Short Communication

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Weather-based yield prediction in banana (*Musa* spp.) by using principal component analysis

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Banana (*Musa* spp.) production is greatly influenced by weather parameters. Accurate weather-based yield forecast helps planners and policy-makers. Weather-based yield prediction models provide a trustworthy yield forecast, and also helps in forewarning of pest and diseases (Agrawal and Mehta, 2007). According to Salau *et al*., 2016 excessive rainfall and extremely high temperature can reduce banana productivity, while production is also small when both rainfall and temperature are very low with poor humidity. Information on yield climate relationship helps in forecasting yield and formulating suitable policies. Yield prediction or forecasting is an important aspect of developing economy so that proper planning can be undertaken for the sustainable growth.

The field experiments were conducted on banana (cv. Nendran) at College of Agriculture, Kerala Agricultural University, Thrissur, during 2012-2017. Planting was done at 15 days interval in two seasons, *viz*. first season (15th April, 1st May, 15th May, 1st June and 15th June) and second season (15th August, 1st September, 15th September, 1st October and 15th October), with a spacing 2 m × 2m, in three replications in randomized block design. Yield data were collected from each plant for analysis.

Principal component analysis (PCA) was carried out for different weather elements experienced during the crop period using R statistical software. The PCA helps in minimizing the complexity of a data set to a lower appropriate dimension, the contributions of which will be more towards the system that we analysing. It also helps to deal with the multi colinearity of observed weather data. Scree plot and biplot were drawn with the help of R statistical software. By this method, principle components were obtained and were used for fitting regression models

Principle component analysis was carried out with required weather variables and ten principle components were identified with variable proportions. It was observed that a cumulative proportion of 98.9 was obtained for first three components (component 1, component 2 and component 3) (Table 1). Component 1 showed a proportion of variance of 83.23%, component 2 with 9.99% and that for component 3 was 5.73%. Proportion was very less for other seven components. So for yield prediction only first three components were used for fitting regression equation. The variation showed by each component was also depicted using a scree plot (Fig. 1).

The variable factor map was drawn which explains the importance of different weather parameters in forming first two components. The parameters that are closer to yield in variables factor map showed more contribution in forming the components and those

Table 1. Proportion of variance of various component

Principal componenet	Variance percent	Cumulative variance percent
Component 1	83.23	83.23
Component 2	9.99	93.2
Component 3	5.73	98.9
Component 4	0.56	99.52
Component 5	0.34	99.87
Component 6	0.06	99.93
Component 7	0.04	99.97
Component 8	0.01	99.992
Component 9	0.006	99.998
Component 10	0.001	100.00

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which had a loading value greater than 0.5 were more influential in formation of corresponding components (Haritharaj, 2019). It is clear that weather parameters like forenoon and afternoon relative humidity are closely related to banana yield (Table 2, Fig. 2). Similar findings were proposed by Rao *et al*. (2002), Regression equations were fitted using three components and are described here,

Yield = $5.60+0.331X_1+0.561X_2+0.283X_3$

Where,

X_1, core of principal component 1; X_2, core of principal component 2; X_3, core of principal component 3

Using this equation the yield (bunch weight per plant) was predicted. A comparison between actual and predicted yield is given in Fig.3. The model overestimated the yield, even though it predicted values close to that of actual yield. Principal component analysis can be used as an effective tool in forecasting yield of banana and it solves the problem with the multi-colinearity of weather variables and large numbers of weather variables are reduced to three principle components by constructing the regression equation.

Table 2. Different weather parameters in forming principal components

Variable	Component 1	Component 2	Component 3
Maximum temperature	-0.340	0.119	-0.071
Minimum temperature	-0.074	0.971	0.145
Forenoon relative humidity	0.345	0.058	0.056
Afternoon vapour pressure deficit	0.345	0.047	0.072
Wind speed	-0.341	-0.022	-0.004
Bright sunshine hours	-0.342	-0.104	-0.082
Rainfall	0.342	-0.021	0.068
Rainy days	0.341	-0.013	0.151
Evaporation	-0.341	-0.023	-0.174

