

# Biplot

Demetrio Sanchez Jimenez

2022-06-09

## Introduccion

## BIPLOT

Se cargan las librerías necesesarias:

Se carga la matriz de datos:

```
vinos <- read_excel("C:/Users/Demetrio Sanchez/Downloads/vinos.xls")
BD<-as.data.frame(vinos)[,-1]
```

## Exploracion de matriz

```
#Dimensión de la matriz.
dim(BD)
```

```
## [1] 45 21
```

```
colnames(BD)
```

```
## [1] "a_o"      "denomina" "grupo"    "grado"    "avol"     "atot"
## [7] "acfi"     "ph"        "folin"    "somers"   "srv"      "procian"
## [13] "acrg"     "acse"      "achplc"   "ic"       "ic2"      "tono"
## [19] "iim"      "eq1"       "vla"
```

```
str(BD)
```

```
## 'data.frame': 45 obs. of 21 variables:
## $ a_o : num 1 1 1 1 1 1 1 1 1 1 ...
## $ denomina: num 1 1 1 1 1 1 1 1 1 1 ...
## $ grupo : num 1 1 1 1 1 1 1 1 1 1 ...
## $ grado : num 12.8 12.8 12.5 11.9 12.5 12.1 12.2 12.6 13 12.4 ...
## $ avol : num 1.2 0.75 1 0.7 0.95 0.5 0.8 0.4 0.4 0.35 ...
## $ atot : num 6.7 6.9 7.2 7.7 7.7 5.8 5.9 5.4 4.6 5.5 ...
## $ acfi : num 5.2 6 6 6.8 6.3 5.2 4.9 4.9 4.1 5 ...
## $ ph : num 3.7 3.5 3.6 3.3 3.6 3.2 3.4 3.3 3.6 3.3 ...
## $ folin : num 2827 1818 1459 2054 2930 ...
```

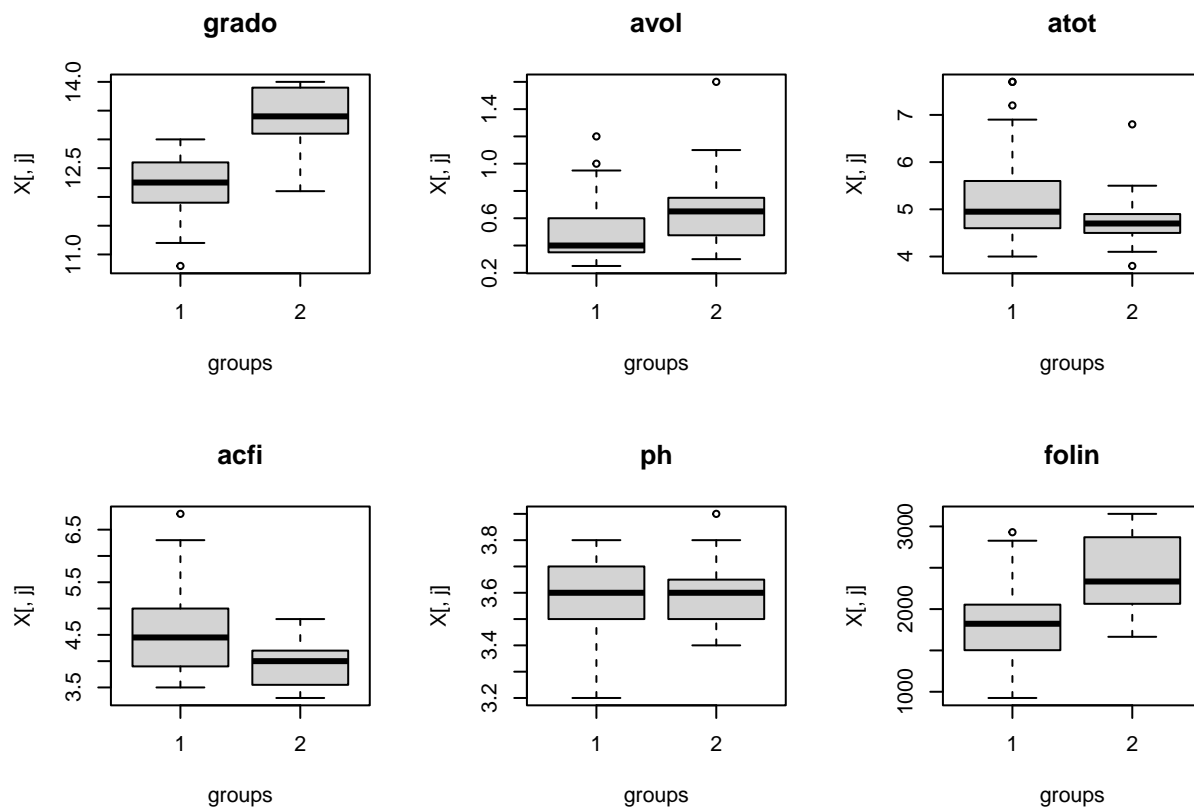
```
## $ somers : num 50.8 37.8 35.1 32.1 49.6 30.6 35.6 30.6 41.7 30 ...
## $ srv    : num 811 968 866 978 1128 ...
## $ procian : num 3794 1736 2306 3420 3158 ...
## $ acrg    : num 386 144 225 204 214 167 252 315 293 152 ...
## $ acse    : num 287 141 132 110 148 95 160 124 170 67 ...
## $ achplc  : num 181 69 78 84 75 74 101 101 137 56 ...
## $ ic      : num 7.81 4.88 5.52 4.64 6.99 3.98 7.6 6.15 6.6 5.49 ...
## $ ic2     : num 8.95 5.55 6.35 5.15 7.87 4.36 8.84 7.11 7.85 6.23 ...
## $ tono    : num 0.72 0.755 0.456 0.675 0.672 0.716 0.716 0.74 0.93 0.75 ...
## $ iim     : num 18.4 23.6 36.8 36.4 34.2 38.1 28.5 27.7 21.6 30.3 ...
## $ eq1     : num 0.489 0.48 0.598 0.42 0.45 0.434 0.501 0.566 0.557 0.689 ...
## $ vla     : num 0.21 0.56 0.38 0.29 0.36 0.3 0.24 0.4 0.28 0.26 ...
```

```
BD$denomina = as.factor(BD$denomina)
BD$grupo = as.factor(BD$grupo)
```

