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Modern Methodologies for Crop Improvement

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ABSTRACT: We live in a more advanced, technically sound and intelligent world thus to grow a healthy food there is a need for more intelligent tools, techniques and approaches in farming. Modern farmers have incredible resources to protect their crops from the threats that seem to be most efficient. Methods such as seed treatment precision application tools, predictive analytics and targeted pesticide solutions suite of innovative technologies. To track any disease, early and exact identification is necessary, 'machine learning' in agriculture provides more precise disease diagnosis which terminates the wastage of resources and energy from misdiagnosis. The software is utilized for diagnosis and to develop the management strategy by uploading images taken by smartphones, UAVs and land based rovers. Instead of synthesizing new chemicals, agro-based companies are trying out a new strategy using plant extracts, soil microbes, animal by-products and their combinations which are a bit more advanced than using compost in the soil. To divert animal intrusions into the crop a wireless sensor network is being used to protect the crop. Sound generating devices, PIR sensor, RF module and light flashers are fitted near nodes in the crop field.

Keywords: Intelligent farming; Innovative technologies; precision application tools; Machine learning; Sensor network application; Integrated disease management.

INTRODUCTION

Man has discovered agriculture almost ten thousand years ago. Agriculture is domestication of wild plants for private use of humans. Food is the need for sustainability of human life on this planet. Numerous crops have been harvested seeing those thousands of years. However, it was impossible to cope with the demand for food by using conventional methods of farming. There was clearly a need to develop new methods to improve the yield qualitatively and quantitatively. As the global population is rapidly increasing, new strategies have been introduced for greater production, improved nutrient content and disease resistant plants. As a start, man has been planning to manipulate different ideas and as well, techniques to save the plants from different diseases by making use of conventional methods. Unfortunately, regular methods are no more functional towards the current needs. Though from past five ages global food grain development is growing as with increasing human population still 1 billion people of the world are malnourished as a result of food insecurity (Hazell *et al.*, 2008). It is often estimated that worldwide crop production must be increased by 70% by the year 2050 to fulfil the need of expanding populace and growing consumption of food (Godfray *et al*., 2010). In this age of technology, biotechnology has opened up a new course in the field of science. It is a practical option, which can provide increased genotypes that can survive below the changing climate. Developments in fields of genomics, stress biology and bioinformatics can help in the development of stress tolerant crops. There are adjustable approaches like transformation, mutagenesis and proteome profiling used to adopt better traits in agronomic importance. This assessment focused on molecular biology applications for crop advancement like allele mining, gene pyramiding, linkage and relationship mapping, genetic engineering (GE) or recombinant DNA concept, Molecular Breeding (MB), Marked Assisted Back Cross (MABC) and Marker Assisted Repeated Selection (MARS), Genome Wide Range (GWS) and Next Generation Sequencing (NGS).

Wireless controlling robotic systems. A wireless robotic system which can even work in a hostile agricultural environment (Hirakawa *et al.,* 2002). In which a distributed control system and wireless transmission system to designed a new wireless robust manipulator type robot.

(i) eAGROBOT. Detecting Plant Diseases Through Image Processing. eAGROBOT is constructed as a self-governing farm robot which can work even at a mini level (resolutions of an image is more than 0.01m) and also helps in disease detection along with controlled spraying of pesticides (Sai Kirthi Pilli *et al*., 2015). eAGROBOT gives an sensible consolidation at macro level, i.e. an outlook of the field crop. These robots have certain features like contrast, correlation, Energy, Homogeneity. Administration of farmland from immature period to mature pickup period involves recognition and then controlling plant diseases, deficiency of various macro and micro-nutrients, limited irrigation, utilization of pesticides and fertilizers. Despite the quantity of remote sensing solutions are usually developing, the possibility, floor visibility during the critical development period of crops remain a major burden. eAGROBOT is a prototype ground centered field robot which prevails over challenges extant in huge, complex satellite centered solutions. Further, the grower can acquire a developed view from the field along with decision assist statistics for outlining reasons. Advancement of eAGROBOT, real time screening outcome accessed in various crops like groundnut, cotton crops and long term target has been described in different papers. Different new system uses Euclidean metric method, E means a clustering method separates the image to section the leaf area and background part of the internal image of the leaf. This image helps users to know the percentage of infection and additionally to classify them into numerous classes. Old techniques are replaced by new ones which is often used by agricultural expertise on analysing right pesticide as well as capacity to overcome the situation in an efficient and effective manner. In today's scenario, it is important to have set up access that detect the infectious part of the plant automatically.

