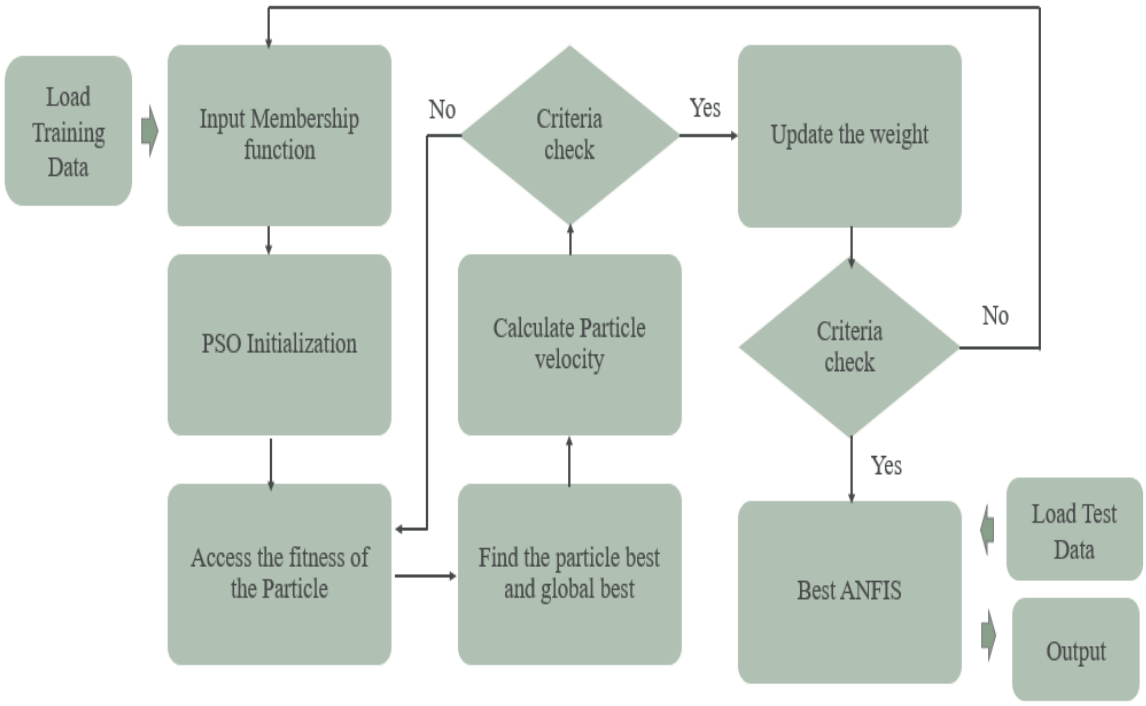

Fig 4. PSO-ANFIS Classifier work-flow

4. Result and Discussion

In our proposed method we consider three micro nutrients like Calcium, sulfur and magnesium in paddy plant. The input paddy leaf images are of different sizes, so the first image resize was done then the color image is converted into the gray image after that image denoising was done using the Gaussian filter which is followed by segmentation by using proposed modified K-means segmentation algorithm. After performing segmentation useful features are extracted from ROI using the GLCM feature extraction method. After getting useful features classification was done using M-SVM, K-NN, Decision Tree, Naïve Bayes and PSO-ANFIS classifiers. The following table 1 shows number of training and testing images used in our proposed work.

Table 1. Paddy Leaf Dataset

Type of Leaf	No. of Training Images	No. of Testing Images	Total No. of images
Healthy images	40	10	50
Calcium defected	40	10	50
Magnesium defected	40	10	50
Sulfur defected	40	10	50
Total			200

The following figure 5, shows the calcium deficient leaf image and its segmented part

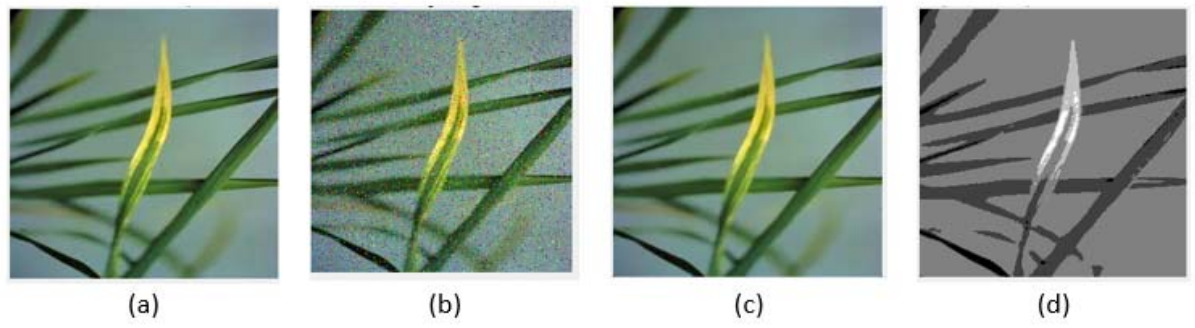

Fig. 5. (a) Original image (b) Noised Image (c) De-noised image (d) Segmented image

The following table shows the performance of different classifier after Modified K-Means segmentation

Table 2. Performance of classifier after K-means and Modified K-Means segmentation

Classifier	Precision	Recall	Specificity	False positive Rate	Accuracy (%)
KNN	0.7047	0.6933	0.8587	0.0953	88.11
Decision Tree	0.6809	0.6667	0.8533	0.1191	87.22
Naïve Bayes	0.6379	0.6167	0.8433	0.1621	85.56
M-SVM	0.7219	0.7133	0.8627	0.0781	91.78
PSO-ANFIS	0.8443	0.8333	0.9667	0.1557	94.44

The comparison of different classifiers is shown in the following figure 6 and 7.

