RDecisionTree

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LIBRARIES

```
library(rpart)   ## FOR Decision Trees
library(rattle)  ## FOR Decision Tree Vis
```

```
## Loading required package: tibble
```

```
## Loading required package: bitops
```

```
## Rattle: A free graphical interface for data science with R.
## Version 5.4.0 Copyright (c) 2006-2020 Togaware Pty Ltd.
## Type 'rattle()' to shake, rattle, and roll your data.
```

```
library(rpart.plot)
library(RColorBrewer)
library(Cairo)
library(network)
```

```
##
## 'network' 1.17.1 (2021-06-12), part of the Statnet Project
## * 'news(package="network")' for changes since last version
## * 'citation("network")' for citation information
## * 'https://statnet.org' for help, support, and other information
```

```
library(ggplot2)
library(ggtext)
library(readxl)
library(wordcloud)
library(RColorBrewer)
library(slam)
library(quanteda)
```

```
## Package version: 3.0.0
## Unicode version: 10.0
## ICU version: 61.1
```

```
## Parallel computing: 16 of 16 threads used.
```

```
## See https://quanteda.io for tutorials and examples.
```

```
library(proxy)
```

```
##
## Attaching package: 'proxy'

## The following objects are masked from 'package:stats':
##
##     as.dist, dist

## The following object is masked from 'package:base':
##
##     as.matrix
```

```
library(stringr)
library(textmineR)
```

```
## Loading required package: Matrix

##
## Attaching package: 'textmineR'

## The following object is masked from 'package:Matrix':
##
##     update

## The following object is masked from 'package:stats':
##
##     update
```

```
library(igraph)
```

```
##
## Attaching package: 'igraph'

## The following objects are masked from 'package:network':
##
##     %c%, %s%, add.edges, add.vertices, delete.edges, delete.vertices,
##     get.edge.attribute, get.edges, get.vertex.attribute, is.bipartite,
##     is.directed, list.edge.attributes, list.vertex.attributes,
##     set.edge.attribute, set.vertex.attribute

## The following object is masked from 'package:tibble':
##
##     as_data_frame

## The following objects are masked from 'package:stats':
##
##     decompose, spectrum
```

```
## The following object is masked from 'package:base':
##
##     union
```

```
library(caret)
```

```
## Loading required package: lattice
```

```
library(ggthemes)
```

```
MyPath="Crop_recommendation.csv"

RecordDF_A<-read.csv(MyPath, stringsAsFactors=TRUE)
head(RecordDF_A)
```

```
##    N  P  K temperature humidity       ph rainfall label
## 1 90 42 43    20.87974 82.00274 6.502985 202.9355  rice
## 2 85 58 41    21.77046 80.31964 7.038096 226.6555  rice
## 3 60 55 44    23.00446 82.32076 7.840207 263.9642  rice
## 4 74 35 40    26.49110 80.15836 6.980401 242.8640  rice
## 5 78 42 42    20.13017 81.60487 7.628473 262.7173  rice
## 6 69 37 42    23.05805 83.37012 7.073454 251.0550  rice
```

Split it into a TRAINING and a TESTING set, remove the label and save it.

```
str(RecordDF_A)
```

```
## 'data.frame':    2200 obs. of  8 variables:
##  $ N          : int  90 85 60 74 78 69 69 94 89 68 ...
##  $ P          : int  42 58 55 35 42 37 55 53 54 58 ...
##  $ K          : int  43 41 44 40 42 42 38 40 38 38 ...
##  $ temperature: num  20.9 21.8 23 26.5 20.1 ...
##  $ humidity   : num  82 80.3 82.3 80.2 81.6 ...
##  $ ph         : num  6.5 7.04 7.84 6.98 7.63 ...
##  $ rainfall   : num  203 227 264 243 263 ...
##  $ label      : Factor w/ 22 levels "apple","banana",..: 21 21 21 21 21 21 21 21 21 21 ...
```

```
head(RecordDF_A)
```

```
##    N  P  K temperature humidity       ph rainfall label
## 1 90 42 43    20.87974 82.00274 6.502985 202.9355  rice
## 2 85 58 41    21.77046 80.31964 7.038096 226.6555  rice
## 3 60 55 44    23.00446 82.32076 7.840207 263.9642  rice
## 4 74 35 40    26.49110 80.15836 6.980401 242.8640  rice
## 5 78 42 42    20.13017 81.60487 7.628473 262.7173  rice
## 6 69 37 42    23.05805 83.37012 7.073454 251.0550  rice
```

Split into TRAIN and TEST data

Use random sampling without replacement.

```
(DataSize=nrow(RecordDF_A))
```

```
## [1] 2200
```

```
(TrainingSet_Size<-floor(DataSize*(3/4))) ## Size for training set
```

```
## [1] 1650
```

```
(TestSet_Size <- DataSize - TrainingSet_Size) ## Size for testing set
```

```
## [1] 550
```

Random sample without replacement

```
set.seed(1234)
```

The sample of row numbers

```
MyTrainSample <- sample(DataSize,
                        TrainingSet_Size,replace=FALSE)

MyTrainingSET <- RecordDF_A[MyTrainSample,]
table(MyTrainingSET$label)
```

```
##
##       apple      banana   blackgram    chickpea     coconut      coffee
##          68          79          79          72          74          76
##      cotton      grapes        jute kidneybeans      lentil       maize
##          72          69          83          76          78          74
##       mango   mothbeans    mungbean   muskmelon      orange      papaya
##          73          83          80          72          78          65
##  pigeonpeas pomegranate        rice  watermelon
##          75          75          73          76
```

```
MyTestSET <- RecordDF_A[-MyTrainSample,]
table(MyTestSET$label)
```

```
##
##       apple      banana   blackgram    chickpea     coconut      coffee
##          32          21          21          28          26          24
##      cotton      grapes        jute kidneybeans      lentil       maize
```

```
##          28          31          17          24          22          26
##       mango   mothbeans    mungbean   muskmelon      orange      papaya
##          27          17          20          28          22          35
##  pigeonpeas pomegranate        rice  watermelon
##          25          25          27          24
```

Training and Testing datasets are balanced

REMOVE THE LABELS from the test set

```
TestKnownLabels <- MyTestSET$label
MyTestSET <- MyTestSET[ , -which(names(MyTestSET) %in% c("label"))]
```

Decision Trees

First - train the model with training data

Second - test the model - get predictions - compare to the known labels.