## Gráficos de exploración

```
BX1<-BoxPlotPanel(BD[,4:9], nrow=2, groups=BD$denomina)
```

```
## [1] 2
```

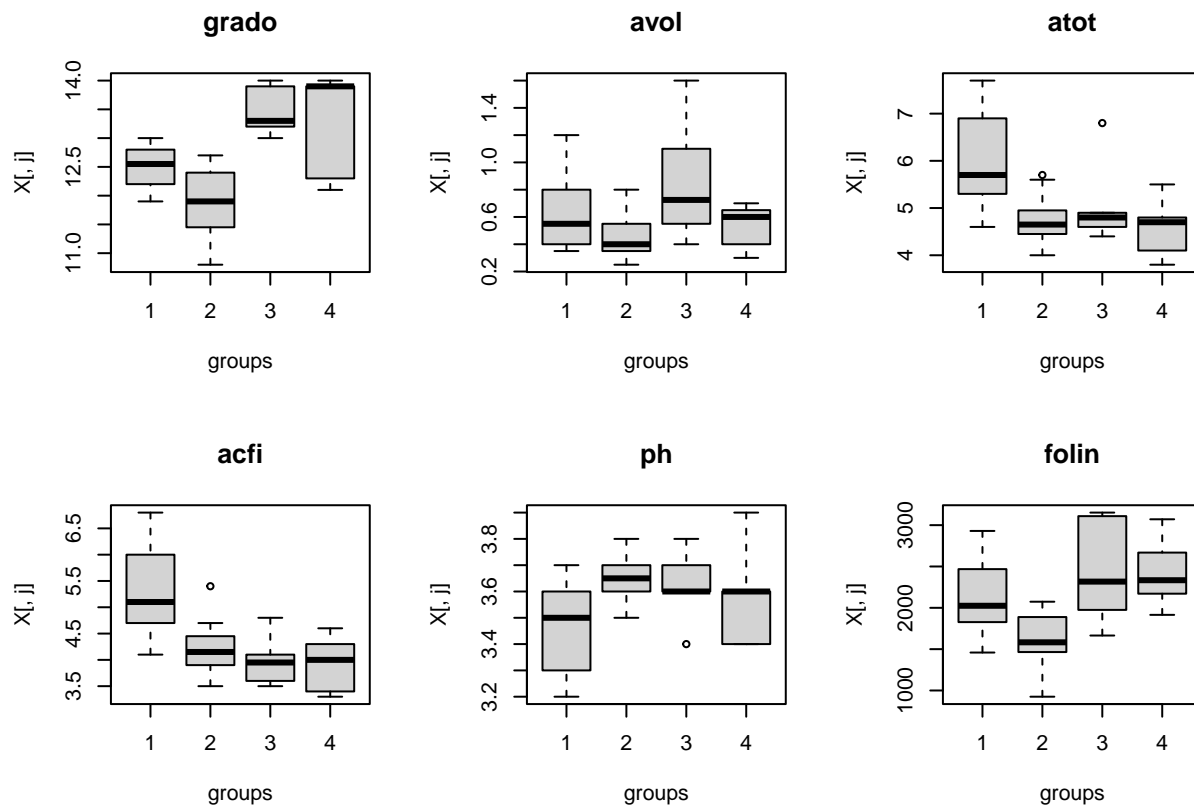


```
BX1
```

```
## $mfrow  
## [1] 2 3
```

```
BX2<-BoxPlotPanel(BD[,4:9], nrow=2, groups=BD$grupo)
```

```
## [1] 2
```



```
BX2
```

```
## $mfrow  
## [1] 2 3
```

