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Identification of Weeds on Crop Lands for Site Specific Spraying

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Abstract: ***Adaptation of this method of identification of weeds in specific areas on crop lands which help for healthy agriculture. Mostly separations of weeds from the crops are done with the help of image processing. It is the process of separation of weeds specifically from the crops. This method of separation will be helpful in optimization of herbicide usage. There are several methods of image pre-processing used to remove the information which is irrelevant from the image other than weeds. Crops are separated in rows. Different colour models are used and then proposed for grey image, vertical projection is used to identify centre line of crop row. Image segmentation is the first process to segment the image using various methods like greenness identification with the help of RGB and H-components with YIQ, HSV, HIS colour spaces. It leads to 126 colour feature extraction from the image. Cultural algorithm is used for separation of feature from the image and Search algorithm is used in specific identification of crops and weeds for specific spraying. After feature extraction SVM algorithm and BP algorithm is used for experimental result for higher accuracy of about 92.8% in real-time decision.***

Keywords: Colour Features, Feature extraction, Image pre-processing, Image segmentation, Image separation, Weed Identification

I.INTRODUCTION

A. Problems and Solutions

There are several countries working on agriculture development which results in long term production in agriculture. It helps in the management of economic growth and social development weed is the only threat for crops that drops the production rate. Weed has the feature of higher growth rate, consumes larger amount of water and fertilizer.

Weeds are highly harmful for growth and production of crops. The speed of harvesting is reduced and cost of removal of weeds are higher in farmland, larger number of labour is used in weed removal, which reduces the production rate 1/3 – 1/2 workload is taken in farmland weeding. Chemical herbicides are not evenly distributed in the farmland. Therefore large amount of herbicide are used, which affect the growth of crops. With the help of precision agriculture herbicide are directly used on the weeds which results in increased rate of growth in crops and reduced amount of usage of herbicide. This process does not affect the growth of crops. The herbicides are accurately distributed and growth of weeds are reduced,removal of weeds had become easy process. Machine vision system is used to identify and spray herbicides on weed identification has classified in many ways based on colour, shape, texture and location. Multi feature weed identification is done by SVM (Support Vector Machine). It gives about 89.2% accuracy in weed identification based on texture and spacing.[2] This method is applicable for the crops planted equal in space in a row. Several combined suitable and basic image processing methods are used extract cells or pixels of an image. Support Vector Machine method is used to determine whether the cell must be sprayed or not. But, this technique is only suitable for a plant which has the characteristics of green plants. This makes drop in economic growth in agriculture. The future trend in agriculture has set a path with help of algorithms which paved a way for precision agriculture for site specific spraying.[7]All the growth stages of crops and weeds are considered to precisely identify weed which is intermixed with crops. By applying distance algorithm for crops planted in equal distance to identify the accurate location of weeds and to optimize the search time of weeds between the crops which are planted equal in distance in a row with vertical row precision point.

B. Technical approaches

After extracting the feature and finding the weeds present in the farmland, it is separated with the help of several algorithms like Culture Algorithm (CA) which is used to identify weeds apart from crops and Search Algorithm (SA) which is used to search the weeds which is present between the crops in the agricultural land.[3]Both the algorithm is used to identify and search the weeds in farmland based on their features and properties, it is also used to label the weeds to train the machine or program developed with the help of Artificial Neural Networks (ANN).

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This is used to provide high accuracy, highest accuracy is given by Convolutional Neural Network (CNN) algorithm it gives an output of about 98.6% accuracy.

II.EXPERIMENTAL STEPS AND METHODS

A. Image collection methods

In every experimental papers regarding weed identification in terms of making real time dataset, at least more than 1000 images are collected in different lighting condition to form a flawless dataset. All the images are taken in varying size, it depends on the dataset to be created, but all the images are taken in *JPEG* format. Images are collected using various methods according to the hardware and financial availability. Sometimes, images are collected using cameras which are fixed on the moving platform. The cameras are fixed at a height of 60 - 80 cm form the ground level. Fixed cameras are directly connected to a laptop for spot correction of images like cropping, colour correction, rotation, etc. after the correction the images are saved in a sequence which is captured based on lighting conditions that leads to the next step for creating datasets for all the images for further processes. Other than that many methods are followed to capture the images in farmland, like fixing camera on the tractor, by using drones and also manual methods are used to collect images accurately without any texture and shading defects. Cameras are installed on the front board of the tractor, just upon the hood of the tractor. It covers all the plants including all the crops planted and weeds grown on the farmland. *DSLR* cameras are used to capture the image manually in all suitable and available lighting condition from all directions and angles needed for the creation of datasets **Fig. 1**.