Create decision tree

```
DT <- rpart(MyTrainingSET$label ~ ., data = MyTrainingSET, method="class")
summary(DT)
```

```
## Call:
## rpart(formula = MyTrainingSET$label ~ ., data = MyTrainingSET,
##     method = "class")
##   n= 1650
##
##            CP nsplit  rel error     xerror        xstd
## 1  0.05073389      0 1.00000000 1.02042119 0.004486404
## 2  0.05041481      2 0.89853223 0.96490108 0.007176364
## 3  0.04850032      5 0.74728781 0.85386088 0.010150662
## 4  0.04786216      7 0.65028717 0.68985322 0.012321342
## 5  0.04722399      9 0.55456286 0.68347160 0.012371520
## 6  0.04658583     10 0.50733886 0.61518826 0.012775844
## 7  0.04594767     11 0.46075303 0.53988513 0.012956934
## 8  0.04499043     13 0.36885769 0.49457562 0.012937308
## 9  0.04467135     15 0.27887683 0.38289726 0.012469795
## 10 0.04403318     16 0.23420549 0.29100191 0.011592407
## 11 0.04339502     17 0.19017230 0.22782387 0.010673882
## 12 0.03765156     18 0.14677728 0.14486280 0.008929033
## 13 0.03701340     19 0.10912572 0.12571793 0.008405334
## 14 0.01021059     21 0.03509892 0.05232929 0.005633379
## 15 0.01000000     22 0.02488832 0.05105297 0.005567803
##
## Variable importance
```

```
##    rainfall           K    humidity           N temperature           P
##          21          18          17          12          12          11
##          ph
##           8
##
## Node number 1: 1650 observations,    complexity param=0.05073389
##   predicted class=jute         expected loss=0.949697  P(node) =1
##     class counts:    68    79    79    72    74    76    72    69    83    76    78    74    73    83
##    probabilities: 0.041 0.048 0.048 0.044 0.045 0.046 0.044 0.042 0.050 0.046 0.047 0.045 0.044 0.050
##   left son=2 (148 obs) right son=3 (1502 obs)
##   Primary splits:
##       humidity < 27.66972 to the left,  improve=74.17282, (0 missing)
##       K        < 25.5     to the right, improve=73.03883, (0 missing)
##       N        < 59.5     to the left,  improve=72.68730, (0 missing)
##       rainfall < 30.39348 to the right, improve=72.14872, (0 missing)
##       P        < 107.5    to the right, improve=69.11537, (0 missing)
##
## Node number 2: 148 observations,    complexity param=0.04594767
##   predicted class=kidneybeans  expected loss=0.4864865  P(node) =0.08969697
##     class counts:     0     0     0    72     0     0     0     0     0    76     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.486 0.000 0.000 0.000 0.000 0.000 0.514 0.000 0.000 0.000 0.000
##   left son=4 (72 obs) right son=5 (76 obs)
##   Primary splits:
##       K        < 50       to the right, improve=73.94595, (0 missing)
##       ph       < 5.982653 to the right, improve=70.05405, (0 missing)
##       humidity < 19.86542 to the left,  improve=42.64160, (0 missing)
##       rainfall < 94.9401  to the left,  improve=39.08279, (0 missing)
##       N        < 27.5     to the right, improve=25.64938, (0 missing)
##   Surrogate splits:
##       ph          < 5.982653 to the right, agree=0.986, adj=0.972, (0 split)
##       humidity    < 19.86542 to the left,  agree=0.865, adj=0.722, (0 split)
##       rainfall    < 94.9401  to the left,  agree=0.845, adj=0.681, (0 split)
##       N           < 27.5     to the right, agree=0.791, adj=0.569, (0 split)
##       temperature < 20.91114 to the left,  agree=0.682, adj=0.347, (0 split)
##
## Node number 3: 1502 observations,    complexity param=0.05073389
##   predicted class=jute         expected loss=0.9447403  P(node) =0.910303
##     class counts:    68    79    79     0    74    76    72    69    83     0    78    74    73    83
##    probabilities: 0.045 0.053 0.053 0.000 0.049 0.051 0.048 0.046 0.055 0.000 0.052 0.049 0.049 0.055
##   left son=6 (522 obs) right son=7 (980 obs)
##   Primary splits:
##       humidity < 70.81499 to the left,  improve=73.44901, (0 missing)
##       N        < 59.5     to the right, improve=72.96276, (0 missing)
##       K        < 25.5     to the right, improve=72.93519, (0 missing)
##       rainfall < 30.39348 to the right, improve=72.17009, (0 missing)
##       P        < 107.5    to the right, improve=69.19362, (0 missing)
##   Surrogate splits:
##       K           < 34.5     to the left,  agree=0.783, adj=0.375, (0 split)
##       ph          < 5.49996  to the left,  agree=0.698, adj=0.132, (0 split)
##       temperature < 29.94382 to the right, agree=0.694, adj=0.121, (0 split)
##
## Node number 4: 72 observations
##   predicted class=chickpea     expected loss=0  P(node) =0.04363636
##     class counts:     0     0     0    72     0     0     0     0     0     0     0     0     0     0
```

```
##    probabilities: 0.000 0.000 0.000 1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 5: 76 observations
##   predicted class=kidneybeans  expected loss=0  P(node) =0.04606061
##     class counts:     0     0     0     0     0     0     0     0     0    76     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000 0.000
##
## Node number 6: 522 observations,    complexity param=0.04850032
##   predicted class=mothbeans    expected loss=0.8409962  P(node) =0.3163636
##     class counts:     0     0    79     0     0    76     0     0     0     0    78    58    73    83
##    probabilities: 0.000 0.000 0.151 0.000 0.000 0.146 0.000 0.000 0.000 0.000 0.149 0.111 0.140 0.159
##   left son=12 (135 obs) right son=13 (387 obs)
##   Primary splits:
##       N        < 59.5     to the right, improve=69.95623, (0 missing)
##       rainfall < 88.73199 to the left,  improve=69.34965, (0 missing)
##       K        < 25.5     to the right, improve=66.73531, (0 missing)
##       P        < 40.5     to the left,  improve=60.70013, (0 missing)
##       humidity < 60.01602 to the right, improve=46.89821, (0 missing)
##   Surrogate splits:
##       rainfall    < 101.8468 to the right, agree=0.787, adj=0.178, (0 split)
##       K           < 26.5     to the right, agree=0.761, adj=0.074, (0 split)
##       temperature < 25.08603 to the left,  agree=0.753, adj=0.044, (0 split)
##       P           < 15.5     to the left,  agree=0.747, adj=0.022, (0 split)
##       humidity    < 69.89581 to the right, agree=0.747, adj=0.022, (0 split)
##
## Node number 7: 980 observations,    complexity param=0.05041481
##   predicted class=jute         expected loss=0.9153061  P(node) =0.5939394
##     class counts:    68    79     0     0    74     0    72    69    83     0     0    16     0     0
##    probabilities: 0.069 0.081 0.000 0.000 0.076 0.000 0.073 0.070 0.085 0.000 0.000 0.016 0.000 0.000
##   left son=14 (605 obs) right son=15 (375 obs)
##   Primary splits:
##       P        < 32.5     to the right, improve=74.10570, (0 missing)
##       rainfall < 60.33439 to the right, improve=73.13643, (0 missing)
##       K        < 25.5     to the right, improve=71.59715, (0 missing)
##       N        < 59.5     to the left,  improve=70.19522, (0 missing)
##       humidity < 90.00119 to the right, improve=67.05884, (0 missing)
##   Surrogate splits:
##       humidity    < 87.12095 to the left,  agree=0.766, adj=0.389, (0 split)
##       rainfall    < 32.99362 to the right, agree=0.691, adj=0.192, (0 split)
##       K           < 14.5     to the right, agree=0.690, adj=0.189, (0 split)
##       N           < 18.5     to the right, agree=0.646, adj=0.075, (0 split)
##       temperature < 19.88038 to the right, agree=0.632, adj=0.037, (0 split)
##
## Node number 12: 135 observations,    complexity param=0.0370134
##   predicted class=coffee       expected loss=0.437037  P(node) =0.08181818
##     class counts:     0     0     1     0     0    76     0     0     0     0     0    58     0     0
##    probabilities: 0.000 0.000 0.007 0.000 0.000 0.563 0.000 0.000 0.000 0.000 0.000 0.430 0.000 0.000
##   left son=24 (76 obs) right son=25 (59 obs)
##   Primary splits:
##       rainfall    < 112.454  to the right, improve=65.32279, (0 missing)
##       K           < 25.5     to the right, improve=56.25764, (0 missing)
##       P           < 40.5     to the left,  improve=41.68889, (0 missing)
##       N           < 79.5     to the right, improve=32.43430, (0 missing)
##       temperature < 23.03995 to the right, improve=26.93937, (0 missing)
```

```
##   Surrogate splits:
##       K           < 25.5     to the right, agree=0.963, adj=0.915, (0 split)
##       P           < 40.5     to the left,  agree=0.896, adj=0.763, (0 split)
##       N           < 79.5     to the right, agree=0.844, adj=0.644, (0 split)
##       temperature < 23.03995 to the right, agree=0.800, adj=0.542, (0 split)
##       humidity    < 58.63808 to the left,  agree=0.719, adj=0.356, (0 split)
##
## Node number 13: 387 observations,    complexity param=0.04786216
##   predicted class=mothbeans    expected loss=0.7855297  P(node) =0.2345455
##     class counts:     0     0    78     0     0     0     0     0     0     0    78     0    73    83
##    probabilities: 0.000 0.000 0.202 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.202 0.000 0.189 0.214
##   left son=26 (239 obs) right son=27 (148 obs)
##   Primary splits:
##       rainfall < 82.10354 to the left,  improve=76.20211, (0 missing)
##       K        < 25.5     to the left,  improve=65.49581, (0 missing)
##       P        < 54.5     to the right, improve=62.23062, (0 missing)
##       humidity < 60.01602 to the right, improve=59.74215, (0 missing)
##       N        < 40.5     to the right, improve=34.57863, (0 missing)
##   Surrogate splits:
##       humidity    < 54.57495 to the right, agree=0.817, adj=0.520, (0 split)
##       K           < 25.5     to the left,  agree=0.788, adj=0.446, (0 split)
##       ph          < 6.488595 to the right, agree=0.788, adj=0.446, (0 split)
##       P           < 38.5     to the right, agree=0.770, adj=0.399, (0 split)
##       temperature < 31.21583 to the left,  agree=0.687, adj=0.182, (0 split)
##
## Node number 14: 605 observations,    complexity param=0.05041481
##   predicted class=jute         expected loss=0.8628099  P(node) =0.3666667
##     class counts:    68    79     0     0     0     0    72    69    83     0     0    16     0     0
##    probabilities: 0.112 0.131 0.000 0.000 0.000 0.000 0.119 0.114 0.137 0.000 0.000 0.026 0.000 0.000
##   left son=28 (519 obs) right son=29 (86 obs)
##   Primary splits:
##       rainfall < 60.33439 to the right, improve=73.09850, (0 missing)
##       P        < 69.5     to the right, improve=71.99882, (0 missing)
##       K        < 30       to the right, improve=71.28377, (0 missing)
##       humidity < 90.01095 to the right, improve=68.23664, (0 missing)
##       N        < 59.5     to the right, improve=66.82469, (0 missing)
##
## Node number 15: 375 observations,    complexity param=0.04850032
##   predicted class=orange       expected loss=0.792  P(node) =0.2272727
##     class counts:     0     0     0     0    74     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.197 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##   left son=30 (297 obs) right son=31 (78 obs)
##   Primary splits:
##       K           < 20       to the right, improve=77.22613, (0 missing)
##       N           < 60       to the left,  improve=74.70557, (0 missing)
##       rainfall    < 79.93772 to the right, improve=74.70557, (0 missing)
##       humidity    < 89.99513 to the right, improve=57.91125, (0 missing)
##       temperature < 24.98573 to the right, improve=45.36166, (0 missing)
##   Surrogate splits:
##       ph          < 7.163125 to the left,  agree=0.877, adj=0.410, (0 split)
##       temperature < 18.06138 to the right, agree=0.851, adj=0.282, (0 split)
##
## Node number 24: 76 observations
##   predicted class=coffee       expected loss=0  P(node) =0.04606061
```

```
##     class counts:     0     0     0     0     0    76     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 25: 59 observations
##   predicted class=maize        expected loss=0.01694915  P(node) =0.03575758
##     class counts:     0     0     1     0     0     0     0     0     0     0     0    58     0     0
##    probabilities: 0.000 0.000 0.017 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.983 0.000 0.000
##
## Node number 26: 239 observations,    complexity param=0.04499043
##   predicted class=mothbeans    expected loss=0.6527197  P(node) =0.1448485
##     class counts:     0     0    78     0     0     0     0     0     0     0    78     0     0    83
##    probabilities: 0.000 0.000 0.326 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.326 0.000 0.000 0.347
##   left son=52 (171 obs) right son=53 (68 obs)
##   Primary splits:
##       humidity    < 59.92886 to the right, improve=60.73728, (0 missing)
##       rainfall    < 59.82946 to the right, improve=54.87011, (0 missing)
##       P           < 59.5     to the right, improve=53.89166, (0 missing)
##       N           < 40.5     to the right, improve=31.73360, (0 missing)
##       temperature < 24.14643 to the right, improve=26.52112, (0 missing)
##   Surrogate splits:
##       P        < 57.5     to the right, agree=0.858, adj=0.500, (0 split)
##       ph       < 6.044377 to the right, agree=0.799, adj=0.294, (0 split)
##       rainfall < 35.03445 to the right, agree=0.736, adj=0.074, (0 split)
##
## Node number 27: 148 observations,    complexity param=0.04658583
##   predicted class=pigeonpeas   expected loss=0.4932432  P(node) =0.08969697
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0    73     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.493 0.000
##   left son=54 (73 obs) right son=55 (75 obs)
##   Primary splits:
##       P           < 47.5     to the left,  improve=73.98649, (0 missing)
##       K           < 24.5     to the right, improve=64.62751, (0 missing)
##       rainfall    < 100.3867 to the left,  improve=62.66401, (0 missing)
##       humidity    < 45.08619 to the right, improve=21.47771, (0 missing)
##       temperature < 26.94473 to the right, improve=17.54951, (0 missing)
##   Surrogate splits:
##       K           < 24.5     to the right, agree=0.966, adj=0.932, (0 split)
##       rainfall    < 100.3867 to the left,  agree=0.959, adj=0.918, (0 split)
##       humidity    < 45.08619 to the right, agree=0.723, adj=0.438, (0 split)
##       temperature < 26.94473 to the right, agree=0.689, adj=0.370, (0 split)
##       ph          < 6.837862 to the left,  agree=0.581, adj=0.151, (0 split)
##
## Node number 28: 519 observations,    complexity param=0.05041481
##   predicted class=jute         expected loss=0.8400771  P(node) =0.3145455
##     class counts:    68    79     0     0     0     0    72    69    83     0     0    16     0     0
##    probabilities: 0.131 0.152 0.000 0.000 0.000 0.000 0.139 0.133 0.160 0.000 0.000 0.031 0.000 0.000
##   left son=56 (216 obs) right son=57 (303 obs)
##   Primary splits:
##       P        < 69.5     to the right, improve=71.27012, (0 missing)
##       K        < 125      to the right, improve=69.34089, (0 missing)
##       humidity < 89.95841 to the right, improve=66.09299, (0 missing)
##       rainfall < 125.8596 to the left,  improve=65.75991, (0 missing)
##       N        < 59.5     to the left,  improve=62.82665, (0 missing)
##   Surrogate splits:
```

```
##       K           < 45.5     to the right, agree=0.884, adj=0.722, (0 split)
##       N           < 41       to the left,  agree=0.815, adj=0.556, (0 split)
##       ph          < 6.499974 to the left,  agree=0.800, adj=0.519, (0 split)
##       rainfall    < 125.8596 to the left,  agree=0.790, adj=0.495, (0 split)
##       temperature < 22.65896 to the left,  agree=0.655, adj=0.171, (0 split)
##
## Node number 29: 86 observations
##   predicted class=mungbean     expected loss=0.06976744  P(node) =0.05212121
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 30: 297 observations,    complexity param=0.04786216
##   predicted class=watermelon   expected loss=0.7441077  P(node) =0.18
##     class counts:     0     0     0     0    74     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.249 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##   left son=60 (149 obs) right son=61 (148 obs)
##   Primary splits:
##       N           < 60       to the left,  improve=74.27795, (0 missing)
##       rainfall    < 81.09887 to the right, improve=74.27795, (0 missing)
##       K           < 35.5     to the left,  improve=69.19472, (0 missing)
##       temperature < 24.98573 to the right, improve=56.19987, (0 missing)
##       humidity    < 90.0007  to the right, improve=54.96973, (0 missing)
##   Surrogate splits:
##       rainfall    < 81.09887 to the right, agree=1.000, adj=1.000, (0 split)
##       K           < 44.5     to the left,  agree=0.976, adj=0.953, (0 split)
##       ph          < 6.029566 to the left,  agree=0.697, adj=0.392, (0 split)
##       temperature < 23.97947 to the left,  agree=0.694, adj=0.385, (0 split)
##       humidity    < 92.51365 to the right, agree=0.657, adj=0.311, (0 split)
##
## Node number 31: 78 observations
##   predicted class=orange       expected loss=0  P(node) =0.04727273
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 52: 171 observations,    complexity param=0.04499043
##   predicted class=blackgram    expected loss=0.5438596  P(node) =0.1036364
##     class counts:     0     0    78     0     0     0     0     0     0     0    78     0     0    15
##    probabilities: 0.000 0.000 0.456 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.456 0.000 0.000 0.088
##   left son=104 (86 obs) right son=105 (85 obs)
##   Primary splits:
##       rainfall    < 57.70438 to the right, improve=71.16763, (0 missing)
##       temperature < 26.18741 to the right, improve=26.58765, (0 missing)
##       N           < 19.5     to the right, improve=25.91273, (0 missing)
##       P           < 53.5     to the right, improve=19.03587, (0 missing)
##       ph          < 8.230802 to the left,  improve=10.47724, (0 missing)
##   Surrogate splits:
##       temperature < 26.18741 to the right, agree=0.772, adj=0.541, (0 split)
##       N           < 19.5     to the right, agree=0.766, adj=0.529, (0 split)
##       ph          < 6.496591 to the right, agree=0.620, adj=0.235, (0 split)
##       humidity    < 64.13017 to the right, agree=0.608, adj=0.212, (0 split)
##       P           < 68.5     to the left,  agree=0.550, adj=0.094, (0 split)
##
## Node number 53: 68 observations
##   predicted class=mothbeans    expected loss=0  P(node) =0.04121212
```

```
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0    68
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 1.000
##
## Node number 54: 73 observations
##   predicted class=mango        expected loss=0  P(node) =0.04424242
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0    73     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 1.000 0.000
##
## Node number 55: 75 observations
##   predicted class=pigeonpeas   expected loss=0  P(node) =0.04545455
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 56: 216 observations,    complexity param=0.04403318
##   predicted class=banana       expected loss=0.6342593  P(node) =0.1309091
##     class counts:    68    79     0     0     0     0     0    69     0     0     0     0     0     0
##    probabilities: 0.315 0.366 0.000 0.000 0.000 0.000 0.000 0.319 0.000 0.000 0.000 0.000 0.000 0.000
##   left son=112 (79 obs) right son=113 (137 obs)
##   Primary splits:
##       P        < 107.5    to the left,  improve=75.16106, (0 missing)
##       K        < 125      to the left,  improve=75.16106, (0 missing)
##       N        < 60       to the right, improve=75.16106, (0 missing)
##       rainfall < 82.51242 to the right, improve=70.56897, (0 missing)
##       humidity < 87.49949 to the right, improve=69.99525, (0 missing)
##   Surrogate splits:
##       N           < 60       to the right, agree=1.000, adj=1.000, (0 split)
##       K           < 125      to the left,  agree=1.000, adj=1.000, (0 split)
##       temperature < 24.99137 to the right, agree=0.870, adj=0.646, (0 split)
##       humidity    < 79.80441 to the left,  agree=0.810, adj=0.481, (0 split)
##       rainfall    < 82.51242 to the right, agree=0.685, adj=0.139, (0 split)
##
## Node number 57: 303 observations,    complexity param=0.04467135
##   predicted class=jute         expected loss=0.7260726  P(node) =0.1836364
##     class counts:     0     0     0     0     0     0    72     0    83     0     0    16     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.238 0.000 0.274 0.000 0.000 0.053 0.000 0.000
##   left son=114 (74 obs) right son=115 (229 obs)
##   Primary splits:
##       N           < 99.5     to the right, improve=68.58261, (0 missing)
##       K           < 30       to the left,  improve=65.07111, (0 missing)
##       humidity    < 89.96485 to the left,  improve=61.60318, (0 missing)
##       rainfall    < 101.0098 to the left,  improve=56.20780, (0 missing)
##       temperature < 27.28566 to the left,  improve=45.60008, (0 missing)
##   Surrogate splits:
##       K        < 30       to the left,  agree=0.941, adj=0.757, (0 split)
##       rainfall < 101.0098 to the left,  agree=0.911, adj=0.635, (0 split)
##       ph       < 7.630955 to the right, agree=0.785, adj=0.122, (0 split)
##
## Node number 60: 149 observations,    complexity param=0.04722399
##   predicted class=pomegranate  expected loss=0.4966443  P(node) =0.09030303
##     class counts:     0     0     0     0    74     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.497 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##   left son=120 (74 obs) right son=121 (75 obs)
##   Primary splits:
##       temperature < 24.98573 to the right, improve=74.49664, (0 missing)
```

```
##       rainfall    < 121.7625 to the right, improve=74.49664, (0 missing)
##       K           < 35.5     to the left,  improve=66.90690, (0 missing)
##       humidity    < 91.47194 to the right, improve=28.28154, (0 missing)
##       ph          < 6.483916 to the left,  improve=24.28236, (0 missing)
##   Surrogate splits:
##       rainfall < 121.7625 to the right, agree=1.000, adj=1.000, (0 split)
##       K        < 35.5     to the left,  agree=0.973, adj=0.946, (0 split)
##       humidity < 91.47194 to the right, agree=0.799, adj=0.595, (0 split)
##       ph       < 6.483916 to the left,  agree=0.745, adj=0.486, (0 split)
##       P        < 15.5     to the left,  agree=0.611, adj=0.216, (0 split)
##
## Node number 61: 148 observations,    complexity param=0.04594767
##   predicted class=watermelon   expected loss=0.4864865  P(node) =0.08969697
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##   left son=122 (72 obs) right son=123 (76 obs)
##   Primary splits:
##       temperature < 27.00314 to the right, improve=73.945950, (0 missing)
##       humidity    < 90.02702 to the right, improve=73.945950, (0 missing)
##       rainfall    < 34.99666 to the left,  improve=73.945950, (0 missing)
##       ph          < 6.752669 to the left,  improve= 9.311537, (0 missing)
##       P           < 10.5     to the right, improve= 1.495549, (0 missing)
##   Surrogate splits:
##       humidity < 90.02702 to the right, agree=1.000, adj=1.000, (0 split)
##       rainfall < 34.99666 to the left,  agree=1.000, adj=1.000, (0 split)
##       ph       < 6.188393 to the left,  agree=0.622, adj=0.222, (0 split)
##       N        < 105.5    to the right, agree=0.561, adj=0.097, (0 split)
##       P        < 23.5     to the right, agree=0.561, adj=0.097, (0 split)
##
## Node number 104: 86 observations
##   predicted class=blackgram    expected loss=0.09302326  P(node) =0.05212121
##     class counts:     0     0    78     0     0     0     0     0     0     0     0     0     0     0     8
##    probabilities: 0.000 0.000 0.907 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.093
##
## Node number 105: 85 observations
##   predicted class=lentil       expected loss=0.08235294  P(node) =0.05151515
##     class counts:     0     0     0     0     0     0     0     0     0     0    78     0     0     7     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.918 0.000 0.000 0.082 0.000
##
## Node number 112: 79 observations
##   predicted class=banana       expected loss=0  P(node) =0.04787879
##     class counts:     0    79     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 113: 137 observations,    complexity param=0.04339502
##   predicted class=grapes       expected loss=0.4963504  P(node) =0.0830303
##     class counts:    68     0     0     0     0     0     0    69     0     0     0     0     0     0     0
##    probabilities: 0.496 0.000 0.000 0.000 0.000 0.000 0.000 0.504 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##   left son=226 (68 obs) right son=227 (69 obs)
##   Primary splits:
##       humidity    < 86.9554  to the right, improve=68.496350, (0 missing)
##       rainfall    < 87.5162  to the right, improve=68.496350, (0 missing)
##       temperature < 21.02449 to the right, improve=23.163020, (0 missing)
##       N           < 37.5     to the left,  improve= 5.053422, (0 missing)
```

