SEIR Model of Brown rust on Wheat

Correction of practical work

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Equations of the **simplified** SEIR model.

Definition of the model structure as difference equations.

XVAC(day+1) = XVAC(day)-rocc

XLAT(day + 1) = XLAT(day) +rocc - rapp

XINF(day+1) = XINF(day) + rapp - rrem

XCTR(day+1) = XCTR(day) + rrem

Definition of rates

Note that you need to add rules to avoid having negative state variables and the order of calculation in important.

rocc: rate of occupation : nb of sites Vacant=>Latent

rocc = min(cofr*dmfr*XINF(day), XVAC(day))

with $cofr = \max(\frac{XVAC(day)}{SITE0} ; 0)$

rapp: rate of apparition : nb of sites Latent=>Infectant

rapp= min(XLAT[day]*1/nlpd, XLAT[day]+rocc)

$$rapp = \min\left(\frac{XLAT(day)}{nlpd}, XLAT(day) + rocc\right)$$

rrem: rate of removal : nb of sites Infectant=>removed

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$$rrem = \min\left(\frac{XINF(day)}{nipd}, XINF(day) + rapp\right)$$

Additional auxillary variables of interest are :

XTO1 = XLAT+XINF+XCTR

XSEV = XINF+XCTR

$$\text{severity} = \frac{\text{XSEV}}{\text{XLAT} + \text{XINF} + \text{XCTR} + \text{XVAC}}$$