Every image of weeds which are collected for creating datasets is taken from all directions and angles in every lighting condition available. All images are taken in following lighting conditions: (i) sunny day, (ii) cloudy day, (iii) intermediate day, (iv) rainy day. The condition are applied for both curved and straight crop rows, to create a perfect collection of images to train the machine algorithm that it does not miss any of the weeds in farmland during feature extraction and labelling.

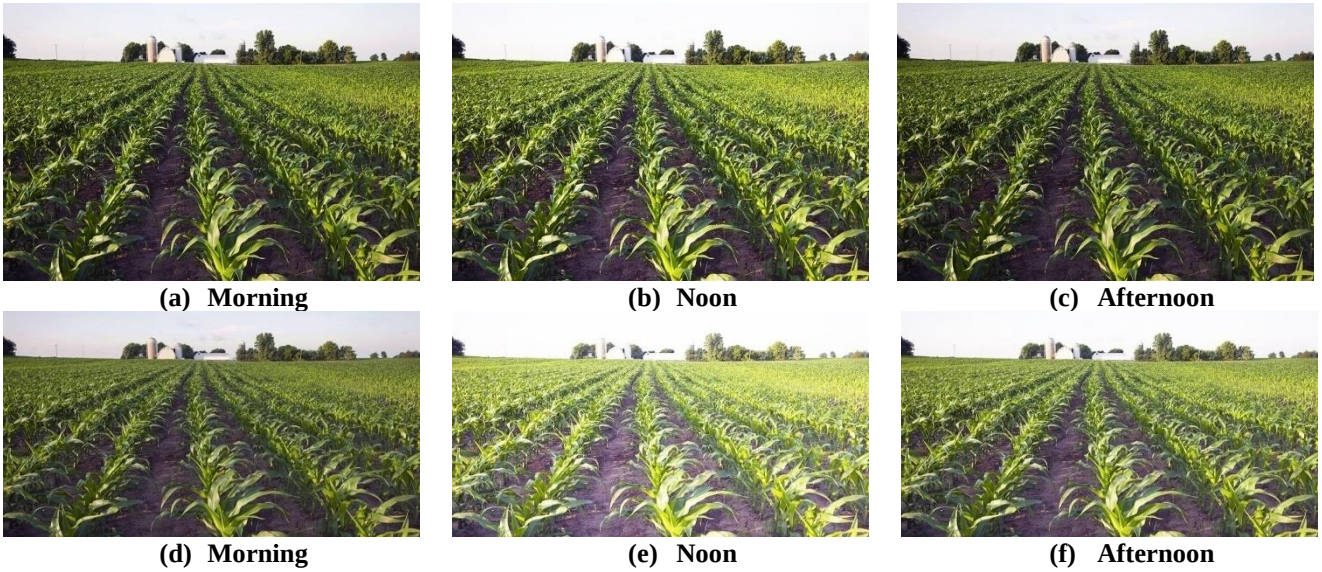
B. Image pre-processing methods and architecture

Collected images are processed to next step in weed identification. The first step of image pre-processing is segmentation of images. Segmentation of images consists of separating the features of crops and weeds captured.[6] Firstly the images are converted into grey scale images, no colour information is taken in account when images are converted into grey, and only luminance information is present. In order to process the images accurately all the images are convert in to grey images as shown in **Fig.1**to obtain the plant's characteristics. In the process of image collection there are several factors that affect the Weed Infestation Rate (WIR).