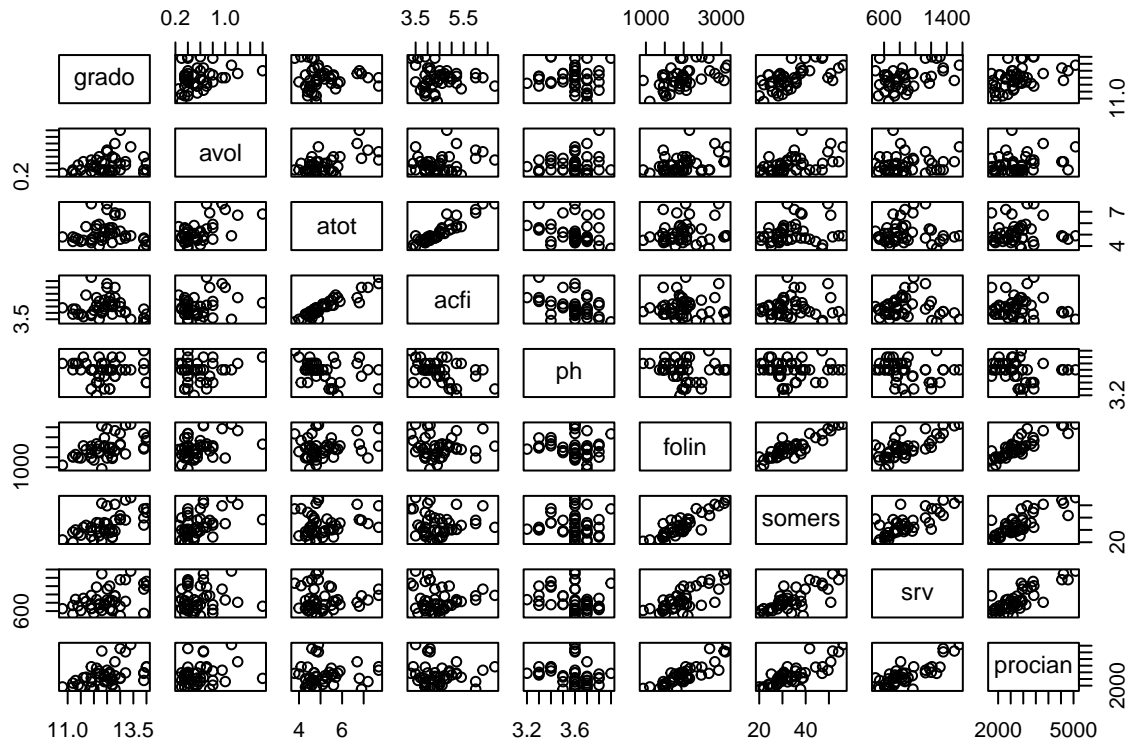
## Filtrado de variables

### 1.- Selección de variables numéricas

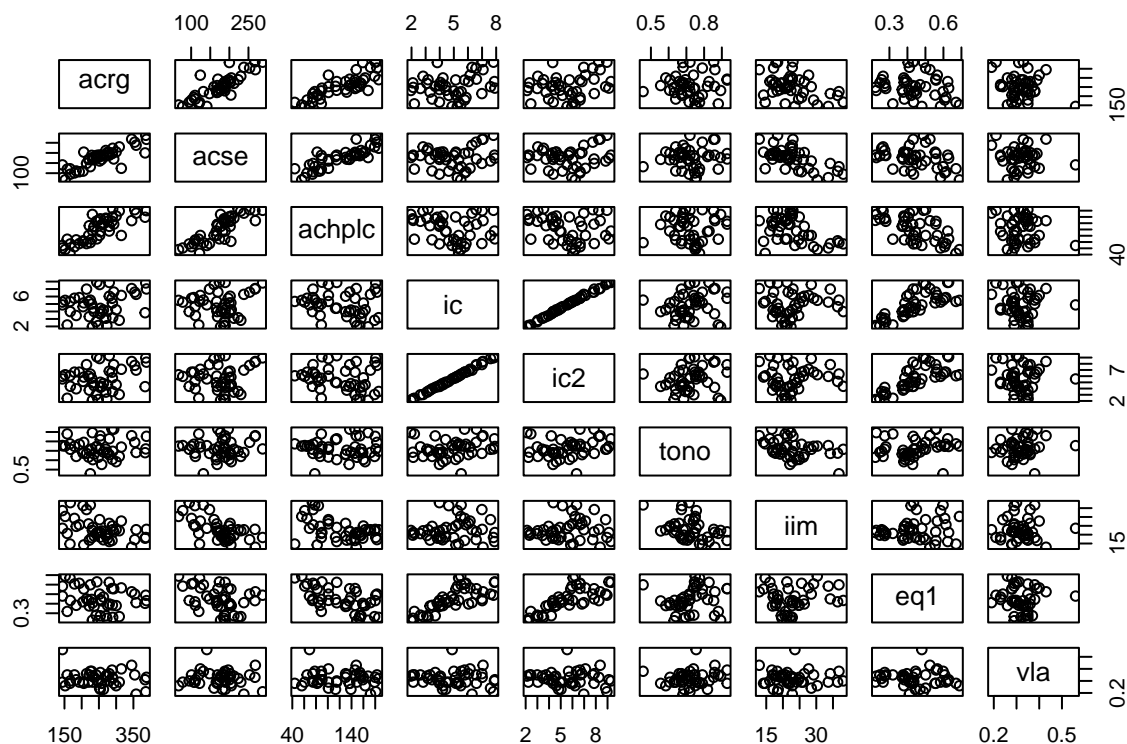
```
X<-BD[,4:21]
```

## 2.- Generación del scatter plot

```
PL1<-plot(X[,1:9])
```



```
PL2<-plot(X[,10:18])
```



## Reducción de la dimensionalidad

### 1.- ACP

```
acpvino<-PCA.Analysis(X,Scaling = 5)
summary(acpvino)
```

```
## ##### Principal Components Analysis #####
##
## Transformation of the raw data:
## [1] "Standardize columns"
##
## Eigenvalues & Explained Variance (Inertia)
##      Eigenvalue Exp. Var Cumulative
## [1,]  277.12688   34.991    34.991
## [2,]  199.36534   25.172    60.163
## [3,]   85.42317   10.786    70.949
##
##
## STRUCTURE OF THE PRINCIPAL COMPONENTS
##      Dim 1 Dim 2 Dim 3
## grado  -0.676 -0.142  0.188
## avol   -0.450  0.204 -0.519
```

```
## atot      -0.225  0.738 -0.526
## acfi      -0.063  0.797 -0.397
## ph        0.191 -0.593 -0.193
## folin     -0.910 -0.094 -0.072
## somers    -0.920 -0.154 -0.090
## srv       -0.798 -0.088  0.277
## procian   -0.873 -0.102  0.036
## acrg      -0.301 -0.726 -0.441
## acse      -0.213 -0.856 -0.372
## achplc    0.119 -0.830 -0.355
## ic        -0.926  0.117 -0.074
## ic2       -0.932  0.095 -0.048
## tono      -0.351 -0.290  0.612
## iim       0.021  0.810 -0.179
## eq1       -0.688  0.416  0.255
## vla       0.006  0.071  0.368
```

## 2.- Contenido del objeto acpvino

```
names(acpvino)
```

```
## [1] "Title"           "Type"           "call"
## [4] "Non_Scaled_Data" "alpha"          "Dimension"
## [7] "Means"          "Medians"        "Deviations"
## [10] "Minima"         "Maxima"         "P25"
## [13] "P75"           "GMean"          "Initial_Transformation"
## [16] "Scaled_Data"    "nrows"          "ncols"
## [19] "nrowsSup"      "ncolsSup"       "dim"
## [22] "EigenValues"   "Inertia"        "CumInertia"
## [25] "EV"            "Structure"      "RowCoordinates"
## [28] "ColCoordinates" "RowContributions" "ColContributions"
## [31] "Scale_Factor"  "ClusterType"    "Clusters"
## [34] "ClusterColors" "ClusterNames"
```