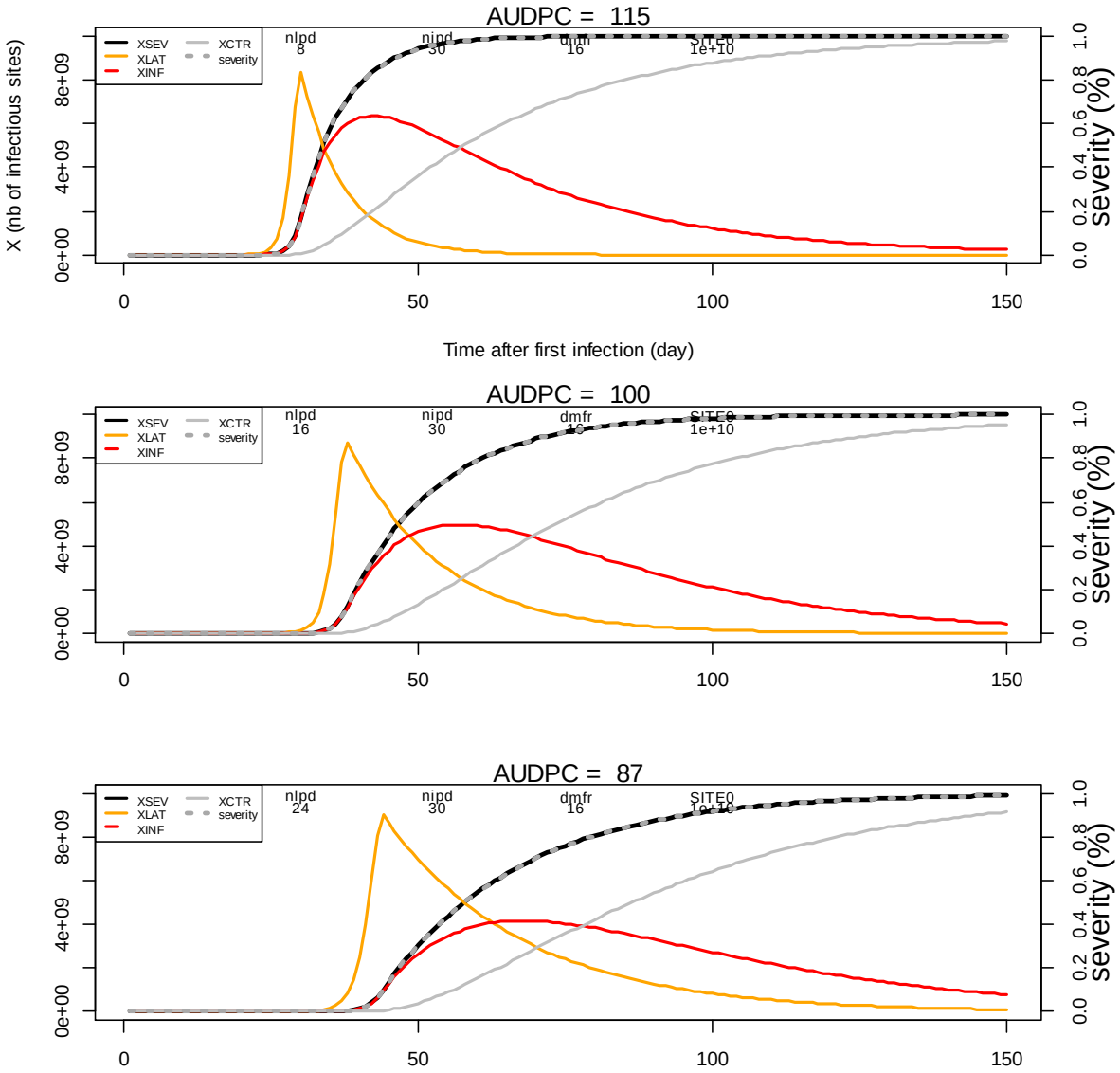
First Simulations

Name	**Value**	**Description**	**Unit**
nlpd	8	Duration for latency period	day
nipd	30	Duration for infectious period	day
dmfr	16	Coefficient of multiplication	-
XVAC0	1e+10	Initial number of vacant sites	sites
XLAT0	1	Initial number of latent sites (first contamination	sites

correction

You may obtain such graph

for nipd = 8 or 16 or 24



Function : correction (please do not look at it too early)

```
zakoks.simple.model = function (nlpd=4,nipd=1,dmfr=16,SITE0 = 1e+10,weather=NULL, sdate = 1, ldate = 140){
   XVAC <- rep(NA, ldate)
   # Latent
   XLAT <- rep(NA, ldate)
   # Infectious
   XINF <- rep(NA, ldate)
   XCTR <- rep(NA, ldate)

   # initialization of state variable
   XVAC[sdate] <- SITE0-1
   XLAT[sdate] <- 1
   XINF[sdate] <- 0
   XCTR[sdate] <- 0

   for (day in sdate:(ldate - 1)) {
      #if (day==inf_start){BOXI[day,"XINF"]=1, BOXI[sdate,"sumTEEQ"] = 1}
      # correction factor : feed back from total occupied sites
      cofr<-max(XVAC[day]/SITE0, 0)
      # rocc: rate of occupation : nb of sites Vacant=>Latent
      rocc = min(cofr * dmfr * XINF[day], XVAC[day])

      # rapp: rate of apparition : nb of sites Latent=>Infectant
      rapp= min(XLAT[day] * 1/nlpd, XLAT[day]+rocc)

      # rrem: rate of removal : nb of sites Infectant=>removed
      rrem=min(XINF[day] * 1/nipd, XINF[day]+rapp)


      XVAC[day+1] <- XVAC[day]-rocc
      XLAT[day+1] <-XLAT[day] +rocc - rapp
      XINF[day+1] <- XINF[day] + rapp - rrem
      XCTR[day+1] <- XCTR[day] + rrem
   }

   XTO1 = XLAT+XINF+XCTR
   XSEV = XINF+XCTR
   severity=XSEV/(XLAT+XINF+XCTR+XVAC)
   return(list(sim=data.frame(day = sdate:ldate, XVAC = XVAC[sdate:ldate], XLAT = XLAT[sdate:ldate], XINF = XINF[sdate:ldate],XCTR =
XCTR[sdate:ldate],XTO1=XTO1[sdate:ldate],  XSEV= XSEV[sdate:ldate], severity=severity[sdate:ldate]), param=c(nlpd=nlpd,nipd=nipd,dmfr=dmfr,SITE0 = SITE0)))
}
```