Some of the factors that cause noise to images are over and under exposure of image, uneven spread of lighting that is fallen on the image which gives insufficient lighting for the image while the image is taken. The image pre-processing process is clearing guided the in images of the process which includes flowchart which is shown in **Fig. 2**.

When each crop is described with its respective equation as straight ($z=ny+d$) or quadr ($z=ay^2+by+e$) line which lies within the Region Of Interest (*ROI*) **Fig. 3**these both images displays the crop row with four vertical lines which describes the crops within *ROI* concept. In some method, detection of crops in straight and curved row, [10] it has been successfully identified by applying many methods: Hough transforms, Linear regression, Exploration horizontal, Accumulation of green pixel.

Collection of Image based on different natural lighting conditions according to Climate



(a) Morning **(b) Noon** **(c) Afternoon**

(d) Morning **(e) Noon** **(f) Afternoon**

Fig. 1 Different times in a day, images collected in various lighting condition in a day. These images are classified in various climatic conations like Sunny day and Cloudy day. It shows the weed density and plant size in images from (a), (b), (c) shows images collected during sunny day and (d), (e), (f) shows images collected during cloudy day.

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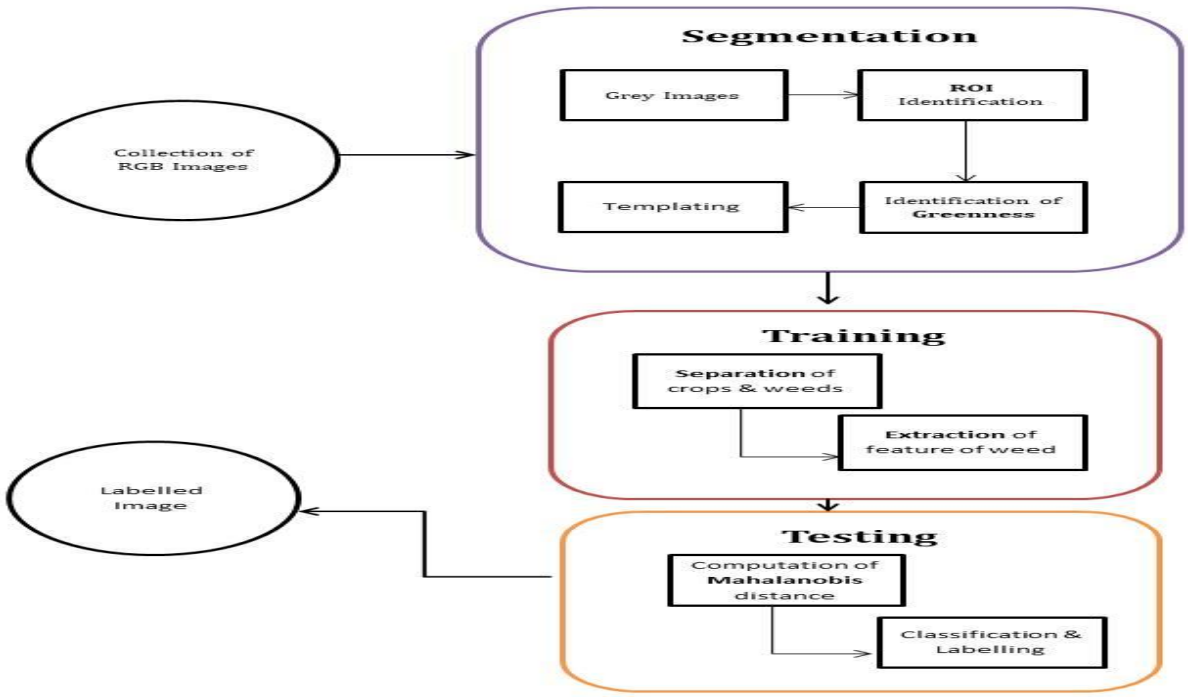

Fig. 2 Determination of step to be followed during the process of weed identification.