## 3.- Generación del gráfico sin caja

```
acp1<-plot(acpvino, ShowBox=FALSE)
```

[illegible]

```
acp2<-princomp(X, cor=TRUE, score=TRUE)
plot(acp2)
```

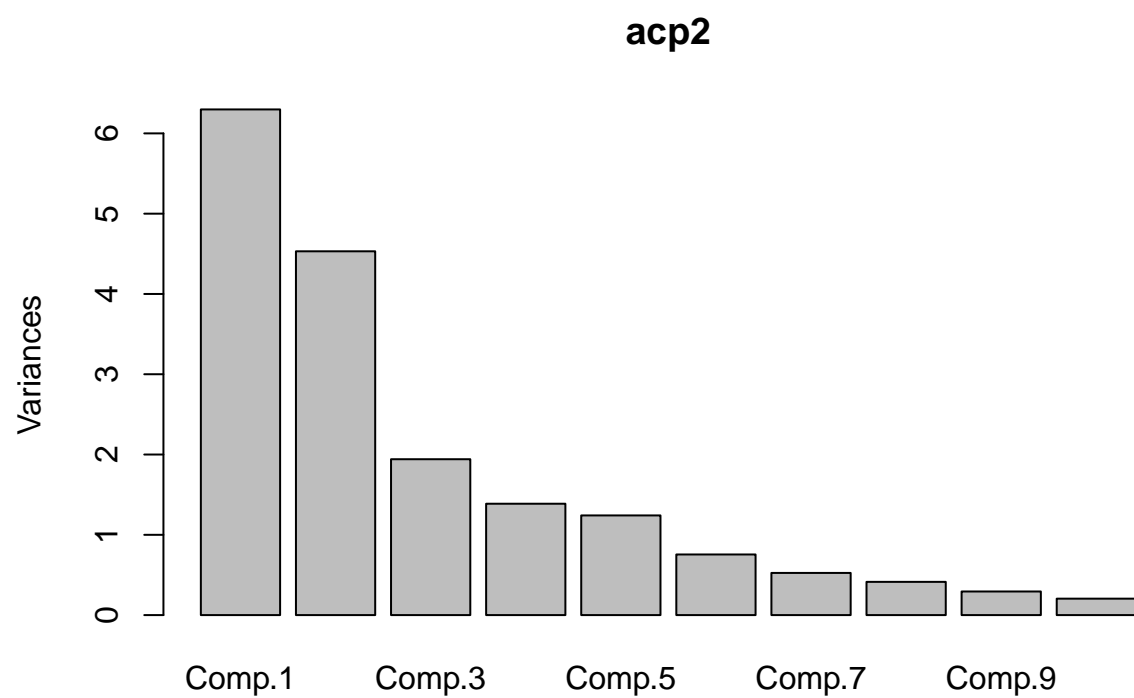
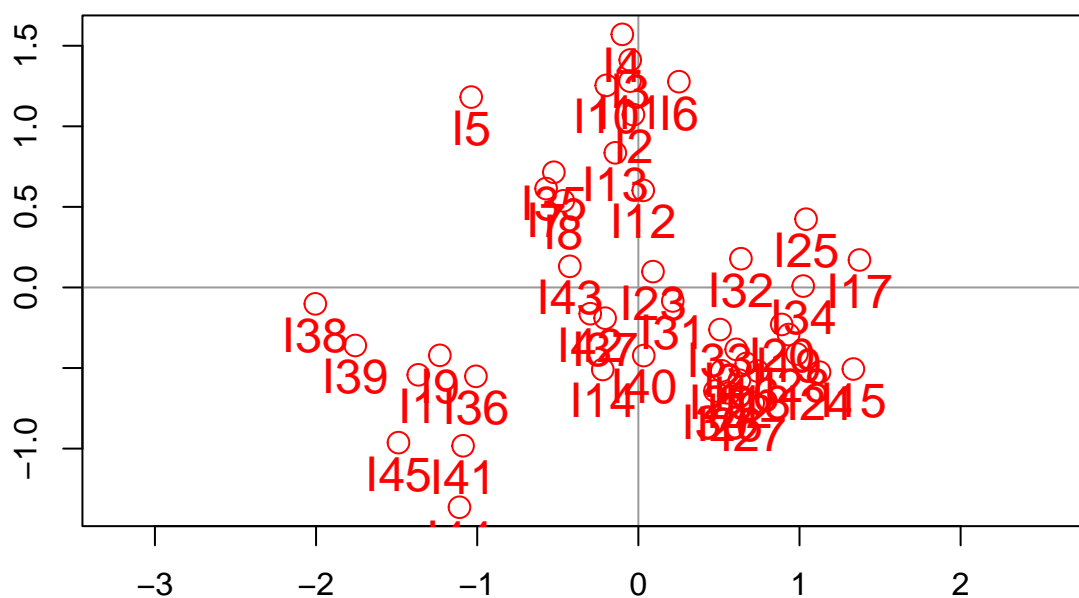


Gráfico circular de correlación

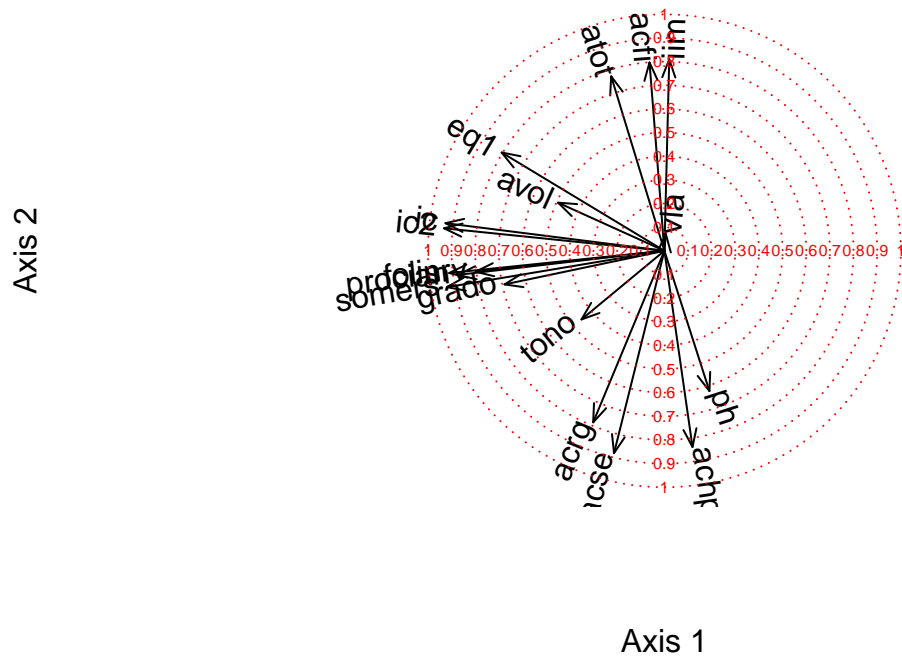
```
acp3<-plot(acpvino, CorrelationCircle=TRUE,  
           ShowAxis=TRUE, CexInd=1.5)
```



# Principal Components Analysis (Dim 1 ( 35 %)- 2 ( 25.2 %))



## Principal Components Analysis – Correlation Circle



Agregar grupos al biplot definido por usuario

```
acpvino1<-AddCluster2Biplot(acpvino, ClusterType="us",
                             Groups = BD$grupo)
```

Grafico con poligonos

CexInd= tamaño de los argumentos

```
acp4<-plot(acpvino1, PlotClus=TRUE,
            ClustCenters=TRUE, margin=0.05,
            CexInd=0.7, ShowBox=TRUE)
```

## Principal Components Analysis (Dim 1 ( 35 %)- 2 ( 25.2 %))

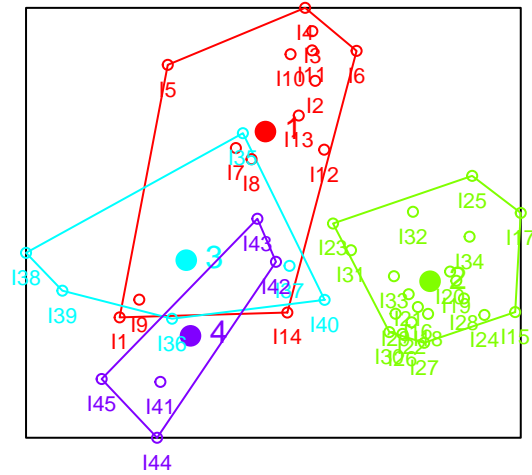


Gráfico con elipses

```
acp5<-plot(acpvino1, PlotClus=TRUE, ClustCenters=TRUE,  
margin=0.05, CexInd=0.7, TypeClus="el",  
ShowBox=F)
```