For this, a system based Machine Vision Technology and an Artificial Neural Network (ANN) is of great use to automatically detect foliage parts that have leaf sickness (Bhosale, 2016). Such kind of techniques or programs are more efficient than other Instruction methods and very much helpful to the agriculturist. A robot for leaf disease detection by using Gaussian noise but the leaf's photo seems blurred, because of the fact the vein of the leaf is not visible clearly (Valliammal, 2001). Due to the occurrence of Speckle noise leaf design and morphology is damaged. So the greatest objective is to establish a structure where both multiple speckle noise and Gaussian will be taken off and renewed as the photo produces clear vein and becomes noise free.

Application of remote sensing for precision agriculture. Precision farming strategies (mixture of various present tools - sensors, data management systems) will decrease inexperienced and negative economic impacts for crop production (Gebbers *et al.,* 2010). In view (Oerke and Dehne 2004), forty percent of world food production was lost due to pest attack. Manifestation of weeds, disease attack depends on direct ecological dynamics and leads to irregular diffusion within the farm (Franke *et al.,* 2009). (Mulla, David J*et al*., 2013) So the timely identity operations of predominant pest foci as well as discovering zones changed due to infection severity is of more important (Moshou *et al*., 2015 2004). Insect observing and the decision making-process are essential for location-specific charge of pests (Hillnhutter *et al.,* 2008). Such precise plant administration implies a great occurrence of spatial and secular information.

(i) Stress detection and monitoring field conditions. Different techniques to find and interrupt patterns and shape of remotely perceived images depends upon supportive spectral signatures to asses and anticipate structural and physical variations when plant respond to different stress and an elegant solution can be provided by these techniques for quantification of stress through assimilation approaches (Baret *et al.,* 2006) for example, information acquired from 2 Positive Systems flights in 1999 utilizing the ADAR 5500 camera offered to end users in St. Thomas, ND, a first-time chance to utilize high-resolution image. Photographs were collected at 70 cm ground resolution in green, red, blue (Seelan *et al.,* 2003). Stressed area was able to determine by the farmers where the crop has been destroyed because of inundation, cultivator blight, fertilizer skips, lodging and wind damaged.

(ii) Variable rate technology. By using remote sensing applications nitrogen stress can be detected in which it is based upon empirical relationships due to spectral indices which are terribly sensitive to chlorophyll level (Penuelas *et al*., 1994), Versions that occur in nutritious levels, soil type, soil -water, and so topography are natural within a niche. For good management practices we need to map or ''zone'' these variations. Individual zone, in that case, develops into a management unit in which profit can be increased depends upon differential rate functions guided by merely differential GPS.

However, when examined the traditional zoning technique of grid based soil samples, utilization of high-resolution images helps in a compensating US$810 for the 30 hectare area of the field (Seelan *et al.,* 2003). In case of fertilizer, the cost was reduced up to US$466 per year. The foremost spectacular achievement was an increased earning (due to increased sugar content) of US$6050 per year. The overall savings out to be US$7326 per ha. Additionally, this technique helps in applying 35% (2900 kg) less nitrogen (Mishra *et al*., 2017).

(iii) Validating the effectiveness of fungicide application. Farmers are always confused or worried about the quantity and time of fungicide application. Plant disorders/diseases appear in sectors of the field which needs an adjustable rate of fungicides alternative to standard application across the entire niche.

K.H. Dammer offered adoption of CROP-meter regulated field sprayer. Choosing CROP- meter (a real-time sensor which help in measuring the density of crop biomass) we can know the detail geographical division along with plant leaf area to which pesticide should be applied can be obtained. Different sensor tips are used to control the amount of dose along with fungicides to be sprayed.