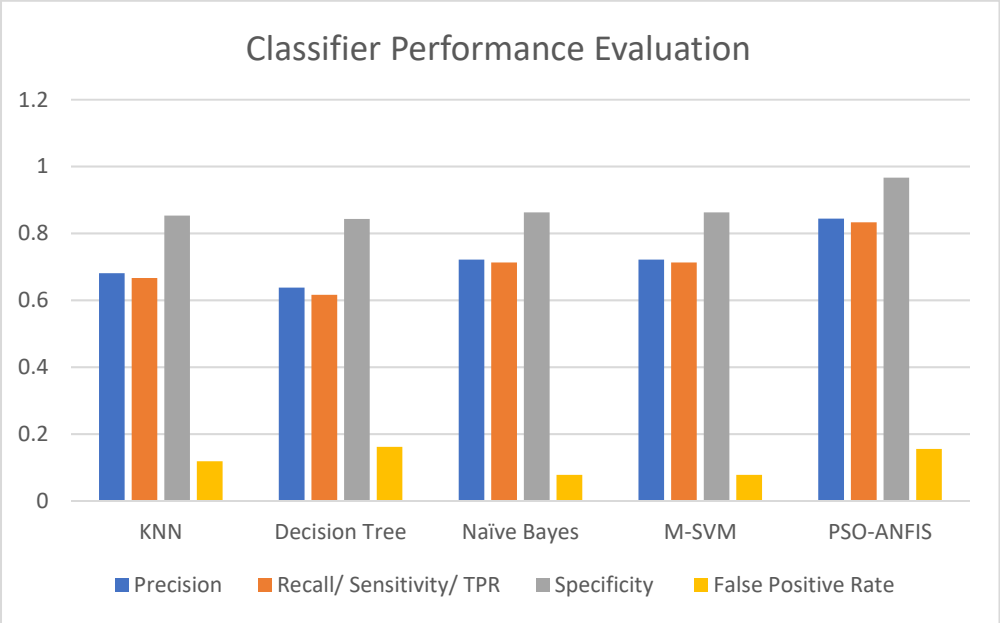

Fig. 6. Performance evaluation of different classifiers

The following formulas are used to calculate Accuracy, precision, recall, specificity and False positive rate (FPR)

$$Accuracy = \frac{Number\ of\ data\ Correctly\ Classified}{Total\ number\ of\ data\ Classified} \quad (1)$$

$$Precision = \frac{TP}{TP + FP} \quad (2)$$

$$Recall = \frac{TP}{TP + FN} \quad (3)$$

$$Specificity = \frac{TN}{TN + FP} \quad (4)$$

$$False\ Positive\ Rate(FPR) = \frac{FP}{FP+FN} \quad (5)$$

Where TP – True Positive, FP – False Positive, TN – True Negative and FN – False Negative

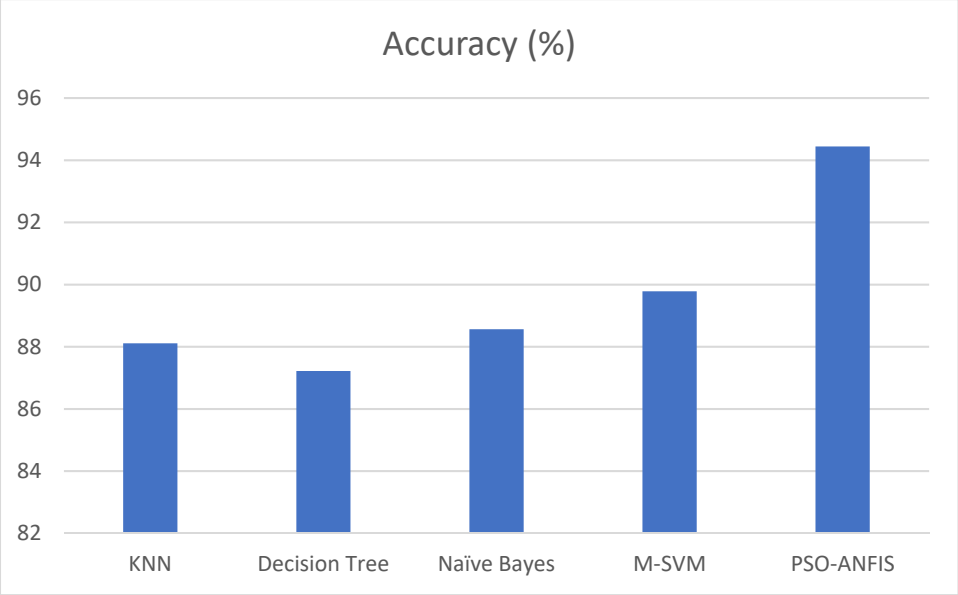

Fig. 7. Accuracy comparison of different classifier

5. Conclusion

This work mainly focussed on the detection of deficiency in paddy plant with the proposed modified K-means segmentation algorithm. In this modified K-Means segmentation algorithm it is not necessary to initialize cluster number and cluster center. Our work also compares the accuracy of different classifiers. Among these five classifiers, PSO-ANFIS provides more accuracy than others, and our proposed Modified K-means and PSO-ANFIS classifier produced a better accuracy of 94.44%. In the future, we can extend the work to other plants as well as a other nutrients too.

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