## Principal Components Analysis (Dim 1 ( 35 %)- 2 ( 25.2 %))

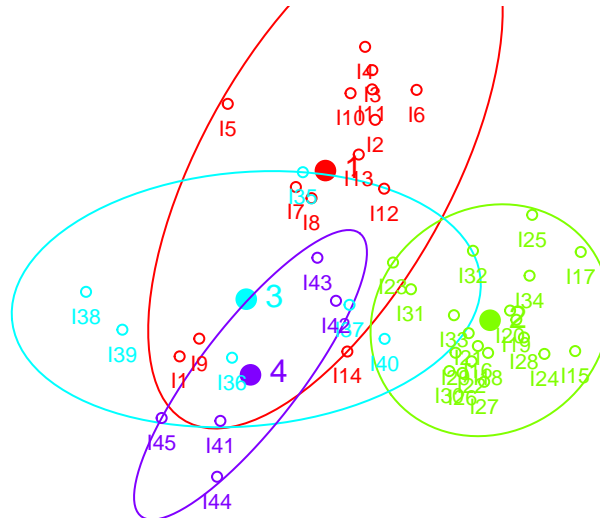
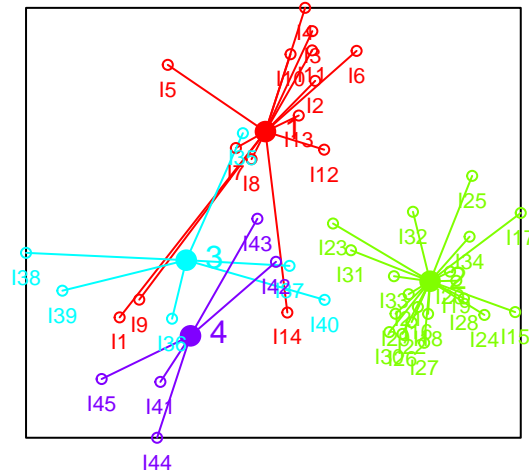


Gráfico con estrellas

```
acp6<-plot(acpvino1, PlotClus=TRUE, ClustCenters=TRUE,  
margin=0.05, CexInd=0.7, TypeClus="st",  
ShowBox=TRUE)
```

## Principal Components Analysis (Dim 1 ( 35 %)- 2 ( 25.2 %))



### Aplicacion del Biplot

Predeterminado JK

```
bipvino<-PCA.Biplot(X, Scaling = 5)
summary(bipvino)
```

```
## ##### Biplot for Principal Components Analysis #####
##
## Call
## PCA.Biplot(X = X, Scaling = 5)
## Type of coordinates:
## Transformation of the raw data:
## [1] "Standardize columns"
## Type of Biplot
## [1] "PCA"
##
## Eigenvalues & Explained Variance (Inertia)
##      Eigenvalue Exp. Var Cumulative
## [1,]  277.12688   34.991    34.991
## [2,]  199.36534   25.172    60.163
## [3,]   85.42317   10.786    70.949
##
##
```

# ## RELATIVE CONTRIBUTIONS OF THE FACTOR TO THE ELEMENT

##

## ## Row Contributions

## Dim 1 Dim 2 Dim 3

## I1	42.04	6.63	44.06
## I2	0.03	32.75	2.51
## I3	0.07	57.27	18.53
## I4	0.28	70.89	8.84
## I5	29.69	38.53	12.87
## I6	2.64	67.95	1.86
## I7	23.63	27.17	9.95
## I8	15.06	20.09	8.55
## I9	60.32	7.05	10.79
## I10	1.55	61.24	11.60
## I11	0.12	74.78	12.48
## I12	0.09	35.48	28.14
## I13	1.68	57.21	29.79
## I14	2.95	15.65	39.81
## I15	64.41	9.27	3.81
## I16	35.26	17.46	4.85
## I17	63.73	0.99	14.28
## I18	51.05	25.08	0.12
## I19	75.88	7.45	9.01
## I20	77.10	5.13	0.77
## I21	24.48	9.79	18.31
## I22	30.80	25.95	0.05
## I23	2.08	2.45	0.20
## I24	71.22	15.56	0.82
## I25	72.83	12.08	2.23
## I26	32.34	43.51	1.52
## I27	35.29	35.58	11.66
## I28	63.06	11.10	3.65
## I29	16.99	16.98	27.32
## I30	17.97	32.85	0.25
## I31	9.13	1.41	35.53
## I32	55.95	4.40	3.60
## I33	28.58	7.60	26.59
## I34	67.06	0.00	4.97
## I35	7.12	13.24	1.64
## I36	41.97	12.56	27.66
## I37	4.81	4.11	20.46
## I38	83.21	0.21	0.95
## I39	88.41	3.71	2.38
## I40	0.08	13.31	0.69
## I41	42.39	34.59	1.36
## I42	9.24	2.75	29.92
## I43	23.86	2.26	7.75
## I44	29.74	44.90	6.03
## I45	56.52	23.65	1.05

##

## ## Column Contributions

## Dim 1 Dim 2 Dim 3

## grado	45.71	2.02	3.54
## avol	20.23	4.14	26.96

```

## atot      5.06 54.44 27.69
## acfi      0.40 63.45 15.73
## ph        3.63 35.20  3.72
## folin     82.89  0.89  0.52
## somers    84.58  2.36  0.81
## srv       63.74  0.78  7.65
## procian   76.19  1.04  0.13
## acrg       9.08 52.64 19.41
## acse       4.54 73.25 13.87
## achplc     1.41 68.84 12.61
## ic        85.75  1.37  0.54
## ic2       86.89  0.91  0.23
## tono      12.30  8.43 37.44
## iim        0.04 65.55  3.20
## eq1       47.38 17.28  6.51
## vla        0.00  0.51 13.58
##
##
##
## Qualities of representation of the rows (Cummulative contributions)
##      Dim 1 Dim 2 Dim 3
## I1  42.04 48.67 92.73
## I2   0.03 32.78 35.29
## I3   0.07 57.34 75.87
## I4   0.28 71.17 80.01
## I5  29.69 68.22 81.09
## I6   2.64 70.59 72.45
## I7  23.63 50.80 60.75
## I8  15.06 35.15 43.70
## I9  60.32 67.37 78.16
## I10  1.55 62.79 74.39
## I11  0.12 74.90 87.38
## I12  0.09 35.57 63.71
## I13  1.68 58.89 88.68
## I14  2.95 18.60 58.41
## I15 64.41 73.68 77.49
## I16 35.26 52.72 57.57
## I17 63.73 64.72 79.00
## I18 51.05 76.13 76.25
## I19 75.88 83.33 92.34
## I20 77.10 82.23 83.00
## I21 24.48 34.27 52.58
## I22 30.80 56.75 56.80
## I23  2.08  4.53  4.73
## I24 71.22 86.78 87.60
## I25 72.83 84.91 87.14
## I26 32.34 75.85 77.37
## I27 35.29 70.87 82.53
## I28 63.06 74.16 77.81
## I29 16.99 33.97 61.29
## I30 17.97 50.82 51.07
## I31  9.13 10.54 46.07
## I32 55.95 60.35 63.95
## I33 28.58 36.18 62.77