Carson farms, North Dakota, utilized fungicide on rice crops leaving the test strips, fifty five as well as, thirty seven meter wide. Quality strips stood out plainly on IKONOS imagery considered August 21, 2000. Further, images obtained viewed that crop was healthier where fungicides were applied. Impression shows the multispectral resolution IKONOS image of typical fields. Output data had been related to the fungicide packages. Resulting image showed variations in the yield within the test strips. The excellent quality of photographs given permission to be fast recognition of the 40m wide test reel, but the yield variations had been more noticeable in the fifty-five meters wide strip. The average yield of wheat crop within the evaluation strip was only 5.1 t/ha as compared to 5. 8 t/ha outside the evaluation strip, therefore indicating the importance of fungicide applications. Aline Baggio (2003) designed a plan which deals with Phytophthora disease of potato. Different Sensors are utilized to sense temperature and humidity. Controlling these parameters made possible to lower the disease incidence.

(iv) Detection of insect infestation. Remote sensing helps in the identification of various affected areas within a niche or orchards that was affected by pathogens, pests and weeds (Hatfield and so Pinter, 1993). Nearly 35 years ago, Agriculture research scientists have used aerial color-infrared photography for various problems which occurs in the field and relating their findings to clinical spectra of pest ruined leaves (Hart and Myers, 1968). Remotely sensed images are utilized by a farmer in the red river area (Minnesota) to check the armyworm population in different wheat crops (Seelan *et al.,* 2003). These images helped the farmer to identify the particular area where the pest population is present and was able to apply insecticide only in that area which even helps in reducing the cost of input. Reflectance response of wheat canopy indicated damage caused by Russian Wheat Aphid (Mirik *et al.,* 2012) this reflectance method helps in detecting, quantifying the pest population with time and place. These reflectance reaction of infested and un-infested areas used to facilitate effective control of pest with GIS based precision farming sprayer gear.

(v) Nutrient Management. One of the important challenges in agriculture was the successful management of nutrients. Remote sensing methods provide field scale diagnostic solutions that help in detecting the nutrient deficiencies. Overall nutrient efficiency can be improved by using variable rate sprayer products, real time canopy sensor that also helps in site specific application (Schepers and so Francis, 1998).

(vi) Yield Prediction. The management of field crop and forecast of produce have an impact every time international and national level which always has a crucial role in food management (Hayes and Decker, 1996). Many attempts had made to advance several indices by utilizing remote sensing: Temperature condition index (TCI), vegetation condition index(VCI), Normalized difference vegetation index(NDVI). These advances used to detect drought, variations in soil such as more wetness, detecting climatic impacts on crop health and its production (Kogan *et al.,* 1998). Among all the several indices NDVI features have used broadly for produce yield estimation. (Thorndyke & Hayes-Roth 1982; Benedetti and Rossinni, 1993; Quarmby *et al.,* 1993).

For assessing yield there are two methods in remote sensing they are the direct method and indirect method. In the direct method prediction of yield are made by using remote sensing measurements but in the indirect method these obtained measurements are inserted into computer and then prediction was calculated.

Nano-Technology for crop protection. Nanotechnology provides a platform to track the benefits of restrictive properties of atoms and molecules at the nanoscale. Industrial application include farming, food and textile has expanded due to the activity of nanomaterial by specific size, structure and distinct properties (Sharon *et al.* 2010; Sastry & Bodson (2011).

(i) Nano scale carriers. Smart nanoscale carriers utilized to deliver pesticides, herbicides, fertilizers and plant growth regulators etc (Ali *et al.,* 2014*)*. These carriers help in gripping the roots and organic matter which will increase the strength in environment and eventually lessen the quantity which should be applied (Ditta 2012). Mechanism involved in active storage, better distribution and under control release comprises: entrapment and encapsulation, surface ionic weak bond and polymers attachments among them.