C. Weed Infestation Rate

Since the images are taken in different lighting condition it leads to several colour space models, one of the colour space model is *YCrCb*colour model. This type of colour model leads to the introduction of Cg component of the grey image. This property of is used to segment the crops and ground from the image it help in identification of weeds.[3] The other two components are used to separate the plants from the ground in the farmland such as 2-G-R-B components and H components. The process of separation of the plants from the ground is shown in the image **Fig. 4.**Each component of separation of plants from ground has varying output value for varying climatic conditions. The varying in values are shown in the table **Table I**, which has values of each process of component in different climatic condition. The vales of the each process of component are plotted in the graph by getting the data from the table. The graph is shown in **Fig. 5**, the graphical representation of the data given the complete understanding that how the process is done to extract the feature of plants. It makes the process of identification easier.

In WIR vector method [5] is used to identify the components which are used to separate plants from ground. Two components are identified with the help of vector method, the represented components are first one is weed coverage and second is weed threat. $\underset{y1}{\rightarrow}$is used to represent weed coverage and $\underset{y2}{\rightarrow}$ is used to represent weed threat.

Weed coverage: $\underset{y1}{\rightarrow} = \frac{Diw}{Bic}$

Weed Threat: $\underset{y2}{\rightarrow} = \frac{Diw}{Dic}\left(1 - \frac{Dis}{Bic}\right)$

For D_{iw}denotes area of weed covered of cell, B_{ic} denoted complete cell coverage, D_{ic} denotes area covered by crops in farmland of cell, D_{is} denotes area covered by soil of cells.

The formula which is used to denote the component of weed threat, which is used to determine the separation of crops from the soil. It is used to extract the features of plants apart from soil in the farmland. Based on Alberto WIR, the parameter $B_{ic}$and D_{is} is removed from the formula. The compared formula if both component leads to the Modified Weed Infestation rate (MWIR), which uses less parameter and makes the calculation easier.

D. Segmentation

Weed identification by using traditional method gives minimum accuracy, it is a crucial process to identify the weeds present in the crop rows and which is also present in between the crops for site specific spraying in precision agriculture. In this case, thresholding process is done to separate the crops from the weeds based on the structure and property,it can be also compared to feature extraction. The performance of identification of weeds based on its feature has been increased by using thresholding method against other methods which previously exists such as Support Vector Machine.[10]

The Segmentation the process that involves in the separation of the plants from the background of the image collected. This process of separation will be helpful in extracting the feature of weeds for the method of precision agriculture. The phase of segmentation is designed with four parts which process the same goals in precision agriculture method, (a) Grey images, (b) *ROI* identification, (c) Identification of Greenness, (d) Templating. This process of segmentation phase allows providing space in the pixel of the images that makes the process of separation of plant and background easier. The Cr component is used in plant and soil binarization. This channel shows red-green scale. The greener the colour which represents grater the value.

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(a) Grey images

The collected RGB images are imported converted into grey images first; it makes the process of segmentation easier. The obtained *RGB* images are affected by the lighting condition this also reduces the feature information of the plants. This also reduces the accuracy of image segmentation by using the *RGB*colour space model in the process of image pre-processing, instead *HSI* colour space model is used to provide luminance information of the plants. *H* denotes hue, *S* denotes saturation and *I*denotes intensity.

H component is used to identify objects in the image which has different colours, which is more suitable for the process of image pre-processing. [12]

(b) ROI identification

Determination of *ROI* methods which is used to identify the region of interest of the image which makes the process of identification of crop row easier as shown in **Fig. 3**above.

(c) Identification of Greenness

ExG is used because of the performance in different indices points where greenness is available. **Fig.6 (a and b)** shows the grey scale images after applying *ExG* for straight and curved crops rows. *ExG* is used to convert the images to grey scale and which makes the process of applying thresholding easier.

Identification of ROI of the images

Fig. 3 Determination of ROI of the image, finding the accurate position of ROI in the image, shown in image (a), and the identification of crop rows which is shown in (b), (c), (d), identification of weed is done in both curved and straight crop rows as shown above

ExG formula is defined as:

ExG = $2g - r - b$

[10]

In this equation the chromatic components are used to identify the colours used for applying grey in the image. The chromatic components are *g*, *r* and *b*.