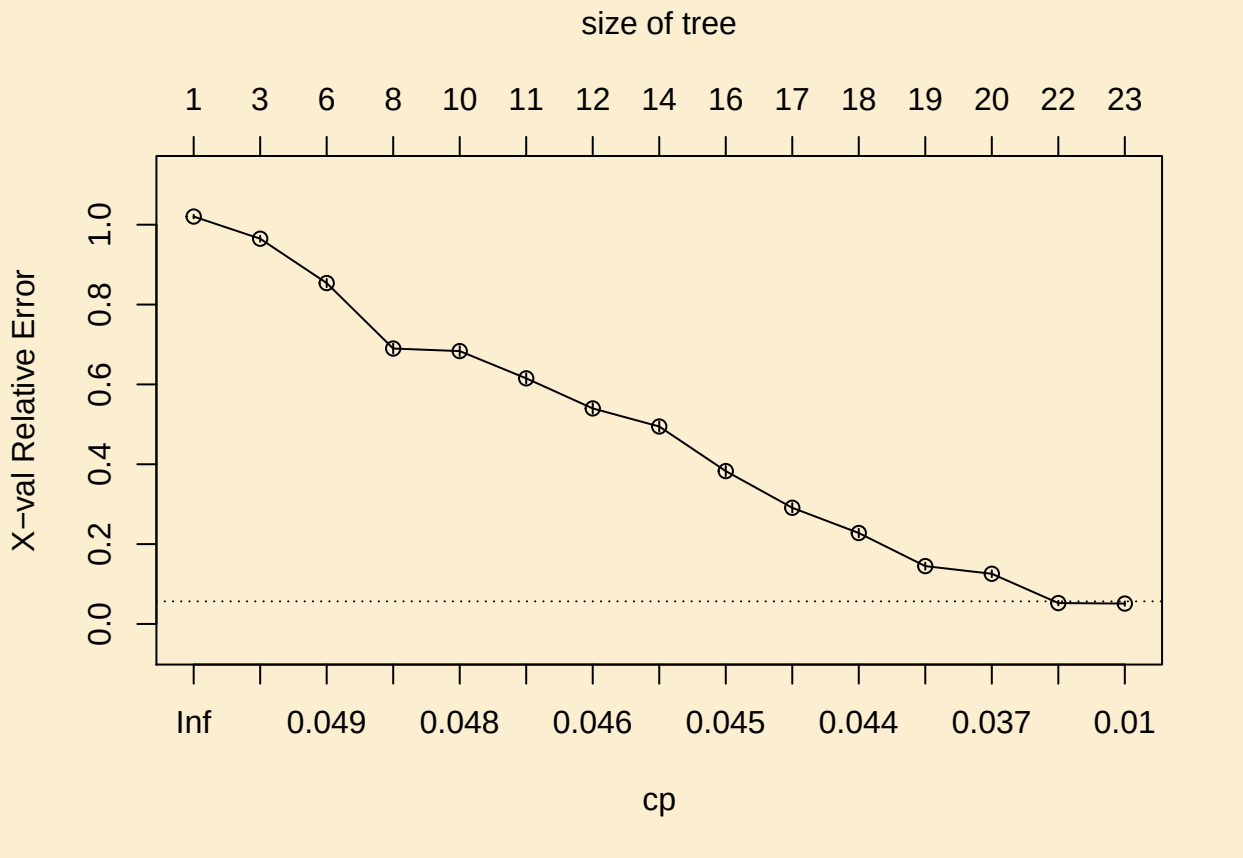
```
##       ph          < 5.83482  to the left,  improve= 4.366871, (0 missing)
##   Surrogate splits:
##       rainfall    < 87.5162  to the right, agree=1.000, adj=1.000, (0 split)
##       temperature < 21.02449 to the right, agree=0.752, adj=0.500, (0 split)
##       ph          < 5.83482  to the left,  agree=0.620, adj=0.235, (0 split)
##       N           < 34.5     to the left,  agree=0.591, adj=0.176, (0 split)
##       P           < 136.5    to the right, agree=0.584, adj=0.162, (0 split)
##
## Node number 114: 74 observations
##   predicted class=cotton       expected loss=0.02702703  P(node) =0.04484848
##     class counts:     0     0     0     0     0     0    72     0     2     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.973 0.000 0.027 0.000 0.000 0.000 0.000 0.000
##
## Node number 115: 229 observations,    complexity param=0.03765156
##   predicted class=jute         expected loss=0.6462882  P(node) =0.1387879
##     class counts:     0     0     0     0     0     0     0     0    81     0     0    16     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.354 0.000 0.000 0.070 0.000 0.000
##   left son=230 (170 obs) right son=231 (59 obs)
##   Primary splits:
##       humidity    < 89.96485 to the left,  improve=62.20688, (0 missing)
##       K           < 45.5     to the left,  improve=51.35533, (0 missing)
##       temperature < 27.28566 to the left,  improve=45.05491, (0 missing)
##       N           < 59.5     to the right, improve=41.43724, (0 missing)
##       rainfall    < 199.9623 to the left,  improve=37.64831, (0 missing)
##   Surrogate splits:
##       K           < 45.5     to the left,  agree=0.965, adj=0.864, (0 split)
##       temperature < 27.28566 to the left,  agree=0.943, adj=0.780, (0 split)
##       N           < 59.5     to the right, agree=0.930, adj=0.729, (0 split)
##       P           < 60.5     to the left,  agree=0.873, adj=0.508, (0 split)
##       rainfall    < 150.0731 to the right, agree=0.803, adj=0.237, (0 split)
##
## Node number 120: 74 observations
##   predicted class=coconut      expected loss=0  P(node) =0.04484848
##     class counts:     0     0     0     0    74     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 121: 75 observations
##   predicted class=pomegranate  expected loss=0  P(node) =0.04545455
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 122: 72 observations
##   predicted class=muskmelon    expected loss=0  P(node) =0.04363636
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 123: 76 observations
##   predicted class=watermelon   expected loss=0  P(node) =0.04606061
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 226: 68 observations
##   predicted class=apple        expected loss=0  P(node) =0.04121212
##     class counts:    68     0     0     0     0     0     0     0     0     0     0     0     0     0
```

```
##    probabilities: 1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 227: 69 observations
##   predicted class=grapes       expected loss=0  P(node) =0.04181818
##     class counts:     0     0     0     0     0     0     0    69     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 230: 170 observations,    complexity param=0.0370134
##   predicted class=jute         expected loss=0.5235294  P(node) =0.1030303
##     class counts:     0     0     0     0     0     0     0     0    81     0     0    16     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.476 0.000 0.000 0.094 0.000 0.000
##   left son=460 (112 obs) right son=461 (58 obs)
##   Primary splits:
##       rainfall    < 199.9623 to the left,  improve=49.42794, (0 missing)
##       humidity    < 80.0719  to the left,  improve=25.97718, (0 missing)
##       K           < 29.5     to the left,  improve=21.76073, (0 missing)
##       temperature < 23.07619 to the right, improve=18.84475, (0 missing)
##       ph          < 6.001247 to the right, improve=14.40532, (0 missing)
##   Surrogate splits:
##       temperature < 22.83232 to the right, agree=0.759, adj=0.293, (0 split)
##       ph          < 5.720147 to the right, agree=0.718, adj=0.172, (0 split)
##       humidity    < 80.0719  to the left,  agree=0.694, adj=0.103, (0 split)
##       N           < 60.5     to the right, agree=0.682, adj=0.069, (0 split)
##       P           < 57.5     to the left,  agree=0.676, adj=0.052, (0 split)
##
## Node number 231: 59 observations
##   predicted class=papaya       expected loss=0  P(node) =0.03575758
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 460: 112 observations,    complexity param=0.01021059
##   predicted class=jute         expected loss=0.2767857  P(node) =0.06787879
##     class counts:     0     0     0     0     0     0     0     0    81     0     0    16     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.723 0.000 0.000 0.143 0.000 0.000
##   left son=920 (96 obs) right son=921 (16 obs)
##   Primary splits:
##       K           < 29.5     to the right, improve=23.812500, (0 missing)
##       rainfall    < 129.074  to the right, improve=23.812500, (0 missing)
##       ph          < 6.001247 to the right, improve=10.751670, (0 missing)
##       humidity    < 73.81215 to the left,  improve= 8.934524, (0 missing)
##       temperature < 22.98882 to the right, improve= 8.815196, (0 missing)
##   Surrogate splits:
##       rainfall    < 129.074  to the right, agree=1.000, adj=1.000, (0 split)
##       temperature < 20.036   to the right, agree=0.884, adj=0.188, (0 split)
##       humidity    < 73.63948 to the right, agree=0.884, adj=0.188, (0 split)
##       P           < 59.5     to the left,  agree=0.866, adj=0.063, (0 split)
##       ph          < 5.926804 to the right, agree=0.866, adj=0.063, (0 split)
##
## Node number 461: 58 observations
##   predicted class=rice         expected loss=0  P(node) =0.03515152
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 920: 96 observations
```

```
##   predicted class=jute          expected loss=0.15625  P(node) =0.05818182
##     class counts:     0     0     0     0     0     0     0     0    81     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.844 0.000 0.000 0.000 0.000 0.000
##
## Node number 921: 16 observations
##   predicted class=maize         expected loss=0  P(node) =0.00969697
##     class counts:     0     0     0     0     0     0     0     0     0     0     0    16     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 1.000 0.000 0.000
```

Create a plot of cp

```
par(bg = "#fbeed1")
par(new = F)
plotcp(DT) ## the cp plot
```



Make another tree - change cp

```
DT2<-rpart(MyTrainingSET$label ~ ., data = MyTrainingSET,cp=.049, method="class")
```

The small cp the larger the tree if cp is too small the result will be overfitting

```
summary(DT2)
```

```
## Call:
## rpart(formula = MyTrainingSET$label ~ ., data = MyTrainingSET,
##     method = "class", cp = 0.049)
##   n= 1650
##
##           CP nsplit rel error    xerror        xstd
## 1 0.05073389      0 1.0000000 1.0191449 0.004570665
## 2 0.05041481      2 0.8985322 0.9451181 0.007859771
## 3 0.04900000      5 0.7472878 0.8800255 0.009604081
##
## Variable importance
##    humidity           P    rainfall           K          ph           N
##          27          22          19          14           7           7
## temperature
##           4
##
## Node number 1: 1650 observations,    complexity param=0.05073389
##   predicted class=jute         expected loss=0.949697  P(node) =1
##     class counts:    68    79    79    72    74    76    72    69    83    76    78    74    73    83
##    probabilities: 0.041 0.048 0.048 0.044 0.045 0.046 0.044 0.042 0.050 0.046 0.047 0.045 0.044 0.050
##   left son=2 (148 obs) right son=3 (1502 obs)
##   Primary splits:
##       humidity < 27.66972 to the left,  improve=74.17282, (0 missing)
##       K        < 25.5     to the right, improve=73.03883, (0 missing)
##       N        < 59.5     to the left,  improve=72.68730, (0 missing)
##       rainfall < 30.39348 to the right, improve=72.14872, (0 missing)
##       P        < 107.5    to the right, improve=69.11537, (0 missing)
##
## Node number 2: 148 observations
##   predicted class=kidneybeans  expected loss=0.4864865  P(node) =0.08969697
##     class counts:     0     0     0    72     0     0     0     0     0    76     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.486 0.000 0.000 0.000 0.000 0.000 0.514 0.000 0.000 0.000 0.000
##
## Node number 3: 1502 observations,    complexity param=0.05073389
##   predicted class=jute         expected loss=0.9447403  P(node) =0.910303
##     class counts:    68    79    79     0    74    76    72    69    83     0    78    74    73    83
##    probabilities: 0.045 0.053 0.053 0.000 0.049 0.051 0.048 0.046 0.055 0.000 0.052 0.049 0.049 0.055
##   left son=6 (522 obs) right son=7 (980 obs)
##   Primary splits:
##       humidity < 70.81499 to the left,  improve=73.44901, (0 missing)
##       N        < 59.5     to the right, improve=72.96276, (0 missing)
##       K        < 25.5     to the right, improve=72.93519, (0 missing)
##       rainfall < 30.39348 to the right, improve=72.17009, (0 missing)
##       P        < 107.5    to the right, improve=69.19362, (0 missing)
##   Surrogate splits:
##       K           < 34.5     to the left,  agree=0.783, adj=0.375, (0 split)
##       ph          < 5.49996  to the left,  agree=0.698, adj=0.132, (0 split)
##       temperature < 29.94382 to the right, agree=0.694, adj=0.121, (0 split)
##
```

```
## Node number 6: 522 observations
##   predicted class=mothbeans    expected loss=0.8409962  P(node) =0.3163636
##     class counts:     0     0    79     0     0    76     0     0     0     0    78    58    73    83
##    probabilities: 0.000 0.000 0.151 0.000 0.000 0.146 0.000 0.000 0.000 0.000 0.149 0.111 0.140 0.153
##
## Node number 7: 980 observations,    complexity param=0.05041481
##   predicted class=jute         expected loss=0.9153061  P(node) =0.5939394
##     class counts:    68    79     0     0    74     0    72    69    83     0     0    16     0     0
##    probabilities: 0.069 0.081 0.000 0.000 0.076 0.000 0.073 0.070 0.085 0.000 0.000 0.016 0.000 0.000
##   left son=14 (605 obs) right son=15 (375 obs)
##   Primary splits:
##       P        < 32.5     to the right, improve=74.10570, (0 missing)
##       rainfall < 60.33439 to the right, improve=73.13643, (0 missing)
##       K        < 25.5     to the right, improve=71.59715, (0 missing)
##       N        < 59.5     to the left,  improve=70.19522, (0 missing)
##       humidity < 90.00119 to the right, improve=67.05884, (0 missing)
##   Surrogate splits:
##       humidity    < 87.12095 to the left,  agree=0.766, adj=0.389, (0 split)
##       rainfall    < 32.99362 to the right, agree=0.691, adj=0.192, (0 split)
##       K           < 14.5     to the right, agree=0.690, adj=0.189, (0 split)
##       N           < 18.5     to the right, agree=0.646, adj=0.075, (0 split)
##       temperature < 19.88038 to the right, agree=0.632, adj=0.037, (0 split)
##
## Node number 14: 605 observations,    complexity param=0.05041481
##   predicted class=jute         expected loss=0.8628099  P(node) =0.3666667
##     class counts:    68    79     0     0     0     0    72    69    83     0     0    16     0     0
##    probabilities: 0.112 0.131 0.000 0.000 0.000 0.000 0.119 0.114 0.137 0.000 0.000 0.026 0.000 0.000
##   left son=28 (519 obs) right son=29 (86 obs)
##   Primary splits:
##       rainfall < 60.33439 to the right, improve=73.09850, (0 missing)
##       P        < 69.5     to the right, improve=71.99882, (0 missing)
##       K        < 30       to the right, improve=71.28377, (0 missing)
##       humidity < 90.01095 to the right, improve=68.23664, (0 missing)
##       N        < 59.5     to the right, improve=66.82469, (0 missing)
##
## Node number 15: 375 observations
##   predicted class=orange       expected loss=0.792  P(node) =0.2272727
##     class counts:     0     0     0     0    74     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.197 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 28: 519 observations,    complexity param=0.05041481
##   predicted class=jute         expected loss=0.8400771  P(node) =0.3145455
##     class counts:    68    79     0     0     0     0    72    69    83     0     0    16     0     0
##    probabilities: 0.131 0.152 0.000 0.000 0.000 0.000 0.139 0.133 0.160 0.000 0.000 0.031 0.000 0.000
##   left son=56 (216 obs) right son=57 (303 obs)
##   Primary splits:
##       P        < 69.5     to the right, improve=71.27012, (0 missing)
##       K        < 125      to the right, improve=69.34089, (0 missing)
##       humidity < 89.95841 to the right, improve=66.09299, (0 missing)
##       rainfall < 125.8596 to the left,  improve=65.75991, (0 missing)
##       N        < 59.5     to the left,  improve=62.82665, (0 missing)
##   Surrogate splits:
##       K           < 45.5     to the right, agree=0.884, adj=0.722, (0 split)
##       N           < 41       to the left,  agree=0.815, adj=0.556, (0 split)
```

```
##       ph          < 6.499974 to the left,  agree=0.800, adj=0.519, (0 split)
##       rainfall    < 125.8596 to the left,  agree=0.790, adj=0.495, (0 split)
##       temperature < 22.65896 to the left,  agree=0.655, adj=0.171, (0 split)
##
## Node number 29: 86 observations
##   predicted class=mungbean     expected loss=0.06976744  P(node) =0.05212121
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 56: 216 observations
##   predicted class=banana       expected loss=0.6342593  P(node) =0.1309091
##     class counts:    68    79     0     0     0     0     0    69     0     0     0     0     0     0
##    probabilities: 0.315 0.366 0.000 0.000 0.000 0.000 0.000 0.319 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 57: 303 observations
##   predicted class=jute         expected loss=0.7260726  P(node) =0.1836364
##     class counts:     0     0     0     0     0     0    72     0    83     0     0    16     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.238 0.000 0.274 0.000 0.000 0.053 0.000 0.000
```

