:(λ,τ) = (*− − λ*)(*− −- λ*) - (+*λ*)*τ*

3.8 = (+)*λ +（λ* +  *- ）*

*+*