$r=\frac{Rn}{Rn+Gn+Bn}$, $g = \frac{Gn}{Rn+Gn+Bn}$

$b = \frac{Bn}{Rn+Gn+Bn}$, with $r + g + b = 1$

whereRn, Gn, Bn are normalized by using RGB spectral channels which has the range of value [0,1].

After computation its shown as follows:

Rn= $\frac{R}{Rmax}$, Gn = $\frac{G}{Gmax}$, Bn = $\frac{B}{Bmax}$

R_{max}, G_{max}, B_{max} are the maximum values in the respective spectral channels. The process of applying this formula to the image pixels, it makes the process of thresholding faster. The process of time complexity is reduced.

(d) Templating

Crop row equation is applied to the imported images to find the crops rows present in the images. The crop rows are labelled as A1, A2 and A3 respectively from left to right, the equation for identifying the crop row is as follows: $z=ny+d$; $z=ay^2+by+e$. [10]

The process of identification of crop rows by applying the formula mentioned above, it is done by the concept of *ROI*, the margins provided are of equal in size for every image of identification of crop rows its shown in **Fig 2.2.3** above. Red lines are used to denote crop rows and respectively the margin of the crop land is bounded with yellow lines. This process is done to represent that crops rows are equally distanced. It is found by measuring base and top of the image respectively. It is calculated by M_{base} and M_{top} which is used to take the value od top and base of the image.

The calculation is done by considering number of horizontal line of ROI (H_{ROI}) starts at the end of M_{base}. The magnitude l is decreased in each line width.[6]

$l = \frac{M_{base}-M_{top}}{H_{(ROI)}}$

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E. Training

The images which are thresholded[10] are sent to the training machine that extracts the weeds through online extraction algorithm to extract the weeds with the help of the features available from the thresholded image in which the plant and background of the images are separated. This training is used to find the crop rows accurately apart from the image with the help of binary mask.

(a) Separation of crops and weeds

After extraction of the crop row with the help binary mask, the accurate and specific location of the crops and weeds are obtained.[6] This process of extraction of the straight and curved crop rows that helps in extraction of weeds apart from crops in the image, this method in separation of crops and weeds which increases the accuracy in feature extraction each images are trained with the help of *ANN-HS* algorithm. This Harmony Search algorithm which is used to extract the weed with the help vector method.

(b) Separation of feature of weed

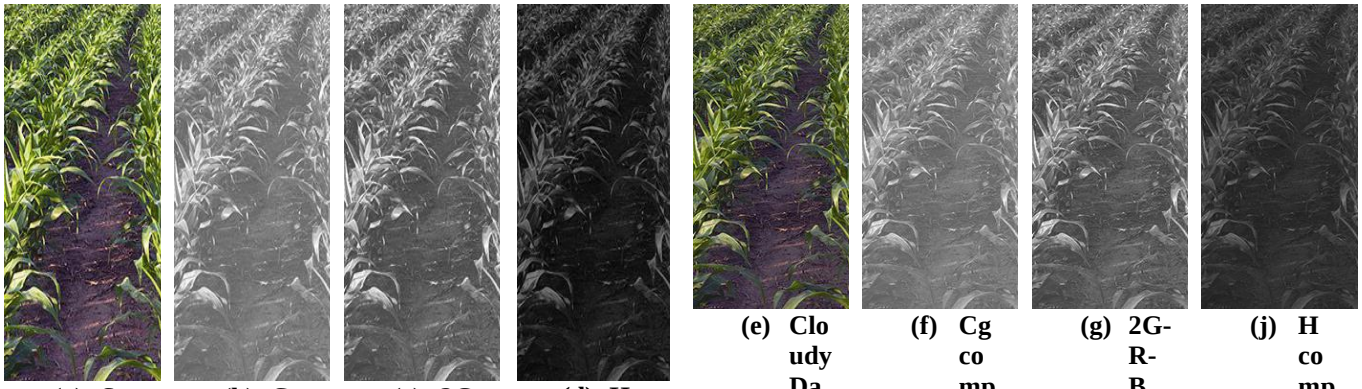
The extraction of feature of weed is done by the accurate identification of the weeds among the crops. The weed are searched by traditional method, the traditional method uses more man power in identification of. It has higher accuracy but it results in more time complexity. This result in the introduction of ANN-CA, this cultural algorithm is used to identify the weed among the crops with available feature. It increases the speed of identification of crops for precision algorithm.