Third tree - here use cp = 0 and "information" as split method instead of the default which is GINI measure

```
DT3<-rpart(MyTrainingSET$label ~ .,
           data = MyTrainingSET,cp=0.02, method="class",
           parms = list(split="information"),minsplit=2)
summary(DT3)
```

```
## Call:
## rpart(formula = MyTrainingSET$label ~ ., data = MyTrainingSET,
##     method = "class", parms = list(split = "information"), cp = 0.02,
##     minsplit = 2)
##   n= 1650
##
##            CP nsplit  rel error     xerror        xstd
## 1  0.05105297      0 1.00000000 1.01850670 0.004612139
## 2  0.05009572      1 0.94894703 0.94511806 0.007859771
## 3  0.04850032      3 0.84875558 0.90555201 0.008994690
## 4  0.04786216      4 0.80025526 0.79897894 0.011090030
## 5  0.04722399      5 0.75239311 0.78493937 0.011291879
## 6  0.04690491      6 0.70516911 0.67708998 0.012419507
## 7  0.04658583      9 0.56413529 0.64901085 0.012605247
## 8  0.04594767     10 0.51754946 0.64901085 0.012605247
## 9  0.04530951     12 0.42565412 0.53222719 0.012960362
## 10 0.04403318     13 0.38034461 0.41735801 0.012679659
## 11 0.04339502     14 0.33631142 0.37843012 0.012438095
## 12 0.04211870     15 0.29291640 0.34971283 0.012208719
## 13 0.04084237     16 0.25079770 0.30121251 0.011714741
## 14 0.04020421     17 0.20995533 0.29100191 0.011592407
## 15 0.03318443     18 0.16975112 0.19336311 0.010036774
## 16 0.03254627     19 0.13656669 0.14805361 0.009010962
## 17 0.03063178     20 0.10402042 0.13465220 0.008656865
## 18 0.02000000     21 0.07338864 0.08040842 0.006884411
```

```
##
## Variable importance
##    humidity           K    rainfall           P           N temperature
##          21          20          17          16          10          10
##          ph
##           6
##
## Node number 1: 1650 observations,    complexity param=0.05105297
##   predicted class=jute         expected loss=0.949697  P(node) =1
##     class counts:    68    79    79    72    74    76    72    69    83    76    78    74    73    83
##    probabilities: 0.041 0.048 0.048 0.044 0.045 0.046 0.044 0.042 0.050 0.046 0.047 0.045 0.044 0.050
##   left son=2 (702 obs) right son=3 (948 obs)
##   Primary splits:
##       humidity < 74.09434 to the left,  improve=1084.5980, (0 missing)
##       K        < 25.5     to the right, improve=1070.8250, (0 missing)
##       N        < 59.5     to the left,  improve=1042.8670, (0 missing)
##       rainfall < 89.20515 to the right, improve= 932.5410, (0 missing)
##       P        < 34.5     to the right, improve= 913.7373, (0 missing)
##   Surrogate splits:
##       K           < 34.5     to the left,  agree=0.759, adj=0.433, (0 split)
##       P           < 53.5     to the right, agree=0.636, adj=0.145, (0 split)
##       ph          < 7.211035 to the right, agree=0.622, adj=0.113, (0 split)
##       temperature < 21.01194 to the left,  agree=0.619, adj=0.104, (0 split)
##       rainfall    < 98.06627 to the left,  agree=0.607, adj=0.077, (0 split)
##
## Node number 2: 702 observations,    complexity param=0.04690491
##   predicted class=mothbeans    expected loss=0.8817664  P(node) =0.4254545
##     class counts:     0     0    79    72     0    76     0     0    16    76    78    74    73    83
##    probabilities: 0.000 0.000 0.113 0.103 0.000 0.108 0.000 0.000 0.023 0.108 0.111 0.105 0.104 0.118
##   left son=4 (225 obs) right son=5 (477 obs)
##   Primary splits:
##       K        < 25.5     to the right, improve=398.8301, (0 missing)
##       N        < 59.5     to the right, improve=372.9544, (0 missing)
##       P        < 54.5     to the right, improve=368.8672, (0 missing)
##       humidity < 27.66972 to the left,  improve=361.5646, (0 missing)
##       rainfall < 88.78482 to the left,  improve=358.9415, (0 missing)
##   Surrogate splits:
##       P           < 40.5     to the left,  agree=0.819, adj=0.436, (0 split)
##       humidity    < 19.86542 to the left,  agree=0.754, adj=0.231, (0 split)
##       N           < 79.5     to the right, agree=0.744, adj=0.200, (0 split)
##       rainfall    < 76.75374 to the right, agree=0.691, adj=0.036, (0 split)
##       temperature < 18.02729 to the left,  agree=0.681, adj=0.004, (0 split)
##
## Node number 3: 948 observations,    complexity param=0.05009572
##   predicted class=mungbean     expected loss=0.9156118  P(node) =0.5745455
##     class counts:    68    79     0     0    74     0    72    69    67     0     0     0     0     0
##    probabilities: 0.072 0.083 0.000 0.000 0.078 0.000 0.076 0.073 0.071 0.000 0.000 0.000 0.000 0.000
##   left son=6 (573 obs) right son=7 (375 obs)
##   Primary splits:
##       P        < 32.5     to the right, improve=636.2733, (0 missing)
##       N        < 59.5     to the left,  improve=619.0669, (0 missing)
##       K        < 44.5     to the right, improve=596.1701, (0 missing)
##       humidity < 90.00119 to the right, improve=591.0270, (0 missing)
##       rainfall < 89.93514 to the right, improve=561.5975, (0 missing)
```

```
##   Surrogate splits:
##       humidity    < 87.12095 to the left,  agree=0.758, adj=0.389, (0 split)
##       rainfall    < 32.99362 to the right, agree=0.680, adj=0.192, (0 split)
##       K           < 14.5     to the right, agree=0.679, adj=0.189, (0 split)
##       N           < 18.5     to the right, agree=0.634, adj=0.075, (0 split)
##       temperature < 19.88038 to the right, agree=0.622, adj=0.045, (0 split)
##
## Node number 4: 225 observations,    complexity param=0.04530951
##   predicted class=chickpea     expected loss=0.68  P(node) =0.1363636
##     class counts:     0     0     0    72     0    71     0     0    16     0     0     0    66     0
##    probabilities: 0.000 0.000 0.000 0.320 0.000 0.316 0.000 0.000 0.071 0.000 0.000 0.000 0.293 0.000
##   left son=8 (87 obs) right son=9 (138 obs)
##   Primary splits:
##       N           < 62.5     to the right, improve=150.1276, (0 missing)
##       rainfall    < 107.9575 to the right, improve=150.1276, (0 missing)
##       K           < 35.5     to the right, improve=146.3869, (0 missing)
##       temperature < 22.02727 to the left,  improve=141.0456, (0 missing)
##       humidity    < 32.5107  to the left,  improve=141.0456, (0 missing)
##   Surrogate splits:
##       rainfall    < 107.9575 to the right, agree=1.000, adj=1.000, (0 split)
##       humidity    < 52.80419 to the right, agree=0.893, adj=0.724, (0 split)
##       K           < 60       to the left,  agree=0.707, adj=0.241, (0 split)
##       temperature < 22.02727 to the right, agree=0.707, adj=0.241, (0 split)
##       P           < 54.5     to the left,  agree=0.689, adj=0.195, (0 split)
##
## Node number 5: 477 observations,    complexity param=0.04690491
##   predicted class=mothbeans    expected loss=0.8259958  P(node) =0.2890909
##     class counts:     0     0    79     0     0     5     0     0     0    76    78    74     7    83
##    probabilities: 0.000 0.000 0.166 0.000 0.000 0.010 0.000 0.000 0.000 0.159 0.164 0.155 0.015 0.174
##   left son=10 (279 obs) right son=11 (198 obs)
##   Primary splits:
##       rainfall    < 74.97404 to the left,  improve=240.9738, (0 missing)
##       humidity    < 58.67534 to the right, improve=224.6778, (0 missing)
##       N           < 40.5     to the right, improve=213.2066, (0 missing)
##       P           < 54.5     to the right, improve=183.2600, (0 missing)
##       temperature < 25.09352 to the right, improve=159.8383, (0 missing)
##   Surrogate splits:
##       ph          < 6.161912 to the right, agree=0.744, adj=0.384, (0 split)
##       humidity    < 40.58744 to the right, agree=0.740, adj=0.374, (0 split)
##       temperature < 23.93996 to the right, agree=0.700, adj=0.278, (0 split)
##       N           < 59.5     to the left,  agree=0.639, adj=0.131, (0 split)
##       P           < 34       to the right, agree=0.602, adj=0.040, (0 split)
##
## Node number 6: 573 observations,    complexity param=0.05009572
##   predicted class=mungbean     expected loss=0.8603839  P(node) =0.3472727
##     class counts:    68    79     0     0     0     0    72    69    67     0     0     0     0     0
##    probabilities: 0.119 0.138 0.000 0.000 0.000 0.000 0.126 0.120 0.117 0.000 0.000 0.000 0.000 0.000
##   left son=12 (217 obs) right son=13 (356 obs)
##   Primary splits:
##       P           < 69.5     to the right, improve=374.9778, (0 missing)
##       K           < 44.5     to the right, improve=361.0879, (0 missing)
##       N           < 59.5     to the right, improve=358.2055, (0 missing)
##       rainfall    < 125.8596 to the left,  improve=310.9209, (0 missing)
##       humidity    < 90.01095 to the right, improve=310.4602, (0 missing)
```

```
##   Surrogate splits:
##       K           < 45.5     to the right, agree=0.887, adj=0.700, (0 split)
##       ph          < 6.334805 to the left,  agree=0.810, adj=0.498, (0 split)
##       temperature < 22.65896 to the left,  agree=0.695, adj=0.194, (0 split)
##       rainfall    < 125.8596 to the left,  agree=0.689, adj=0.180, (0 split)
##       N           < 33.5     to the left,  agree=0.688, adj=0.175, (0 split)
##
## Node number 7: 375 observations,    complexity param=0.04850032
##   predicted class=orange       expected loss=0.792  P(node) =0.2272727
##     class counts:     0     0     0     0    74     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.197 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##   left son=14 (227 obs) right son=15 (148 obs)
##   Primary splits:
##       N           < 60       to the left,  improve=251.5462, (0 missing)
##       rainfall    < 79.93772 to the right, improve=251.5462, (0 missing)
##       K           < 35.5     to the left,  improve=238.9969, (0 missing)
##       humidity    < 89.99513 to the right, improve=180.1431, (0 missing)
##       temperature < 24.98573 to the right, improve=151.2060, (0 missing)
##   Surrogate splits:
##       rainfall    < 79.93772 to the right, agree=1.000, adj=1.000, (0 split)
##       K           < 44.5     to the left,  agree=0.981, adj=0.953, (0 split)
##       humidity    < 89.01028 to the right, agree=0.715, adj=0.277, (0 split)
##       temperature < 25.08774 to the left,  agree=0.669, adj=0.162, (0 split)
##
## Node number 8: 87 observations
##   predicted class=coffee       expected loss=0.183908  P(node) =0.05272727
##     class counts:     0     0     0     0     0    71     0     0    16     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.816 0.000 0.000 0.184 0.000 0.000 0.000 0.000 0.000
##
## Node number 9: 138 observations,    complexity param=0.0421187
##   predicted class=chickpea     expected loss=0.4782609  P(node) =0.08363636
##     class counts:     0     0     0    72     0     0     0     0     0     0     0     0    66     0
##    probabilities: 0.000 0.000 0.000 0.522 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.478 0.000
##   left son=18 (72 obs) right son=19 (66 obs)
##   Primary splits:
##       P           < 47.5     to the right, improve=95.52384, (0 missing)
##       K           < 55       to the right, improve=95.52384, (0 missing)
##       temperature < 23.99909 to the left,  improve=95.52384, (0 missing)
##       humidity    < 32.5107  to the left,  improve=95.52384, (0 missing)
##       rainfall    < 88.98658 to the left,  improve=62.03664, (0 missing)
##   Surrogate splits:
##       K           < 55       to the right, agree=1.000, adj=1.000, (0 split)
##       temperature < 23.99909 to the left,  agree=1.000, adj=1.000, (0 split)
##       humidity    < 32.5107  to the left,  agree=1.000, adj=1.000, (0 split)
##       rainfall    < 89.73764 to the left,  agree=0.920, adj=0.833, (0 split)
##       ph          < 6.478616 to the right, agree=0.833, adj=0.652, (0 split)
##
## Node number 10: 279 observations,    complexity param=0.04690491
##   predicted class=mothbeans    expected loss=0.702509  P(node) =0.1690909
##     class counts:     0     0    79     0     0     0     0     0     0    13    78    26     0    83
##    probabilities: 0.000 0.000 0.283 0.000 0.000 0.000 0.000 0.000 0.000 0.047 0.280 0.093 0.000 0.297
##   left son=20 (143 obs) right son=21 (136 obs)
##   Primary splits:
##       rainfall    < 59.73253 to the right, improve=142.51410, (0 missing)
```

```
##       humidity    < 59.92886 to the right, improve=120.39020, (0 missing)
##       P           < 59.5     to the right, improve=111.60050, (0 missing)
##       N           < 40.5     to the right, improve= 97.88334, (0 missing)
##       temperature < 25.09352 to the right, improve= 77.42147, (0 missing)
##   Surrogate splits:
##       N           < 40.5     to the right, agree=0.724, adj=0.434, (0 split)
##       temperature < 28.2029  to the right, agree=0.616, adj=0.213, (0 split)
##       humidity    < 64.13017 to the right, agree=0.595, adj=0.169, (0 split)
##       ph          < 7.592777 to the left,  agree=0.581, adj=0.140, (0 split)
##       P           < 59.5     to the right, agree=0.556, adj=0.088, (0 split)
##
## Node number 11: 198 observations,    complexity param=0.04020421
##   predicted class=pigeonpeas   expected loss=0.6212121  P(node) =0.12
##     class counts:     0     0     0     0     0     5     0     0     0    63     0    48     7     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.025 0.000 0.000 0.000 0.318 0.000 0.242 0.035 0.000
##   left son=22 (63 obs) right son=23 (135 obs)
##   Primary splits:
##       humidity    < 27.66972 to the left,  improve=123.84730, (0 missing)
##       N           < 50       to the right, improve=115.02500, (0 missing)
##       P           < 54.5     to the left,  improve= 80.47455, (0 missing)
##       temperature < 26.17598 to the left,  improve= 65.01173, (0 missing)
##       rainfall    < 116.8216 to the left,  improve= 60.89840, (0 missing)
##   Surrogate splits:
##       temperature < 17.94496 to the left,  agree=0.773, adj=0.286, (0 split)
##       P           < 77.5     to the right, agree=0.707, adj=0.079, (0 split)
##       K           < 15.5     to the left,  agree=0.692, adj=0.032, (0 split)
##       N           < 0.5      to the left,  agree=0.687, adj=0.016, (0 split)
##
## Node number 12: 217 observations,    complexity param=0.04403318
##   predicted class=banana       expected loss=0.6359447  P(node) =0.1315152
##     class counts:    68    79     0     0     0     0     0    69     0     0     0     0     0     0
##    probabilities: 0.313 0.364 0.000 0.000 0.000 0.000 0.000 0.318 0.000 0.000 0.000 0.000 0.000 0.000
##   left son=24 (80 obs) right son=25 (137 obs)
##   Primary splits:
##       P        < 107.5    to the left,  improve=142.8382, (0 missing)
##       K        < 125      to the left,  improve=142.8382, (0 missing)
##       N        < 60       to the right, improve=142.2903, (0 missing)
##       rainfall < 82.51242 to the right, improve=136.4495, (0 missing)
##       humidity < 87.49949 to the right, improve=135.6970, (0 missing)
##   Surrogate splits:
##       K           < 125      to the left,  agree=1.000, adj=1.000, (0 split)
##       N           < 60       to the right, agree=0.995, adj=0.988, (0 split)
##       temperature < 24.99137 to the right, agree=0.871, adj=0.650, (0 split)
##       humidity    < 79.80441 to the left,  agree=0.806, adj=0.475, (0 split)
##       rainfall    < 82.51242 to the right, agree=0.682, adj=0.138, (0 split)
##
## Node number 13: 356 observations,    complexity param=0.04658583
##   predicted class=mungbean     expected loss=0.7752809  P(node) =0.2157576
##     class counts:     0     0     0     0     0     0    72     0    67     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.202 0.000 0.188 0.000 0.000 0.000 0.000 0.000
##   left son=26 (152 obs) right son=27 (204 obs)
##   Primary splits:
##       K           < 30       to the left,  improve=242.9490, (0 missing)
##       rainfall    < 101.7885 to the left,  improve=207.5607, (0 missing)
```

```