```

```
## I34 67.06 67.06 72.03
## I35 7.12 20.36 22.00
## I36 41.97 54.53 82.19
## I37 4.81 8.92 29.38
## I38 83.21 83.42 84.37
## I39 88.41 92.12 94.50
## I40 0.08 13.39 14.08
## I41 42.39 76.98 78.34
## I42 9.24 11.99 41.91
## I43 23.86 26.12 33.87
## I44 29.74 74.64 80.67
## I45 56.52 80.17 81.22
##
##
##
## Qualities of representation of the columns (Cummulative contributions)
##      Dim 1 Dim 2 Dim 3
## grado 45.71 47.73 51.27
## avol 20.23 24.37 51.33
## atot 5.06 59.50 87.19
## acfi 0.40 63.85 79.58
## ph 3.63 38.83 42.55
## folin 82.89 83.78 84.30
## somers 84.58 86.94 87.75
## srv 63.74 64.52 72.17
## procian 76.19 77.23 77.36
## acrg 9.08 61.72 81.13
## acse 4.54 77.79 91.66
## achplc 1.41 70.25 82.86
## ic 85.75 87.12 87.66
## ic2 86.89 87.80 88.03
## tono 12.30 20.73 58.17
## iim 0.04 65.59 68.79
## eq1 47.38 64.66 71.17
## vla 0.00 0.51 14.09
```

## Valores propios

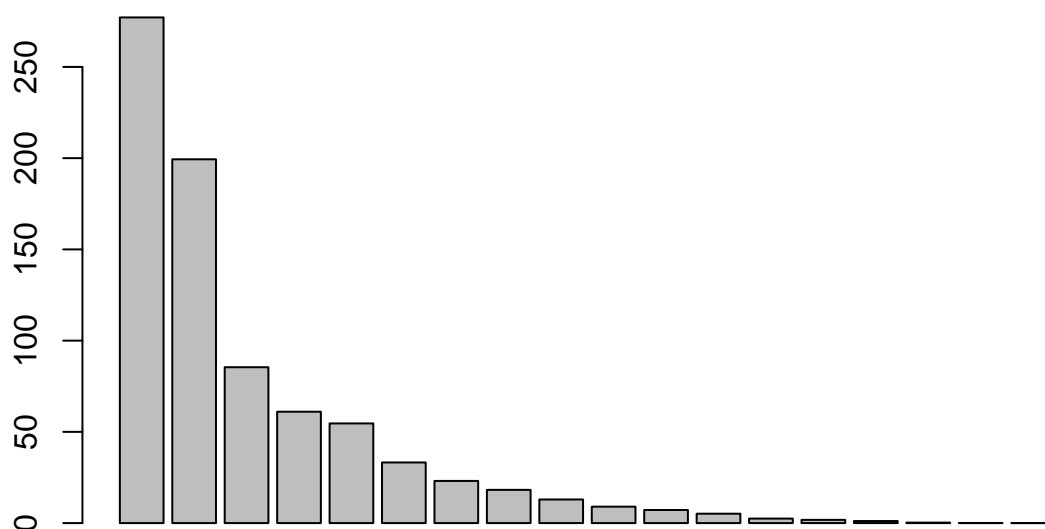
```
bipvino$EigenValues
```

```
## [1] 277.12687550 199.36534193 85.42316719 61.02361652 54.61472549
## [6] 33.21950770 23.10087611 18.20271969 12.93567822 8.99721387
## [11] 7.17039349 5.14634483 2.46693118 1.76863760 1.12884586
## [16] 0.26153511 0.02966717 0.01792254
```

## Screeplot

```
SC<-barplot(bipvino$EigenValues)
```





## Vectores propios

bipvino\$EV

```
##           [,1]      [,2]      [,3]
## [1,] -0.269400471 -0.06678758  0.13502664
## [2,] -0.179235894  0.09563188 -0.37266607
## [3,] -0.089642289  0.34663991 -0.37767939
## [4,] -0.025075364  0.37420670 -0.28461188
## [5,]  0.075921760 -0.27872944 -0.13842752
## [6,] -0.362771201 -0.04421297 -0.05176113
## [7,] -0.366464498 -0.07220257 -0.06472232
## [8,] -0.318130606 -0.04157401  0.19854164
## [9,] -0.347804576 -0.04785685  0.02584725
## [10,] -0.120049408 -0.34086254 -0.31617278
## [11,] -0.084888000 -0.40207820 -0.26728099
## [12,]  0.047378644 -0.38977456 -0.25488092
## [13,] -0.368971746  0.05491570 -0.05287232
## [14,] -0.371435455  0.04476039 -0.03421019
## [15,] -0.139772430 -0.13640832  0.43913353
## [16,]  0.008178563  0.38035721 -0.12838425
## [17,] -0.274261123  0.19527349  0.18313281
## [18,]  0.002361018  0.03345360  0.26444673
```

## Tabla de inercias

```
Inercias<-data.frame(paste("Eje",1:length(bipvino$EigenValues)),
                     bipvino$EigenValues, bipvino$Inertia,
                     bipvino$CumInertia)
colnames(Inercias)<-c("Eje", "Valor Propio",
                     "Inercia", "Inercia acumulada")
kable(Inercias)
```

Eje	Valor Propio	Inercia	Inercia acumulada
Eje 1	277.1268755	34.991	34.991
Eje 2	199.3653419	25.172	60.163
Eje 3	85.4231672	10.786	70.949
Eje 4	61.0236165	7.705	78.654
Eje 5	54.6147255	6.896	85.550
Eje 6	33.2195077	4.194	89.744
Eje 7	23.1008761	2.917	92.661
Eje 8	18.2027197	2.298	94.959
Eje 9	12.9356782	1.633	96.592
Eje 10	8.9972139	1.136	97.728
Eje 11	7.1703935	0.905	98.633
Eje 12	5.1463448	0.650	99.283
Eje 13	2.4669312	0.311	99.594
Eje 14	1.7686376	0.223	99.817
Eje 15	1.1288459	0.143	99.960
Eje 16	0.2615351	0.033	99.993
Eje 17	0.0296672	0.004	99.997
Eje 18	0.0179225	0.002	99.999

## Tabla contribución de columnas

```
kable(bipvino$ColContributions)
```

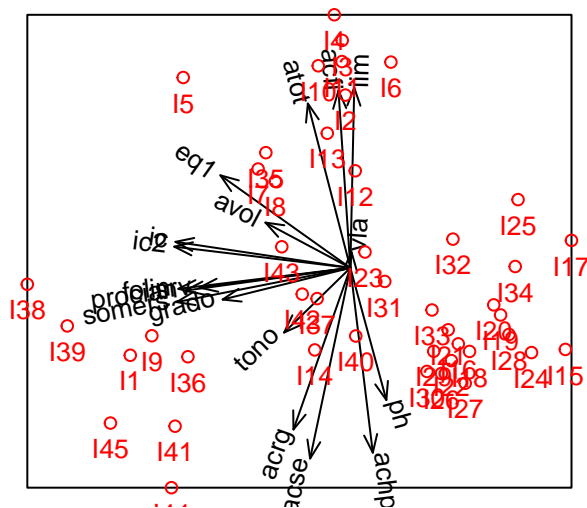
	Dim 1	Dim 2	Dim 3
grado	45.71	2.02	3.54
avol	20.23	4.14	26.96
atot	5.06	54.44	27.69
acfi	0.40	63.45	15.73
ph	3.63	35.20	3.72
folin	82.89	0.89	0.52
somers	84.58	2.36	0.81
srv	63.74	0.78	7.65
procian	76.19	1.04	0.13
acrg	9.08	52.64	19.41
acse	4.54	73.25	13.87
achplc	1.41	68.84	12.61
ic	85.75	1.37	0.54
ic2	86.89	0.91	0.23