Several methods are used in the identification of weeds like K-means algorithm which is used for pre training. Traditional Convolutional Neural Network (CNN), it is the one of the method which is used in the identification of the weeds in the image.[11] .This method of identification is more accurate method comparing to all other methods. It gives about 98.6% of accuracy in feature extraction and identification of weeds.

$$\delta_k = (c_k - z_k) z_k (1 - z_k)$$
$$\delta_j = i_j (1 - i_j) \sum_{k=0}^{n-1} \delta_k X_{jk}$$

It is used in the comparison of feature from the obtained output with the next input.

Extraction of luminance information from the image of different times and climate with the help component extraction



(a) Sunny Day **(b) Cg component** **(c) 2G-R-B component** **(d) H component** **(e) Cloudy Day** **(f) Cg component** **(g) 2G-R-B component** **(h)** **(i) nt** **(j) H component**

Fig. 4Determination of colour spaces and conversion of *RGB* images into grey images by segmenting the components from the image. (a) and (e) are original *RGB* images whereas (b), (c), (d), (f), (g), (h) shows the extracted components.

Table I

Table represents time consumed during the process of extraction of components of each colour space

Time consumption/s	*Cg* component	*2G –R –B* components	*H* components
Cloudy days in morning	0.182	0.478	1.045
Sunny days in morning	0.174	0.465	1.032
Sunny days in noon	0.176	0.432	1.056

Graphical representation of time consumption for the extraction of components in different times

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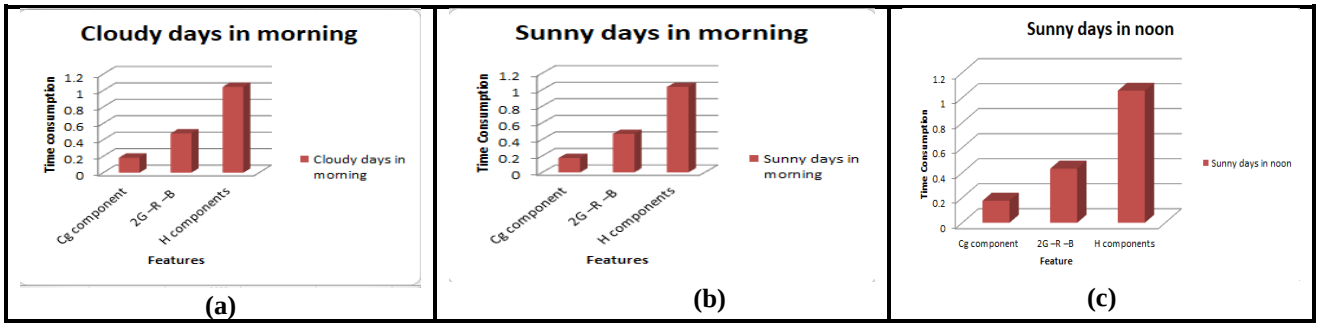
Fig. 5 Time consumption in different climate in varying



timing which is shown as Cloudy days (a), Sunny days (b) and Sunny noon days (c)