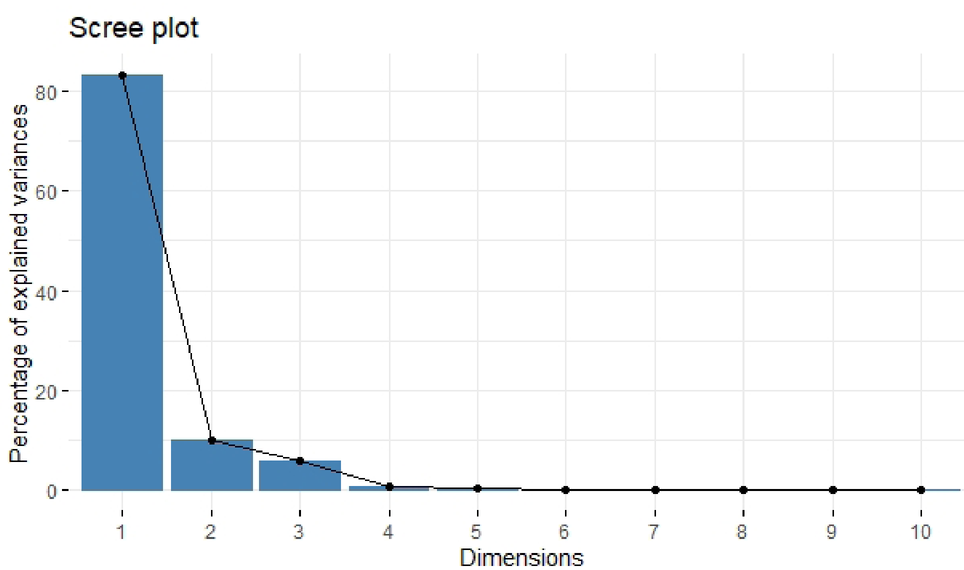

Fig. 1: Variation exhibited by each dimension (component)

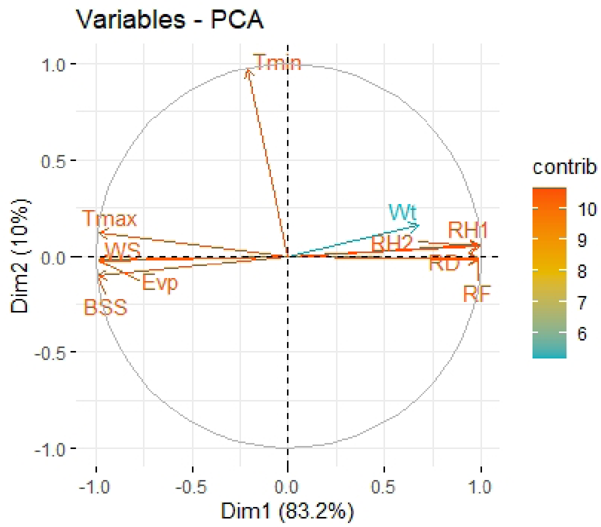

Fig. 2: Variable factor map obtained after PCA.

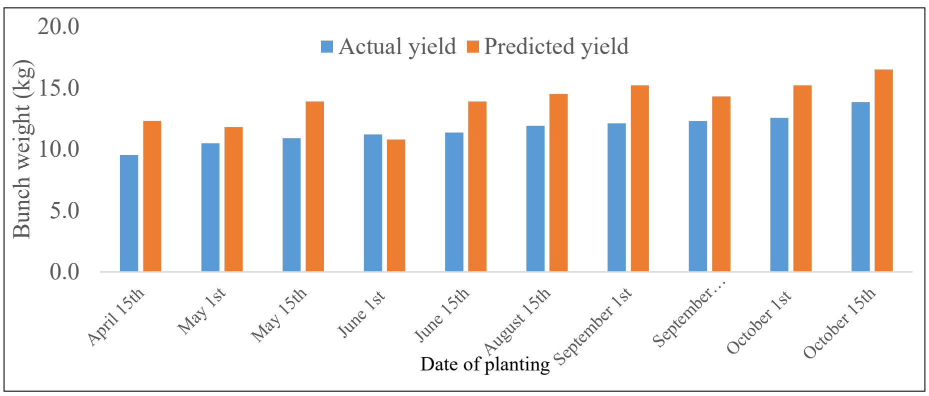

Fig. 3: Actual and predicted yield (bunch weight) of banana under different dates of planting

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