##       temperature < 27.00026 to the left,  improve=200.0344, (0 missing)
##       N           < 59.5     to the right, improve=194.8943, (0 missing)
##       humidity    < 90.01739 to the left,  improve=167.6947, (0 missing)
##   Surrogate splits:
##       rainfall    < 101.7885 to the left,  agree=0.947, adj=0.875, (0 split)
##       N           < 99.5     to the right, agree=0.770, adj=0.461, (0 split)
##       temperature < 27.00026 to the right, agree=0.657, adj=0.197, (0 split)
##       P           < 49.5     to the left,  agree=0.615, adj=0.099, (0 split)
##       humidity    < 80.16859 to the left,  agree=0.615, adj=0.099, (0 split)
##
## Node number 14: 227 observations,    complexity param=0.04786216
##   predicted class=orange       expected loss=0.6563877  P(node) =0.1375758
##     class counts:     0     0     0     0    74     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.326 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##   left son=28 (149 obs) right son=29 (78 obs)
##   Primary splits:
##       K           < 20       to the right, improve=146.05240, (0 missing)
##       rainfall    < 125.3923 to the right, improve=143.30580, (0 missing)
##       temperature < 24.98573 to the right, improve=104.29450, (0 missing)
##       ph          < 6.479343 to the left,  improve= 59.35177, (0 missing)
##       humidity    < 89.97161 to the right, improve= 53.87192, (0 missing)
##   Surrogate splits:
##       ph          < 7.163125 to the left,  agree=0.797, adj=0.410, (0 split)
##       temperature < 18.06138 to the right, agree=0.753, adj=0.282, (0 split)
##       rainfall    < 102.4868 to the right, agree=0.700, adj=0.128, (0 split)
##
## Node number 15: 148 observations,    complexity param=0.04594767
##   predicted class=watermelon   expected loss=0.4864865  P(node) =0.08969697
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##   left son=30 (72 obs) right son=31 (76 obs)
##   Primary splits:
##       temperature < 27.00314 to the right, improve=102.531700, (0 missing)
##       humidity    < 90.02702 to the right, improve=102.531700, (0 missing)
##       rainfall    < 34.99666 to the left,  improve=102.531700, (0 missing)
##       ph          < 6.784512 to the left,  improve= 10.798550, (0 missing)
##       P           < 10.5     to the right, improve=  1.514056, (0 missing)
##   Surrogate splits:
##       humidity < 90.02702 to the right, agree=1.000, adj=1.000, (0 split)
##       rainfall < 34.99666 to the left,  agree=1.000, adj=1.000, (0 split)
##       ph       < 6.188393 to the left,  agree=0.622, adj=0.222, (0 split)
##       N        < 105.5    to the right, agree=0.561, adj=0.097, (0 split)
##       P        < 23.5     to the right, agree=0.561, adj=0.097, (0 split)
##
## Node number 18: 72 observations
##   predicted class=chickpea     expected loss=0  P(node) =0.04363636
##     class counts:     0     0     0    72     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 19: 66 observations
##   predicted class=mango        expected loss=0  P(node) =0.04
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0    66     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 1.000 0.000
##
```

```
## Node number 20: 143 observations
##   predicted class=blackgram    expected loss=0.4475524  P(node) =0.08666667
##     class counts:     0     0    79     0     0     0     0     0     0    13     0    26     0    25
##    probabilities: 0.000 0.000 0.552 0.000 0.000 0.000 0.000 0.000 0.000 0.091 0.000 0.182 0.000 0.175
##
## Node number 21: 136 observations,    complexity param=0.03254627
##   predicted class=lentil       expected loss=0.4264706  P(node) =0.08242424
##     class counts:     0     0     0     0     0     0     0     0     0     0    78     0     0    58
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.574 0.000 0.000 0.426
##   left son=42 (85 obs) right son=43 (51 obs)
##   Primary splits:
##       humidity    < 59.94176 to the right, improve=68.61138, (0 missing)
##       P           < 59.5     to the right, improve=58.99185, (0 missing)
##       temperature < 23.99453 to the left,  improve=22.22050, (0 missing)
##       ph          < 5.900775 to the right, improve=21.69543, (0 missing)
##       rainfall    < 35.03445 to the right, improve=14.05632, (0 missing)
##   Surrogate splits:
##       P           < 57.5     to the right, agree=0.860, adj=0.627, (0 split)
##       ph          < 5.900775 to the right, agree=0.757, adj=0.353, (0 split)
##       temperature < 29.96009 to the left,  agree=0.706, adj=0.216, (0 split)
##       rainfall    < 54.99659 to the left,  agree=0.699, adj=0.196, (0 split)
##       N           < 39.5     to the left,  agree=0.640, adj=0.039, (0 split)
##
## Node number 22: 63 observations
##   predicted class=kidneybeans  expected loss=0  P(node) =0.03818182
##     class counts:     0     0     0     0     0     0     0     0     0    63     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000 0.000
##
## Node number 23: 135 observations,    complexity param=0.03063178
##   predicted class=pigeonpeas   expected loss=0.4444444  P(node) =0.08181818
##     class counts:     0     0     0     0     0     5     0     0     0     0     0    48     7     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.037 0.000 0.000 0.000 0.000 0.000 0.356 0.052 0.000
##   left son=46 (53 obs) right son=47 (82 obs)
##   Primary splits:
##       N           < 50       to the right, improve=90.43565, (0 missing)
##       rainfall    < 113.3311 to the left,  improve=60.59592, (0 missing)
##       P           < 54.5     to the left,  improve=59.21339, (0 missing)
##       humidity    < 55.50057 to the right, improve=44.37796, (0 missing)
##       temperature < 26.54721 to the left,  improve=39.19168, (0 missing)
##   Surrogate splits:
##       P           < 54.5     to the left,  agree=0.852, adj=0.623, (0 split)
##       humidity    < 57.4146  to the right, agree=0.852, adj=0.623, (0 split)
##       rainfall    < 113.3311 to the left,  agree=0.822, adj=0.547, (0 split)
##       temperature < 26.54721 to the left,  agree=0.785, adj=0.453, (0 split)
##       ph          < 5.712156 to the right, agree=0.689, adj=0.208, (0 split)
##
## Node number 24: 80 observations
##   predicted class=banana       expected loss=0.0125  P(node) =0.04848485
##     class counts:     0    79     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.988 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 25: 137 observations,    complexity param=0.04339502
##   predicted class=grapes       expected loss=0.4963504  P(node) =0.0830303
##     class counts:    68     0     0     0     0     0     0    69     0     0     0     0     0     0
```

```
##    probabilities: 0.496 0.000 0.000 0.000 0.000 0.000 0.000 0.504 0.000 0.000 0.000 0.000 0.000 0.000
##   left son=50 (68 obs) right son=51 (69 obs)
##   Primary splits:
##       humidity    < 86.9554  to the right, improve=94.957510, (0 missing)
##       rainfall    < 87.5162  to the right, improve=94.957510, (0 missing)
##       temperature < 21.02449 to the right, improve=30.033070, (0 missing)
##       N           < 37.5     to the left,  improve= 5.885466, (0 missing)
##       ph          < 5.83482  to the left,  improve= 4.435252, (0 missing)
##   Surrogate splits:
##       rainfall    < 87.5162  to the right, agree=1.000, adj=1.000, (0 split)
##       temperature < 21.02449 to the right, agree=0.752, adj=0.500, (0 split)
##       ph          < 5.83482  to the left,  agree=0.620, adj=0.235, (0 split)
##       N           < 34.5     to the left,  agree=0.591, adj=0.176, (0 split)
##       P           < 136.5    to the right, agree=0.584, adj=0.162, (0 split)
##
## Node number 26: 152 observations,    complexity param=0.04594767
##   predicted class=mungbean     expected loss=0.4736842  P(node) =0.09212121
##     class counts:     0     0     0     0     0     0    72     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.474 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##   left son=52 (72 obs) right son=53 (80 obs)
##   Primary splits:
##       N           < 69.5     to the right, improve=105.14770, (0 missing)
##       rainfall    < 60.33439 to the right, improve=105.14770, (0 missing)
##       temperature < 26.50354 to the left,  improve=105.14770, (0 missing)
##       humidity    < 84.71531 to the left,  improve= 38.63942, (0 missing)
##       ph          < 7.21362  to the right, improve= 24.49931, (0 missing)
##   Surrogate splits:
##       temperature < 26.50354 to the left,  agree=1.000, adj=1.000, (0 split)
##       rainfall    < 60.33439 to the right, agree=1.000, adj=1.000, (0 split)
##       humidity    < 81.79784 to the left,  agree=0.796, adj=0.569, (0 split)
##       ph          < 7.21362  to the right, agree=0.711, adj=0.389, (0 split)
##       K           < 19.5     to the left,  agree=0.618, adj=0.194, (0 split)
##
## Node number 27: 204 observations,    complexity param=0.04084237
##   predicted class=rice         expected loss=0.6421569  P(node) =0.1236364
##     class counts:     0     0     0     0     0     0     0     0    67     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.328 0.000 0.000 0.000 0.000 0.000
##   left son=54 (140 obs) right son=55 (64 obs)
##   Primary splits:
##       humidity    < 89.96485 to the left,  improve=126.89800, (0 missing)
##       K           < 44.5     to the left,  improve= 97.60147, (0 missing)
##       temperature < 27.28566 to the left,  improve= 79.98406, (0 missing)
##       N           < 59.5     to the right, improve= 73.06200, (0 missing)
##       rainfall    < 199.9623 to the left,  improve= 60.04503, (0 missing)
##   Surrogate splits:
##       K           < 45.5     to the left,  agree=0.961, adj=0.875, (0 split)
##       temperature < 27.28566 to the left,  agree=0.931, adj=0.781, (0 split)
##       N           < 59.5     to the right, agree=0.917, adj=0.734, (0 split)
##       rainfall    < 150.0731 to the right, agree=0.858, adj=0.547, (0 split)
##       P           < 60.5     to the left,  agree=0.848, adj=0.516, (0 split)
##
## Node number 28: 149 observations,    complexity param=0.04722399
##   predicted class=pomegranate  expected loss=0.4966443  P(node) =0.09030303
##     class counts:     0     0     0     0    74     0     0     0     0     0     0     0     0     0
```

```
##    probabilities: 0.000 0.000 0.000 0.000 0.497 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##   left son=56 (74 obs) right son=57 (75 obs)
##   Primary splits:
##       temperature < 24.98573 to the right, improve=103.27560, (0 missing)
##       rainfall    < 121.7625 to the right, improve=103.27560, (0 missing)
##       K           < 35.5     to the left,  improve= 87.49828, (0 missing)
##       humidity    < 89.97718 to the right, improve= 34.85665, (0 missing)
##       ph          < 6.483916 to the left,  improve= 31.53279, (0 missing)
##   Surrogate splits:
##       rainfall < 121.7625 to the right, agree=1.000, adj=1.000, (0 split)
##       K        < 35.5     to the left,  agree=0.973, adj=0.946, (0 split)
##       humidity < 91.47194 to the right, agree=0.799, adj=0.595, (0 split)
##       ph       < 6.483916 to the left,  agree=0.745, adj=0.486, (0 split)
##       P        < 15.5     to the left,  agree=0.611, adj=0.216, (0 split)
##
## Node number 29: 78 observations
##   predicted class=orange       expected loss=0  P(node) =0.04727273
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 30: 72 observations
##   predicted class=muskmelon    expected loss=0  P(node) =0.04363636
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 31: 76 observations
##   predicted class=watermelon   expected loss=0  P(node) =0.04606061
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 42: 85 observations
##   predicted class=lentil       expected loss=0.08235294  P(node) =0.05151515
##     class counts:     0     0     0     0     0     0     0     0     0     0    78     0     0     7
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.918 0.000 0.000 0.082
##
## Node number 43: 51 observations
##   predicted class=mothbeans    expected loss=0  P(node) =0.03090909
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0    51
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 1.000
##
## Node number 46: 53 observations
##   predicted class=maize        expected loss=0.09433962  P(node) =0.03212121
##     class counts:     0     0     0     0     0     5     0     0     0     0     0    48     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.094 0.000 0.000 0.000 0.000 0.000 0.906 0.000 0.000
##
## Node number 47: 82 observations
##   predicted class=pigeonpeas   expected loss=0.08536585  P(node) =0.04969697
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     7     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.085 0.000
##
## Node number 50: 68 observations
##   predicted class=apple        expected loss=0  P(node) =0.04121212
##     class counts:    68     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
```

```
##
## Node number 51: 69 observations
##   predicted class=grapes       expected loss=0  P(node) =0.04181818
##     class counts:     0     0     0     0     0     0     0    69     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 52: 72 observations
##   predicted class=cotton       expected loss=0  P(node) =0.04363636
##     class counts:     0     0     0     0     0     0    72     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 53: 80 observations
##   predicted class=mungbean     expected loss=0  P(node) =0.04848485
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 54: 140 observations,    complexity param=0.03318443
##   predicted class=rice         expected loss=0.4785714  P(node) =0.08484848
##     class counts:     0     0     0     0     0     0     0     0    67     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.479 0.000 0.000 0.000 0.000 0.000
##   left son=108 (82 obs) right son=109 (58 obs)
##   Primary splits:
##       rainfall    < 199.9623 to the left,  improve=57.896170, (0 missing)
##       humidity    < 80.0719  to the left,  improve=24.522560, (0 missing)
##       temperature < 23.07619 to the right, improve=24.251600, (0 missing)
##       ph          < 6.013602 to the right, improve=19.656710, (0 missing)
##       N           < 91.5     to the left,  improve= 3.636246, (0 missing)
##   Surrogate splits:
##       temperature < 23.07619 to the right, agree=0.750, adj=0.397, (0 split)
##       ph          < 5.905345 to the right, agree=0.671, adj=0.207, (0 split)
##       N           < 61.5     to the right, agree=0.621, adj=0.086, (0 split)
##       P           < 57.5     to the left,  agree=0.614, adj=0.069, (0 split)
##       humidity    < 80.0719  to the left,  agree=0.614, adj=0.069, (0 split)
##
## Node number 55: 64 observations
##   predicted class=papaya       expected loss=0  P(node) =0.03878788
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 56: 74 observations
##   predicted class=coconut      expected loss=0  P(node) =0.04484848
##     class counts:     0     0     0     0    74     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 57: 75 observations
##   predicted class=pomegranate  expected loss=0  P(node) =0.04545455
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
##
## Node number 108: 82 observations
##   predicted class=jute         expected loss=0.1829268  P(node) =0.04969697
##     class counts:     0     0     0     0     0     0     0     0    67     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.817 0.000 0.000 0.000 0.000 0.000
##
```

```
## Node number 109: 58 observations
##   predicted class=rice         expected loss=0  P(node) =0.03515152
##     class counts:     0     0     0     0     0     0     0     0     0     0     0     0     0     0
##    probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
```

```
DT3$variable.importance  ## before re-eval to add to 100
```

```
##    humidity           K    rainfall           P           N temperature
##   2602.8332   2387.9944   1999.0212   1882.8106   1266.1658   1239.5149
##          ph
##    734.4647
```