	Dim 1	Dim 2	Dim 3
tono	12.30	8.43	37.44
iim	0.04	65.55	3.20
eq1	47.38	17.28	6.51
vla	0.00	0.51	13.58

## Gráficos Biplot

```
plot(bipvino, ShowBox=TRUE)
```

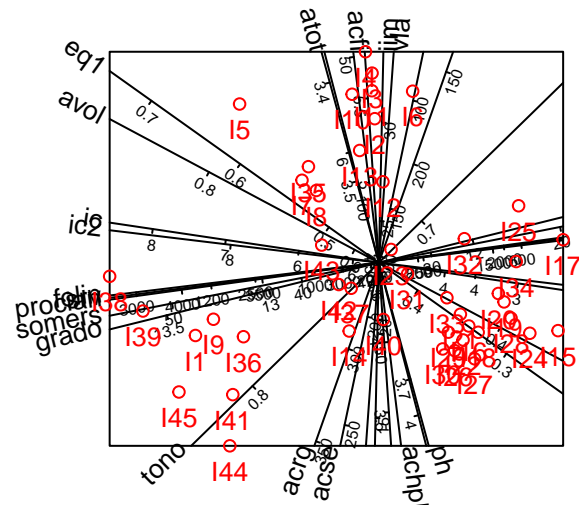
### PCA Biplot (Dim 1 ( 35 %)– 2 ( 25.2 %))



- Prolongación de vectores linea recta

```
BP1<-plot(bipvino, mode="s",  
margin=0.1, ShowBox=TRUE)
```

## PCA Biplot (Dim 1 ( 35 %)- 2 ( 25.2 %))



- Prolongación de vectores con flechas y línea punteada

```
BP2<-plot(bipvino, mode="ah", margin=0.05,
          ShowBox=TRUE)
```

## PCA Biplot (Dim 1 ( 35 %)- 2 ( 25.2 %))

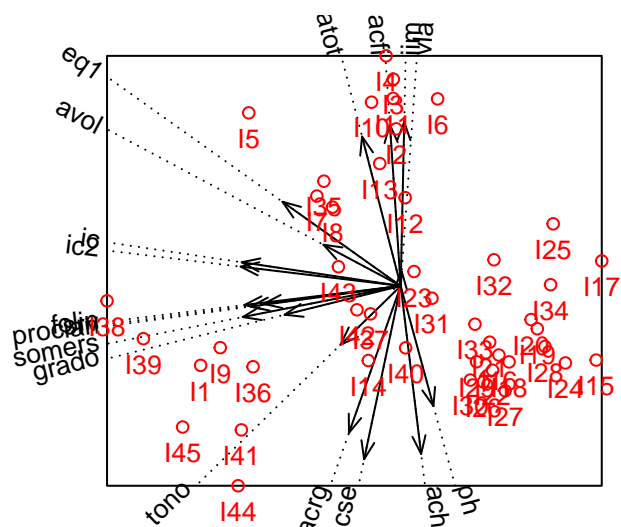
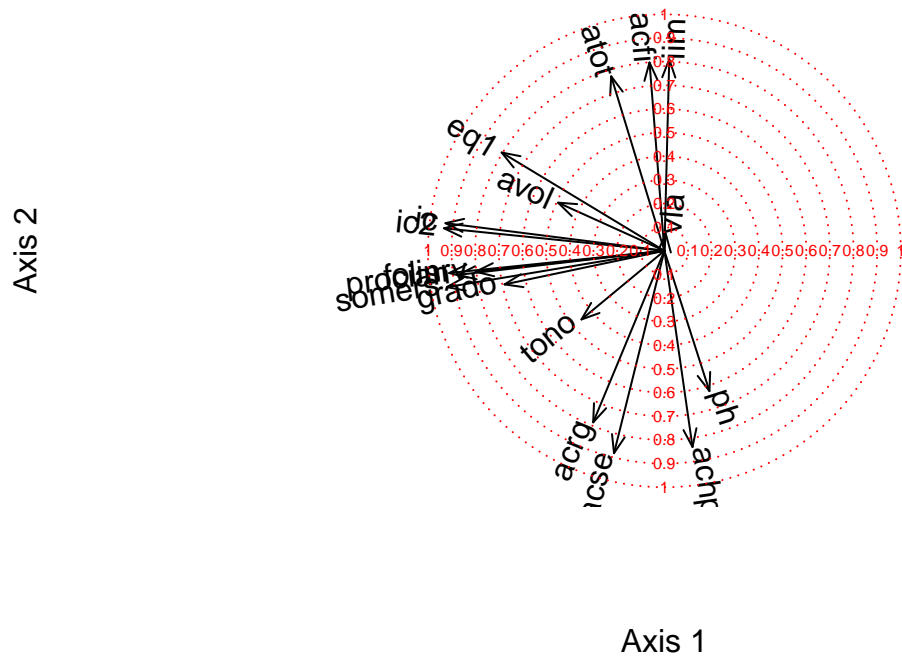