Conversion of Grey scale and Thresholding

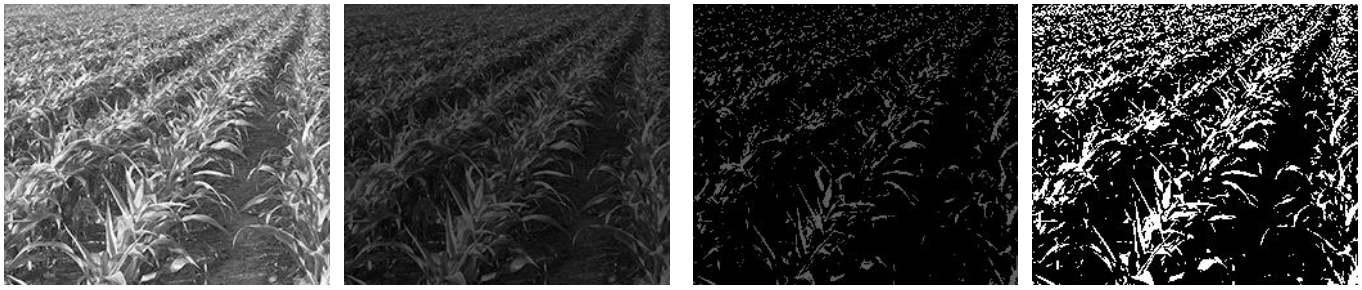


Fig. 6 Grey scale conversion when *ExG* is applied which is shown in (a) and (b); Thresholding is shown in (c) and (d)

F. Testing

Testing is the process of running the segmented and feature extracted image in the machine and practicing the machine, also making the machine familiar for all the conditions in weed identification.

(a) Calculation of Mahalanobis distance

Mahalanobis distance is calculated by placing the centroid points in the crops so that first the crops are identified and by the observation of spectral pixel variation between crop and weed. The identified weeds are represented with the spherical marking. Mostly weeds are present between the crops hence the process of identification of weeds are made easier with the help marking centroids in the crops by the process calculating the mahalanobis distance.

$C_N^2 = (Y - \mu)^T Cov_y^{-1}(Y - \mu)$[13]

Weeds are identified with higher accuracy among the plants in all the lighting and climatic conditions in a day. For higher accuracy of identification of weeds Mahalanobis distance is calculated to identify the weeds present in between the crops in the farmland.

(b) Labelling

In this methods crops and weeds are separated by applying the algorithm of mahalanobis distance separated crops are denoted in yellow color and the weeds in the farm land are denoted in green color so that the machine is allowed to identify the weeds from the crop land easily so that the machine will be allowed to mark the weed in spherical circles as shown in **Fig. 7**apart from crops present in the farm land which makes the process of precision agriculture easy and faster

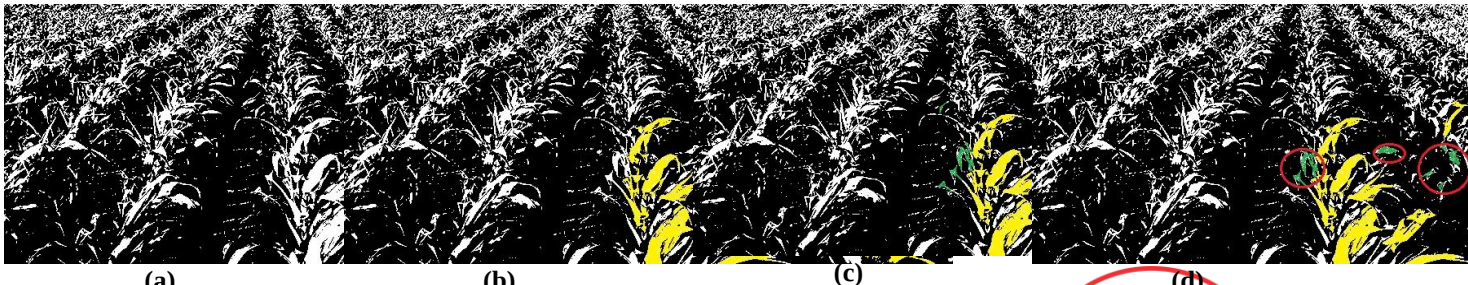


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Fig. 7(a) denotes the process of Thresholding, (b) and (c) denotes the separation of crops and weeds and finally (d) denotes the marked region of weeds in the farm land.

III.CONCLUSION

Weed identification and precision agriculture has become trend in modern times. Man power is not used in recent for identification of weeds and specific site spraying, since man power causes more time complexity in identification of weeds. Firstly the *RGB* images and converted into grey images, which allows getting the luminance information from the image. The components like *Cg* and *H* components are extracted from the image to process the thresholding method in the images for separating plants from the background of the image. After the segmentation of the image from the background algorithms like ANN-HS and ANN-CS is used to identify the weed by extracting the feature of the weeds available and comparing the output with input given to find the possible outcomes.

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