Predict the Testset using all 3 trees

Prediction 1

Confusion Matrix and Heatmap

```
(DT_Prediction= predict(DT, MyTestSET, type="class"))
```

```
##           1           3           4           9          10          12
##        rice        rice        rice        rice        rice        rice
##          18          24          31          37          43          44
##        rice        rice        rice        rice        rice        rice
##          47          56          59          69          70          73
##        jute        rice        jute        rice        rice        rice
##          74          75          81          85          89          90
##        jute        rice        jute        rice        rice        rice
##          93          98          99         101         104         105
##        rice        rice        jute       maize       maize       maize
##         108         114         122         126         130         139
##       maize       maize       maize       maize       maize       maize
##         140         143         144         146         147         149
##       maize       maize       maize       maize       maize       maize
##         150         152         154         157         158         172
##       maize       maize       maize       maize       maize       maize
##         173         179         185         193         195         211
##       maize       maize       maize       maize       maize    chickpea
##         212         219         230         232         238         240
##    chickpea    chickpea    chickpea    chickpea    chickpea    chickpea
##         244         248         252         253         255         257
##    chickpea    chickpea    chickpea    chickpea    chickpea    chickpea
##         260         262         264         265         266         272
##    chickpea    chickpea    chickpea    chickpea    chickpea    chickpea
##         273         274         285         287         289         290
##    chickpea    chickpea    chickpea    chickpea    chickpea    chickpea
##         296         297         300         302         314         316
##    chickpea    chickpea    chickpea kidneybeans kidneybeans kidneybeans
##         317         322         323         325         327         330
```

```
## kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans
##         336         337         342         349         353         356
## kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans
##         358         359         360         363         370         374
## kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans
##         376         392         398         402         403         407
## kidneybeans kidneybeans kidneybeans  pigeonpeas  pigeonpeas  pigeonpeas
##         409         411         412         415         424         425
##  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas
##         426         427         430         432         433         435
##  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas
##         437         439         445         447         450         451
##  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas
##         457         466         470         494         512         513
##  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas   mothbeans   mothbeans
##         516         527         538         539         552         553
##   mothbeans   mothbeans   mothbeans   blackgram   mothbeans   blackgram
##         558         560         564         565         567         575
##   blackgram   mothbeans   blackgram   mothbeans      lentil      lentil
##         581         586         592         605         620         624
##   mothbeans      lentil      lentil    mungbean    mungbean    mungbean
##         628         631         641         646         651         654
##    mungbean    mungbean    mungbean    mungbean    mungbean    mungbean
##         657         661         663         665         666         672
##    mungbean    mungbean    mungbean    mungbean    mungbean    mungbean
##         675         676         678         691         692         705
##    mungbean    mungbean    mungbean    mungbean    mungbean   blackgram
##         718         723         728         736         743         745
##   blackgram   blackgram   blackgram   blackgram   blackgram   blackgram
##         749         750         753         756         766         767
##   blackgram   blackgram   blackgram   blackgram   blackgram   blackgram
##         774         781         787         795         797         798
##   blackgram   blackgram   blackgram   blackgram   blackgram   blackgram
##         799         800         804         805         820         826
##   blackgram   blackgram      lentil      lentil      lentil      lentil
##         829         832         842         847         855         856
##      lentil      lentil      lentil      lentil      lentil      lentil
##         857         858         859         867         868         871
##      lentil      lentil      lentil      lentil      lentil      lentil
##         873         878         881         887         889         900
##      lentil      lentil      lentil      lentil      lentil      lentil
##         905         910         914         923         927         932
## pomegranate pomegranate pomegranate pomegranate pomegranate pomegranate
##         933         935         942         944         945         948
## pomegranate pomegranate pomegranate pomegranate pomegranate pomegranate
##         955         961         965         969         975         976
## pomegranate pomegranate pomegranate pomegranate pomegranate pomegranate
##         977         978         979         981         987         992
## pomegranate pomegranate pomegranate pomegranate pomegranate pomegranate
##         997        1007        1018        1021        1027        1030
## pomegranate      banana      banana      banana      banana      banana
##        1031        1033        1035        1036        1040        1043
##      banana      banana      banana      banana      banana      banana
##        1044        1048        1059        1071        1074        1076
```

```
##      banana      banana      banana      banana      banana      banana
##        1082        1085        1086        1089        1101        1102
##      banana      banana      banana      banana       mango       mango
##        1116        1117        1126        1133        1134        1137
##       mango       mango       mango       mango       mango       mango
##        1140        1141        1149        1152        1161        1162
##       mango       mango       mango       mango       mango       mango
##        1164        1166        1170        1172        1177        1180
##       mango       mango       mango       mango       mango       mango
##        1182        1186        1187        1191        1197        1199
##       mango       mango       mango       mango       mango       mango
##        1200        1204        1205        1213        1214        1220
##       mango      grapes      grapes      grapes      grapes      grapes
##        1221        1223        1224        1231        1232        1239
##      grapes      grapes      grapes      grapes      grapes      grapes
##        1243        1244        1246        1249        1250        1252
##      grapes      grapes      grapes      grapes      grapes      grapes
##        1253        1254        1257        1259        1263        1264
##      grapes      grapes      grapes      grapes      grapes      grapes
##        1270        1272        1273        1278        1280        1281
##      grapes      grapes      grapes      grapes      grapes      grapes
##        1283        1291        1303        1310        1311        1312
##      grapes      grapes  watermelon  watermelon  watermelon  watermelon
##        1317        1325        1334        1338        1341        1347
##  watermelon  watermelon  watermelon  watermelon  watermelon  watermelon
##        1353        1357        1359        1360        1361        1372
##  watermelon  watermelon  watermelon  watermelon  watermelon  watermelon
##        1375        1384        1388        1390        1391        1394
##  watermelon  watermelon  watermelon  watermelon  watermelon  watermelon
##        1397        1400        1414        1416        1420        1421
##  watermelon  watermelon   muskmelon   muskmelon   muskmelon   muskmelon
##        1425        1428        1431        1432        1436        1437
##   muskmelon   muskmelon   muskmelon   muskmelon   muskmelon   muskmelon
##        1438        1439        1440        1444        1449        1450
##   muskmelon   muskmelon   muskmelon   muskmelon   muskmelon   muskmelon
##        1455        1459        1460        1466        1472        1475
##   muskmelon   muskmelon   muskmelon   muskmelon   muskmelon   muskmelon
##        1476        1481        1482        1494        1497        1498
##   muskmelon   muskmelon   muskmelon   muskmelon   muskmelon   muskmelon
##        1504        1505        1508        1510        1511        1512
##       apple       apple       apple       apple       apple       apple
##        1514        1522        1523        1527        1530        1531
##       apple       apple       apple       apple       apple       apple
##        1533        1543        1545        1551        1552        1553
##       apple       apple       apple       apple       apple       apple
##        1554        1559        1562        1565        1569        1572
##       apple       apple       apple       apple       apple       apple
##        1580        1582        1583        1584        1585        1586
##       apple       apple       apple       apple       apple       apple
##        1591        1595        1602        1609        1610        1613
##       apple       apple      orange      orange      orange      orange
##        1627        1631        1632        1633        1640        1643
##      orange      orange      orange      orange      orange      orange
##        1644        1647        1655        1660        1663        1670
```

```
##      orange      orange      orange      orange      orange      orange
##        1672        1673        1680        1683        1687        1700
##      orange      orange      orange      orange      orange      orange
##        1703        1704        1710        1712        1714        1717
##      papaya      papaya      papaya    mungbean      papaya      papaya
##        1727        1730        1732        1733        1737        1739
##      papaya      papaya    mungbean      papaya      papaya      papaya
##        1740        1742        1746        1749        1753        1758
##      papaya      papaya      papaya      papaya      papaya      papaya
##        1759        1765        1766        1767        1768        1774
##      papaya      papaya      papaya    mungbean      papaya      papaya
##        1777        1778        1779        1783        1786        1787
##      papaya      papaya      papaya      papaya      papaya      papaya
##        1791        1795        1797        1798        1799        1804
##      papaya    mungbean      papaya      papaya      papaya     coconut
##        1808        1810        1815        1818        1820        1821
##     coconut     coconut     coconut     coconut     coconut     coconut
##        1824        1827        1831        1833        1834        1836
##     coconut     coconut     coconut     coconut     coconut     coconut
##        1837        1843        1845        1847        1854        1855
##     coconut     coconut     coconut     coconut     coconut     coconut
##        1860        1861        1871        1881        1882        1883
##     coconut     coconut     coconut     coconut     coconut     coconut
##        1893        1901        1902        1907        1914        1917
##     coconut      cotton      cotton      cotton      cotton      cotton
##        1922        1934        1941        1944        1945        1946
##      cotton      cotton      cotton      cotton      cotton      cotton
##        1947        1948        1949        1955        1956        1963
##      cotton      cotton      cotton      cotton      cotton      cotton
##        1965        1966        1967        1975        1976        1984
##      cotton      cotton      cotton      cotton      cotton      cotton
##        1985        1992        1996        1997        2000        2002
##      cotton      cotton      cotton      cotton      cotton        jute
##        2005        2006        2016        2027        2030        2040
##        jute      cotton        jute        jute        jute        jute
##        2041        2047        2053        2071        2077        2079
##        jute        jute        jute        jute        jute        jute
##        2080        2082        2083        2084        2114        2119
##        jute        jute        jute        jute      coffee      coffee
##        2120        2121        2122        2125        2126        2128
##      coffee      coffee      coffee      coffee      coffee      coffee
##        2135        2141        2142        2151        2153        2161
##      coffee      coffee      coffee      coffee      coffee      coffee
##        2171        2177        2178        2179        2188        2190
##      coffee      coffee      coffee      coffee      coffee      coffee
##        2193        2194        2195        2196
##      coffee      coffee      coffee      coffee
## 22 Levels: apple banana blackgram chickpea coconut coffee cotton ... watermelon
```

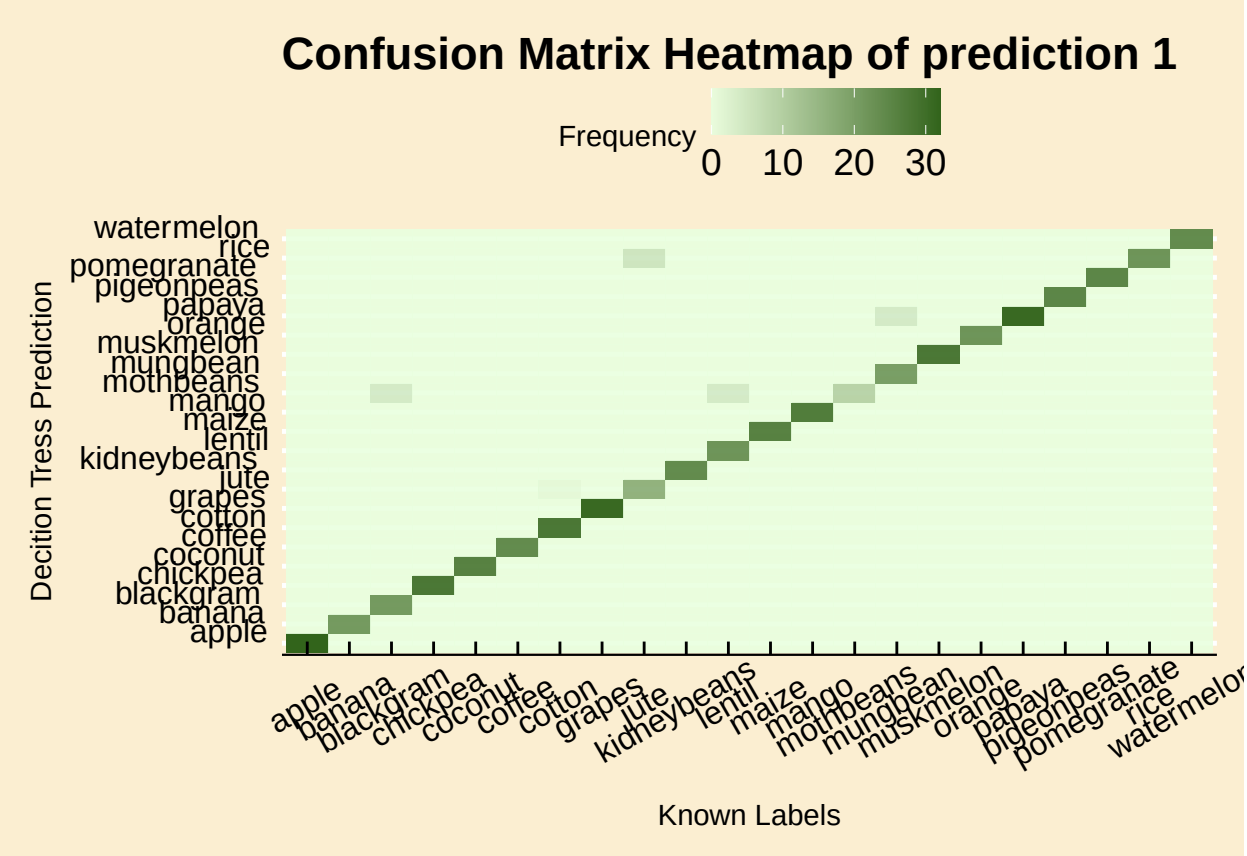
```
confusion_matrix <- table(DT_Prediction,TestKnownLabels)
```

Create a function that generates heatmap from the confusion matrix

```
get_heatmap <- function(mapname, prediction){
  data <- as.data.frame(confusion_matrix)
  data <- as.data.frame((table(prediction,TestKnownLabels)))
plot <- ggplot(data) +
  geom_tile(mapping=aes(x=data[,1], y=data[,2],fill=data[,3])) +
  xlab("Known Labels") +
  ylab("Decition Tress Prediction") +
  theme_economist() +
  ggtitle(mapname) +
  scale_fill_gradient2(name="Frequency",low="#defccf", mid="#e9ffdfe6", high="#32641b") +
  theme(plot.background = element_rect(fill='#fbeed1',color="#fbeed1"),
        legend.background =element_rect(fill='#fbeed1',color="#fbeed1"),
        axis.text.x = element_markdown(size=12, angle = 30, vjust = 0.9, hjust=.6),
        axis.text.y = element_markdown(size=12, angle = 0, vjust = 0.2, hjust=1.1))
return(plot)
}
```

Use the function to generate a confusion matrix heatmap of decision tree 1's prediction

```
get_heatmap('Confusion Matrix Heatmap of prediction 1', DT_Prediction)
```