Gráfico circular correlaciones

```
GC<-CorrelationCircle(bipvino)
```

## PCA Biplot – Correlation Circle

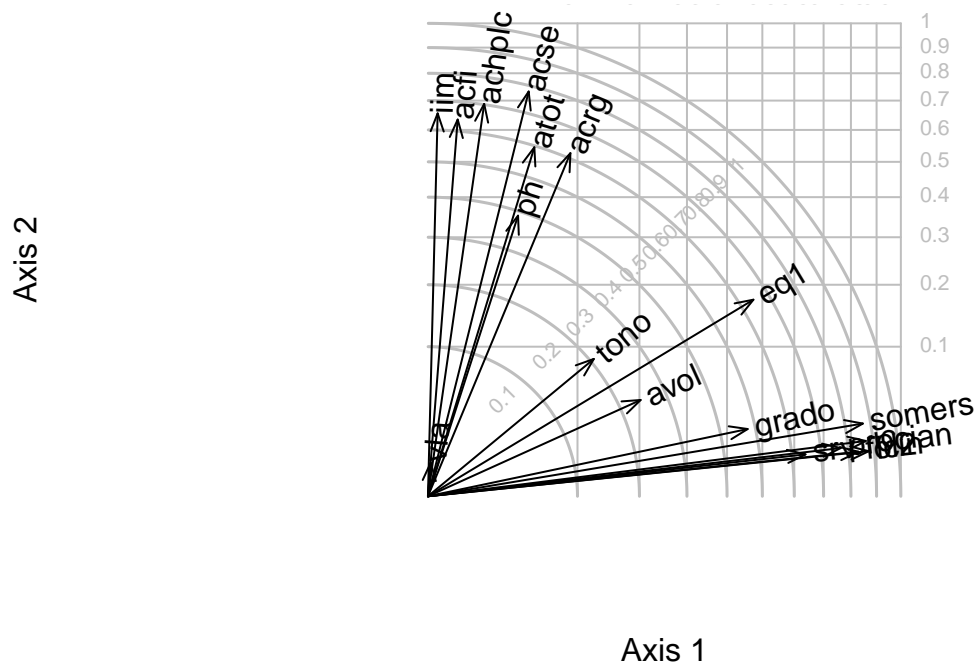


### Gráfico contribuciones de los vectores

- Calidad de representacion eje 1, 2 y 1+2

```
ColContributionPlot(bipvino, AddSigns2Labs = FALSE)
```

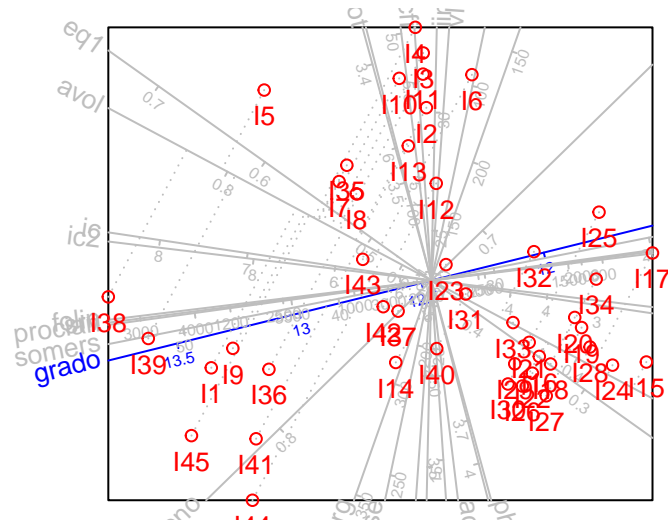
## PCA Biplot – Contribution Plot



- Proyección individuos sobre una variable donde `dp=` selecciona la variable

```
BP3<-plot(bipvino, dp=2, mode="s",
  ColorVar=c("blue", rep("grey",17)),
  ShowBox=TRUE)
```

## PCA Biplot (Dim 1 ( 35 %)– 2 ( 25.2 %))

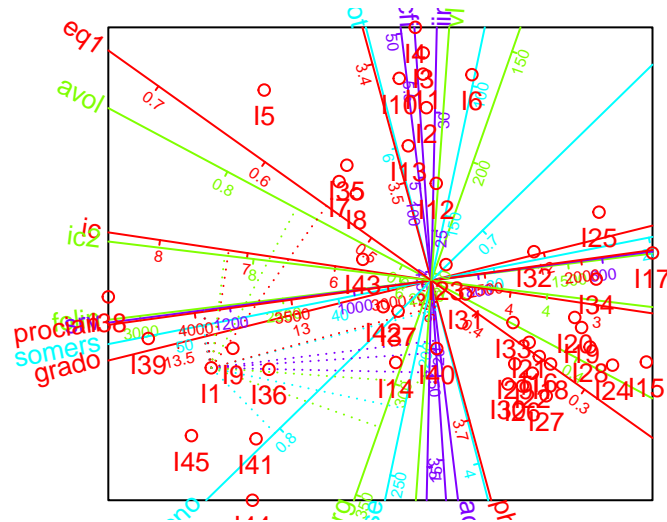


- Proyección de ind sobre todas las variables con *PredPoints= individuo*

```
BP4<-plot(bipvino, PredPoints=1, mode="s",
          ColorVar=1:18, ShowBox=TRUE)
```



## PCA Biplot (Dim 1 ( 35 %)– 2 ( 25.2 %))



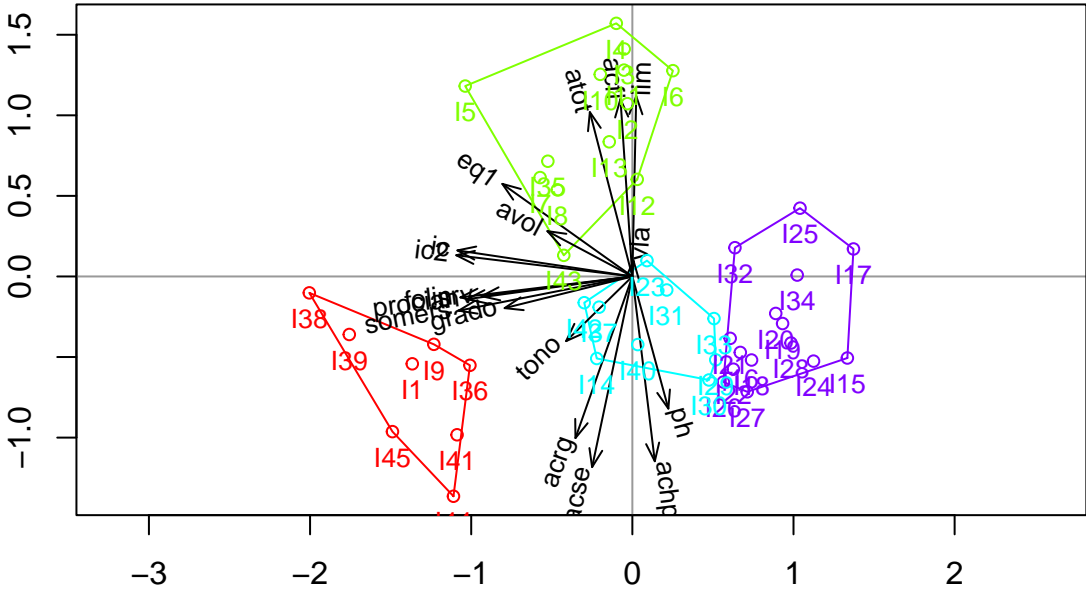
- Cluster Jerárquico con datos originales con el metodo *ward.D*

```
bipvino=AddCluster2Biplot(bipvino, NGroups=4,
                           ClusterType="hi",
                           method="ward.D",
                           Original=TRUE)
```

- Cluster aplicado al biplot

```
clusBP<-plot(bipvino, PlotClus=TRUE, ShowAxis=TRUE)
```

PCA Biplot (Dim 1 ( 35 %)- 2 ( 25.2 %))



clusBP

## NULL