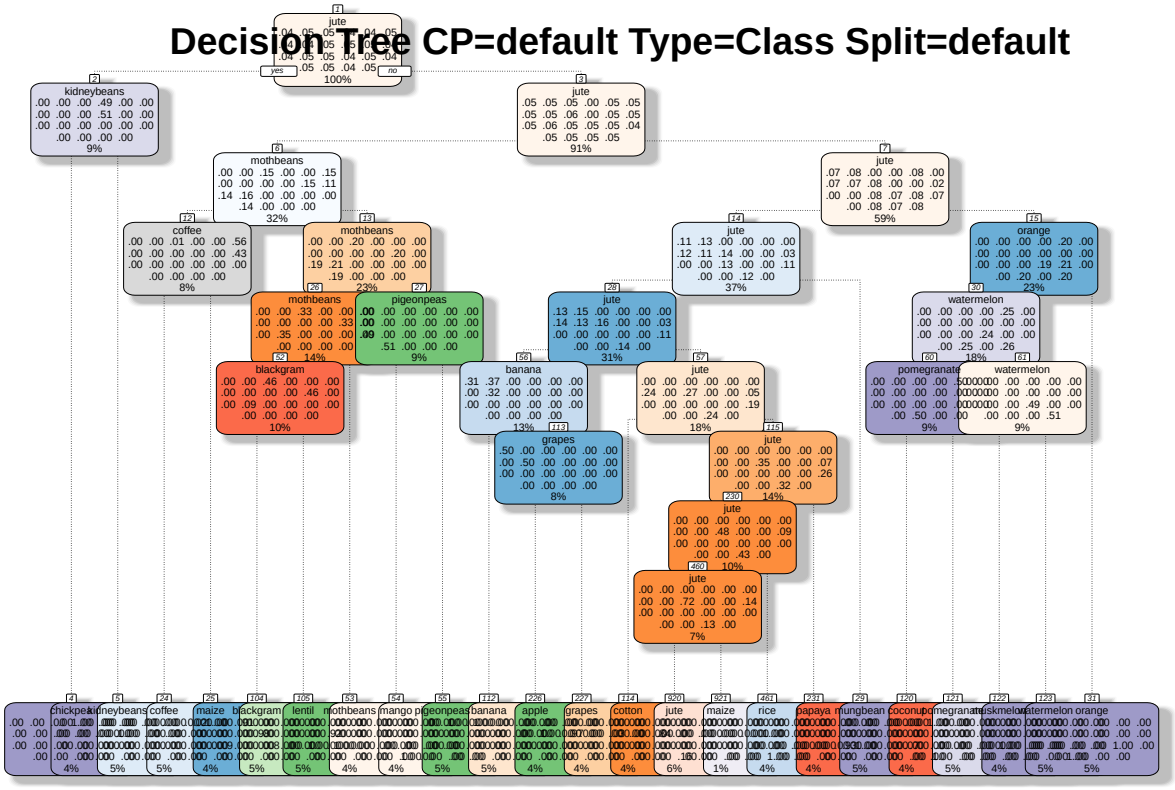


Visualizations

Decision Tree 1

```
par(new = F)
fancyRpartPlot(DT, main="Decision Tree CP=default Type=Class Split=default", cex=0.3)
```

```
## Warning: labs do not fit even at cex 0.15, there may be some overplotting
```



Prediction 2

Confusion Matrix and Heatmap

```
(DT_Prediction2= predict(DT2, MyTestSET, type = "class"))
```

```
##           1           3           4           9          10          12
##       jute        jute        jute        jute        jute        jute
##          18          24          31          37          43          44
##       jute        jute        jute        jute        jute        jute
##          47          56          59          69          70          73
##       jute        jute        jute        jute        jute        jute
```

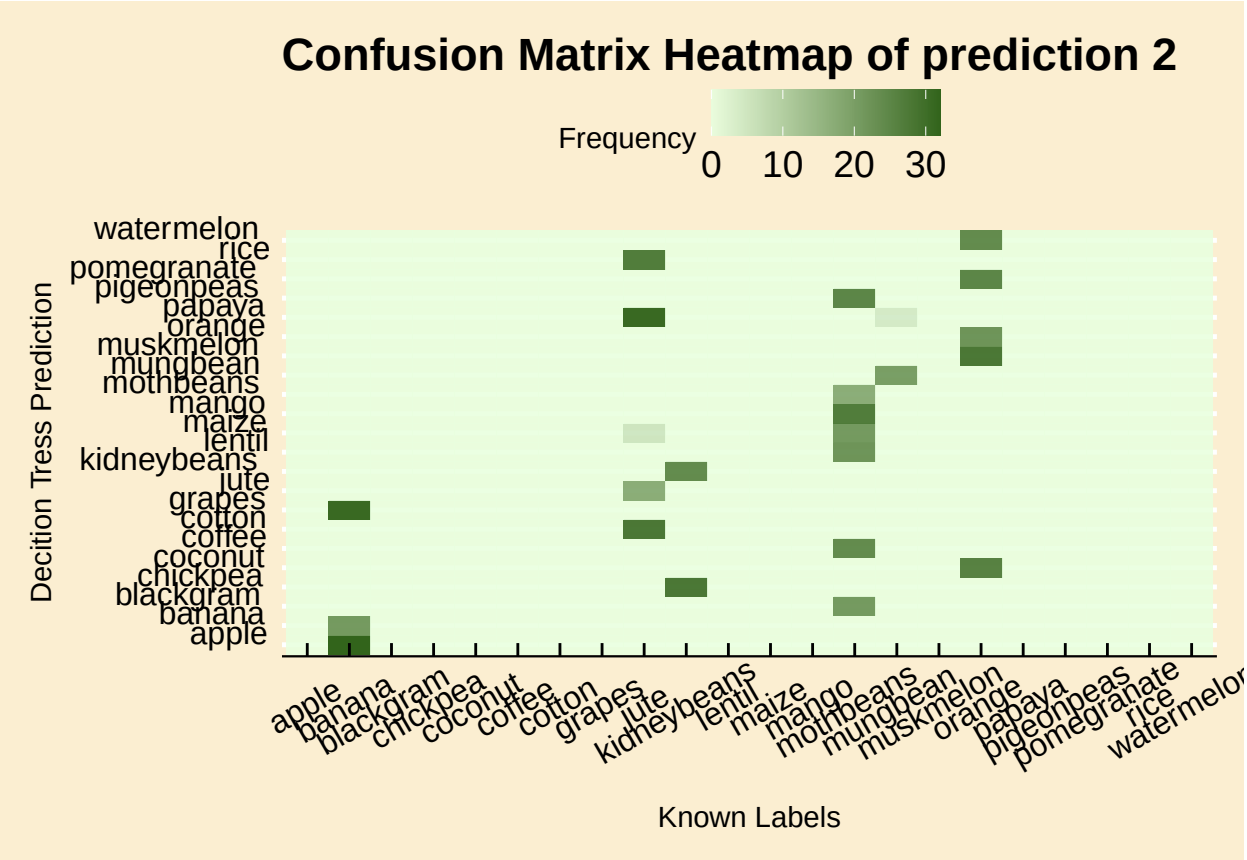
```
##          74          75          81          85          89          90
##        jute        jute        jute        jute        jute        jute
##          93          98          99         101         104         105
##        jute        jute        jute   mothbeans   mothbeans   mothbeans
##         108         114         122         126         130         139
##   mothbeans   mothbeans        jute   mothbeans   mothbeans        jute
##         140         143         144         146         147         149
##        jute   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##         150         152         154         157         158         172
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##         173         179         185         193         195         211
##   mothbeans        jute   mothbeans        jute   mothbeans kidneybeans
##         212         219         230         232         238         240
## kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans
##         244         248         252         253         255         257
## kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans
##         260         262         264         265         266         272
## kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans
##         273         274         285         287         289         290
## kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans
##         296         297         300         302         314         316
## kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans
##         317         322         323         325         327         330
## kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans
##         336         337         342         349         353         356
## kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans
##         358         359         360         363         370         374
## kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans
##         376         392         398         402         403         407
## kidneybeans kidneybeans kidneybeans   mothbeans   mothbeans   mothbeans
##         409         411         412         415         424         425
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##         426         427         430         432         433         435
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##         437         439         445         447         450         451
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##         457         466         470         494         512         513
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##         516         527         538         539         552         553
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##         558         560         564         565         567         575
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##         581         586         592         605         620         624
##   mothbeans   mothbeans   mothbeans    mungbean    mungbean    mungbean
##         628         631         641         646         651         654
##    mungbean    mungbean    mungbean    mungbean    mungbean    mungbean
##         657         661         663         665         666         672
##    mungbean    mungbean    mungbean    mungbean    mungbean    mungbean
##         675         676         678         691         692         705
##    mungbean    mungbean    mungbean    mungbean    mungbean   mothbeans
##         718         723         728         736         743         745
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##         749         750         753         756         766         767
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
```

```
##         774         781         787         795         797         798
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##         799         800         804         805         820         826
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##         829         832         842         847         855         856
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##         857         858         859         867         868         871
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##         873         878         881         887         889         900
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##         905         910         914         923         927         932
##      orange      orange      orange      orange      orange      orange
##         933         935         942         944         945         948
##      orange      orange      orange      orange      orange      orange
##         955         961         965         969         975         976
##      orange      orange      orange      orange      orange      orange
##         977         978         979         981         987         992
##      orange      orange      orange      orange      orange      orange
##         997        1007        1018        1021        1027        1030
##      orange      banana      banana      banana      banana      banana
##        1031        1033        1035        1036        1040        1043
##      banana      banana      banana      banana      banana      banana
##        1044        1048        1059        1071        1074        1076
##      banana      banana      banana      banana      banana      banana
##        1082        1085        1086        1089        1101        1102
##      banana      banana      banana      banana   mothbeans   mothbeans
##        1116        1117        1126        1133        1134        1137
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##        1140        1141        1149        1152        1161        1162
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##        1164        1166        1170        1172        1177        1180
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##        1182        1186        1187        1191        1197        1199
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##        1200        1204        1205        1213        1214        1220
##   mothbeans      banana      banana      banana      banana      banana
##        1221        1223        1224        1231        1232        1239
##      banana      banana      banana      banana      banana      banana
##        1243        1244        1246        1249        1250        1252
##      banana      banana      banana      banana      banana      banana
##        1253        1254        1257        1259        1263        1264
##      banana      banana      banana      banana      banana      banana
##        1270        1272        1273        1278        1280        1281
##      banana      banana      banana      banana      banana      banana
##        1283        1291        1303        1310        1311        1312
##      banana      banana      orange      orange      orange      orange
##        1317        1325        1334        1338        1341        1347
##      orange      orange      orange      orange      orange      orange
##        1353        1357        1359        1360        1361        1372
##      orange      orange      orange      orange      orange      orange
##        1375        1384        1388        1390        1391        1394
##      orange      orange      orange      orange      orange      orange
##        1397        1400        1414        1416        1420        1421
##      orange      orange      orange      orange      orange      orange
```

```
##        1425        1428        1431        1432        1436        1437
##      orange      orange      orange      orange      orange      orange
##        1438        1439        1440        1444        1449        1450
##      orange      orange      orange      orange      orange      orange
##        1455        1459        1460        1466        1472        1475
##      orange      orange      orange      orange      orange      orange
##        1476        1481        1482        1494        1497        1498
##      orange      orange      orange      orange      orange      orange
##        1504        1505        1508        1510        1511        1512
##      banana      banana      banana      banana      banana      banana
##        1514        1522        1523        1527        1530        1531
##      banana      banana      banana      banana      banana      banana
##        1533        1543        1545        1551        1552        1553
##      banana      banana      banana      banana      banana      banana
##        1554        1559        1562        1565        1569        1572
##      banana      banana      banana      banana      banana      banana
##        1580        1582        1583        1584        1585        1586
##      banana      banana      banana      banana      banana      banana
##        1591        1595        1602        1609        1610        1613
##      banana      banana      orange      orange      orange      orange
##        1627        1631        1632        1633        1640        1643
##      orange      orange      orange      orange      orange      orange
##        1644        1647        1655        1660        1663        1670
##      orange      orange      orange      orange      orange      orange
##        1672        1673        1680        1683        1687        1700
##      orange      orange      orange      orange      orange      orange
##        1703        1704        1710        1712        1714        1717
##        jute        jute        jute    mungbean        jute        jute
##        1727        1730        1732        1733        1737        1739
##        jute        jute    mungbean        jute        jute        jute
##        1740        1742        1746        1749        1753        1758
##        jute        jute        jute        jute        jute        jute
##        1759        1765        1766        1767        1768        1774
##        jute        jute        jute    mungbean        jute        jute
##        1777        1778        1779        1783        1786        1787
##        jute        jute        jute        jute        jute        jute
##        1791        1795        1797        1798        1799        1804
##        jute    mungbean        jute        jute        jute      orange
##        1808        1810        1815        1818        1820        1821
##      orange      orange      orange      orange      orange      orange
##        1824        1827        1831        1833        1834        1836
##      orange      orange      orange      orange      orange      orange
##        1837        1843        1845        1847        1854        1855
##      orange      orange      orange      orange      orange      orange
##        1860        1861        1871        1881        1882        1883
##      orange      orange      orange      orange      orange      orange
##        1893        1901        1902        1907        1914        1917
##      orange        jute        jute        jute        jute        jute
##        1922        1934        1941        1944        1945        1946
##        jute        jute        jute        jute        jute        jute
##        1947        1948        1949        1955        1956        1963
##        jute        jute        jute        jute        jute        jute
##        1965        1966        1967        1975        1976        1984
##        jute        jute        jute        jute        jute        jute
```

```
##        1985        1992        1996        1997        2000        2002
##        jute        jute        jute        jute        jute        jute
##        2005        2006        2016        2027        2030        2040
##        jute        jute        jute        jute        jute        jute
##        2041        2047        2053        2071        2077        2079
##        jute        jute        jute        jute        jute        jute
##        2080        2082        2083        2084        2114        2119
##        jute        jute        jute        jute   mothbeans   mothbeans
##        2120        2121        2122        2125        2126        2128
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##        2135        2141        2142        2151        2153        2161
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##        2171        2177        2178        2179        2188        2190
##   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans   mothbeans
##        2193        2194        2195        2196
##   mothbeans   mothbeans   mothbeans   mothbeans
## 22 Levels: apple banana blackgram chickpea coconut coffee cotton ... watermelon
```

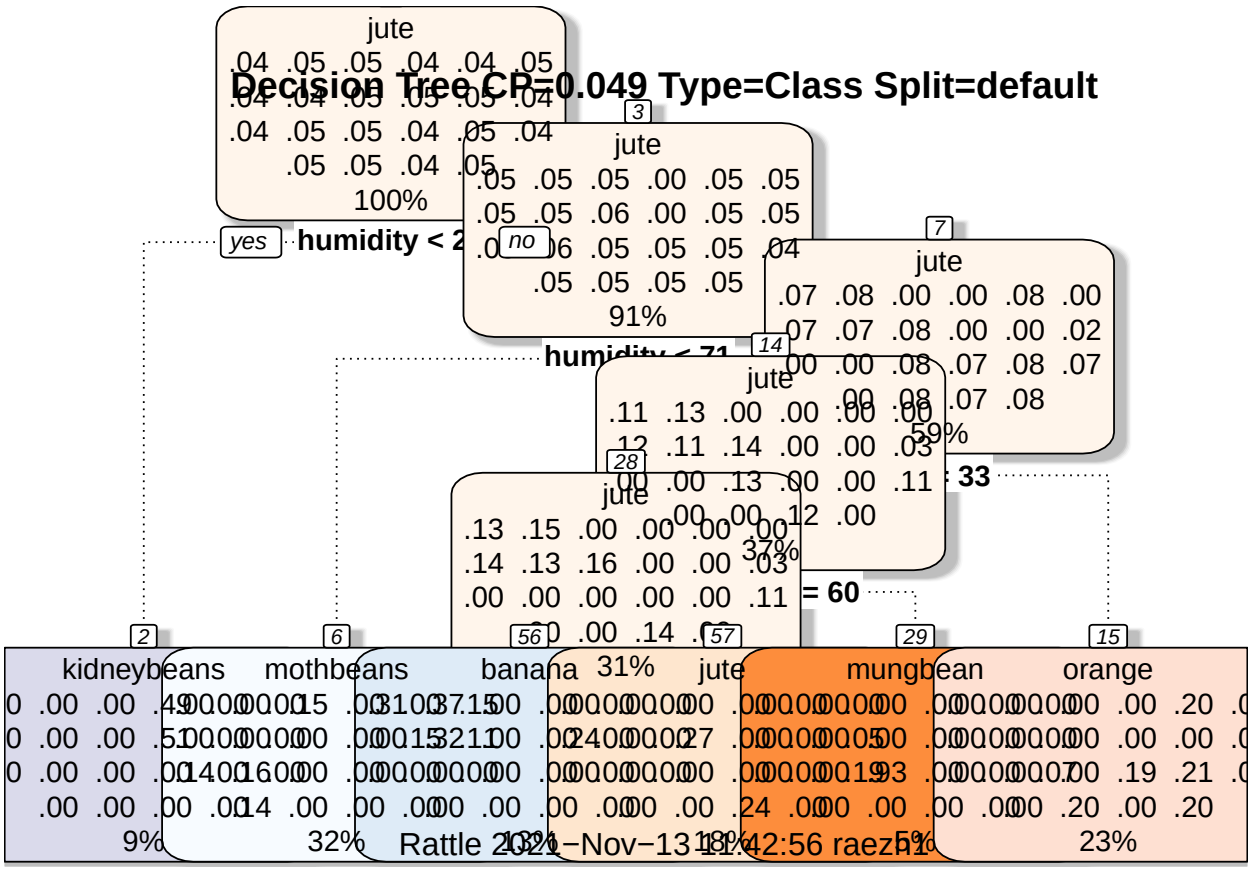
```
confusion_matrix <- table(DT_Prediction2, TestKnownLabels)
get_heatmap('Confusion Matrix Heatmap of prediction 2', DT_Prediction2)
```



Visualizations

Decision Tree 2

```
par(new = F)
fancyRpartPlot(DT2, cex=.9, main="Decision Tree CP=0.049 Type=Class Split=default")
```



Prediction 3

Confusion Matrix and Heatmap

```
(DT_Prediction3= predict(DT3, MyTestSET, type = "class"))
```

```
##           1           3           4           9          10          12
##        rice        rice        rice        rice        rice        rice
##          18          24          31          37          43          44
##        rice        rice        rice        rice        rice        rice
##          47          56          59          69          70          73
##        jute        rice        jute        rice        rice        rice
##          74          75          81          85          89          90
```

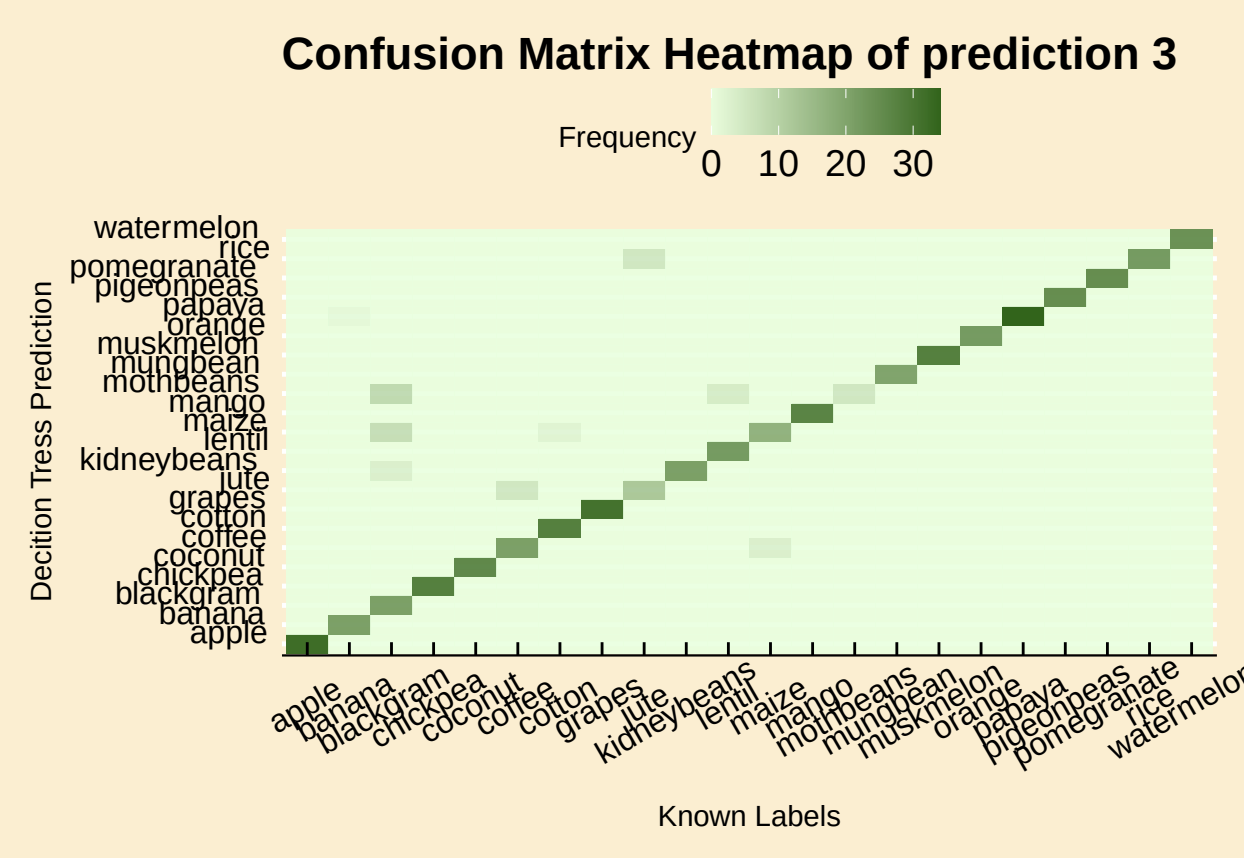
```
##        jute        rice        jute        rice        rice        rice
##          93          98          99         101         104         105
##        rice        rice        jute       maize   blackgram   blackgram
##         108         114         122         126         130         139
##       maize       maize       maize       maize       maize      cotton
##         140         143         144         146         147         149
##      cotton   blackgram       maize   blackgram       maize       maize
##         150         152         154         157         158         172
##   blackgram       maize       maize       maize       maize       maize
##         173         179         185         193         195         211
##   blackgram   blackgram       maize       maize       maize    chickpea
##         212         219         230         232         238         240
##    chickpea    chickpea    chickpea    chickpea    chickpea    chickpea
##         244         248         252         253         255         257
##    chickpea    chickpea    chickpea    chickpea    chickpea    chickpea
##         260         262         264         265         266         272
##    chickpea    chickpea    chickpea    chickpea    chickpea    chickpea
##         273         274         285         287         289         290
##    chickpea    chickpea    chickpea    chickpea    chickpea    chickpea
##         296         297         300         302         314         316
##    chickpea    chickpea    chickpea kidneybeans kidneybeans   blackgram
##         317         322         323         325         327         330
## kidneybeans kidneybeans   blackgram kidneybeans kidneybeans kidneybeans
##         336         337         342         349         353         356
## kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans
##         358         359         360         363         370         374
## kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans kidneybeans
##         376         392         398         402         403         407
##   blackgram kidneybeans kidneybeans  pigeonpeas  pigeonpeas  pigeonpeas
##         409         411         412         415         424         425
##  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas
##         426         427         430         432         433         435
##  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas
##         437         439         445         447         450         451
##  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas
##         457         466         470         494         512         513
##  pigeonpeas  pigeonpeas  pigeonpeas  pigeonpeas   blackgram   mothbeans
##         516         527         538         539         552         553
##   mothbeans   mothbeans   blackgram   blackgram   mothbeans   blackgram
##         558         560         564         565         567         575
##   blackgram   blackgram   blackgram   blackgram      lentil      lentil
##         581         586         592         605         620         624
##   mothbeans      lentil      lentil    mungbean    mungbean    mungbean
##         628         631         641         646         651         654
##    mungbean    mungbean    mungbean    mungbean    mungbean    mungbean
##         657         661         663         665         666         672
##    mungbean    mungbean    mungbean    mungbean    mungbean    mungbean
##         675         676         678         691         692         705
##    mungbean    mungbean    mungbean    mungbean    mungbean   blackgram
##         718         723         728         736         743         745
##   blackgram   blackgram   blackgram   blackgram   blackgram   blackgram
##         749         750         753         756         766         767
##   blackgram   blackgram   blackgram   blackgram   blackgram   blackgram
##         774         781         787         795         797         798
```

```
##   blackgram   blackgram   blackgram   blackgram   blackgram   blackgram
##         799         800         804         805         820         826
##   blackgram   blackgram      lentil      lentil      lentil      lentil
##         829         832         842         847         855         856
##      lentil      lentil      lentil      lentil      lentil      lentil
##         857         858         859         867         868         871
##      lentil      lentil      lentil      lentil      lentil      lentil
##         873         878         881         887         889         900
##      lentil      lentil      lentil      lentil      lentil      lentil
##         905         910         914         923         927         932
## pomegranate pomegranate pomegranate pomegranate pomegranate pomegranate
##         933         935         942         944         945         948
## pomegranate pomegranate pomegranate pomegranate pomegranate pomegranate
##         955         961         965         969         975         976
## pomegranate pomegranate pomegranate pomegranate pomegranate pomegranate
##         977         978         979         981         987         992
## pomegranate pomegranate pomegranate pomegranate pomegranate pomegranate
##         997        1007        1018        1021        1027        1030
## pomegranate      banana      banana      banana      banana      banana
##        1031        1033        1035        1036        1040        1043
##      banana      banana      banana      banana      banana      banana
##        1044        1048        1059        1071        1074        1076
##      banana      banana      banana      banana      banana      banana
##        1082        1085        1086        1089        1101        1102
##      banana      banana      banana      banana       mango       mango
##        1116        1117        1126        1133        1134        1137
##       mango       mango       mango       mango       mango       mango
##        1140        1141        1149        1152        1161        1162
##       mango       mango       mango       mango       mango       mango
##        1164        1166        1170        1172        1177        1180
##       mango       mango       mango       mango       mango       mango
##        1182        1186        1187        1191        1197        1199
##       mango       mango       mango       mango       mango       mango
##        1200        1204        1205        1213        1214        1220
##       mango      grapes      grapes      grapes      grapes      grapes
##        1221        1223        1224        1231        1232        1239
##      grapes      grapes      grapes      grapes      grapes      grapes
##        1243        1244        1246        1249        1250        1252
##      grapes      grapes      grapes      grapes      grapes      grapes
##        1253        1254        1257        1259        1263        1264
##      grapes      grapes      grapes      grapes      grapes      grapes
##        1270        1272        1273        1278        1280        1281
##      grapes      grapes      grapes      grapes      grapes      grapes
##        1283        1291        1303        1310        1311        1312
##      grapes      grapes  watermelon  watermelon  watermelon  watermelon
##        1317        1325        1334        1338        1341        1347
##  watermelon  watermelon  watermelon  watermelon  watermelon  watermelon
##        1353        1357        1359        1360        1361        1372
##  watermelon  watermelon  watermelon  watermelon  watermelon  watermelon
##        1375        1384        1388        1390        1391        1394
##  watermelon  watermelon  watermelon  watermelon  watermelon  watermelon
##        1397        1400        1414        1416        1420        1421
##  watermelon  watermelon   muskmelon   muskmelon   muskmelon   muskmelon
##        1425        1428        1431        1432        1436        1437
```

```
##   muskmelon   muskmelon   muskmelon   muskmelon   muskmelon   muskmelon
##        1438        1439        1440        1444        1449        1450
##   muskmelon   muskmelon   muskmelon   muskmelon   muskmelon   muskmelon
##        1455        1459        1460        1466        1472        1475
##   muskmelon   muskmelon   muskmelon   muskmelon   muskmelon   muskmelon
##        1476        1481        1482        1494        1497        1498
##   muskmelon   muskmelon   muskmelon   muskmelon   muskmelon   muskmelon
##        1504        1505        1508        1510        1511        1512
##       apple       apple       apple       apple       apple       apple
##        1514        1522        1523        1527        1530        1531
##       apple       apple       apple       apple       apple       apple
##        1533        1543        1545        1551        1552        1553
##       apple       apple       apple       apple       apple       apple
##        1554        1559        1562        1565        1569        1572
##       apple       apple       apple       apple       apple       apple
##        1580        1582        1583        1584        1585        1586
##       apple       apple       apple       apple       apple       apple
##        1591        1595        1602        1609        1610        1613
##       apple       apple      orange      orange      orange      orange
##        1627        1631        1632        1633        1640        1643
##      orange      orange      orange      orange      orange      orange
##        1644        1647        1655        1660        1663        1670
##      orange      orange      orange      orange      orange      orange
##        1672        1673        1680        1683        1687        1700
##      orange      orange      orange      orange      orange      orange
##        1703        1704        1710        1712        1714        1717
##      papaya      papaya      papaya      papaya      papaya      papaya
##        1727        1730        1732        1733        1737        1739
##      papaya      papaya      papaya      papaya      papaya      papaya
##        1740        1742        1746        1749        1753        1758
##      papaya      papaya      papaya      papaya      papaya      papaya
##        1759        1765        1766        1767        1768        1774
##      papaya      papaya      papaya      papaya      papaya      papaya
##        1777        1778        1779        1783        1786        1787
##      papaya      papaya      papaya      papaya      papaya      papaya
##        1791        1795        1797        1798        1799        1804
##      papaya      banana      papaya      papaya      papaya     coconut
##        1808        1810        1815        1818        1820        1821
##     coconut     coconut     coconut     coconut     coconut     coconut
##        1824        1827        1831        1833        1834        1836
##     coconut     coconut     coconut     coconut     coconut     coconut
##        1837        1843        1845        1847        1854        1855
##     coconut     coconut     coconut     coconut     coconut     coconut
##        1860        1861        1871        1881        1882        1883
##     coconut     coconut     coconut     coconut     coconut     coconut
##        1893        1901        1902        1907        1914        1917
##     coconut      cotton      cotton      cotton      cotton      cotton
##        1922        1934        1941        1944        1945        1946
##      cotton      cotton      cotton      cotton      cotton      cotton
##        1947        1948        1949        1955        1956        1963
##      cotton      cotton      cotton      cotton      cotton      cotton
##        1965        1966        1967        1975        1976        1984
##      cotton      cotton      cotton      cotton      cotton      cotton
##        1985        1992        1996        1997        2000        2002
```

```
##      cotton      cotton      cotton      cotton      cotton        jute
##        2005        2006        2016        2027        2030        2040
##      coffee      coffee        jute        jute        jute      coffee
##        2041        2047        2053        2071        2077        2079
##        jute        jute        jute        jute        jute        jute
##        2080        2082        2083        2084        2114        2119
##        jute        jute      coffee      coffee      coffee      coffee
##        2120        2121        2122        2125        2126        2128
##      coffee      coffee      coffee      coffee      coffee      coffee
##        2135        2141        2142        2151        2153        2161
##      coffee       maize       maize       maize      coffee      coffee
##        2171        2177        2178        2179        2188        2190
##      coffee      coffee      coffee      coffee      coffee      coffee
##        2193        2194        2195        2196
##      coffee      coffee      coffee      coffee
## 22 Levels: apple banana blackgram chickpea coconut coffee cotton ... watermelon
```

```
confusion_matrix <- table(DT_Prediction3, TestKnownLabels)
get_heatmap('Confusion Matrix Heatmap of prediction 3', DT_Prediction3)
```



Visualizations

Decision Tree 3

```
par(new = F)
rattle::fancyRpartPlot(DT3,main="Decision Tree CP=0.02 Type=Class Split=information", cex=.4)
```