(ii) Nano-pesticide. Excess quantity of using chemical pesticides causes pollution to the environment. There is a need to lessen the usage of these harmful pesticides which even reduce the input cost (Sharon, 2014). This could be accomplished by raising the confinement period of pesticides with needed potency. Endurance among chemicals within the first level of plant development assist in transferal down the pest population low the brink level, resulting in good management for an extended amount of time. A nanotechnology approach, "nanoencapsulation" are often increased the pesticidal value. In this technique, the active ingredient is enclosed by a skinny walled shell. The effective strategy during this is "governed discharge of the active ingredient" that will increase efficacy and decreases the quantity of pesticide use as well as hazards to the environment. For instance "Halloysite" is a profitable carriers of pesticides.

For the controlled discharge of pesticide Porous hollow silica nanoparticles piled with validamycin could be utilized. Nano-silica particles also used to regulate the pest population. The working method of these nano-silica particles is physisorption. These particles get absorbed through insect stratum lipids which leads to the death of insects by physical means (Allen *et al.*, 1994). Another successful advancement is the provision of nano-framed that can increase the potency of pesticides, insecticides and conjointly cut back the dose level needed for plants. Karate® ZEON is a nano encapsulated broad range pesticide which has been launched by Syngenta to manage insect pests of rice, soybean, cotton and groundnut (Prasad, 2014). Lambda-cyhalothrin is the a.i of this product that is discharged when contact with leaves. "Gutbuster" is one more useful nanoinsecticide which is released when exposed to the alkaline environment.

(iii) Nano-herbicides for effective weed control. Major problem in the farming system is the evolution of weeds because they decrease the produce up to a great level. Therefore we need another solution apart from eradicating them which can be nanotechnology. Nano-herbicides can be utilized to overcome weeds, devoid of certain harmful residues in soil and environment (Pérez de Luque 2009). By the combination of a.i with "smart" delivery system less amount of herbicide can be used. These herbicides can be easily combined with soil particles because of their nano size and inhibit the development of weeds which are tolerant to traditional herbicides. The herbicides which are existing in the market can just kill the above parts of weeds. These herbicide do not kill the underground parts which can act as a source for the next cropping season. The main aim is to develop target specific nano particle herbicides which target the root as well. They can penetrate into roots of the weeds and prevent glycolysis which ultimately affects the food reserves.

Increased use of herbicides for a longer period affect the health of soil as well as successive crops severely, so detoxification of weeds is necessary (Chinnamuthu and Boopathi, 2009). Continuous use of same herbicide also leads to weed resistance. Nano particles of Carboxy Methyl Cellulose (CMC) reported detoxification of atrazine herbicide nearly 88% (Satapanajaru, 2008).

(iv) "Smart dust" (Smart mini laboratories). The future of farming sector, a great army of nano-sensors would be dispersed just like dust particles throughout the field, operating like sense organs of the agriculture world (Ali *et al.,* 2014). The information sensed by these wireless sensors can be communicated easily. They can respond to varios factors like humidity, temperature and nutrients (Ingale *et al*., 2013). The allocated intelligence of sensible particles will be linked to react immediately for any sort of changes occurs in the surrounding environment (Scott N 2002). It is possible to estimate the number of pollutants in the environment by using smart dust and gas sensors (Mousavi & Rezaei 2011)). The most successful technique is the usage of autonomous sensors that are linked to global positioning system (Prasad 2014). 'smart dust' methods can be used for checking various kinds of factors like humidity, temperature perhaps insect and disease incidence to develop distributed intelligence in orchards and vineyard (Ditta *et al.*, 2012).

(v) Nanofabrication imaging. The nano fabrication imaging helps in scanning the internal and external plant tissue. This method is used to look internal or external plant tissues which help in identifying numerous plant pathogens. Extending the use of an image analysis technique aid the diagnostic capabilities of a plant pathologist. By utilizing this method scientists were capable to heal diseases early and accurately (Rosen *et al.,* 2011). With the size range of 5- 100 nanometer diameter, nanoparticles posses functional groups and more surface area for conjugating to various diagnosis tools (Nie, 2013). Therefore, improvement in this area of nanoscale agents always plays an important role in image analysis.

Photolithography and electron beam utilized to assemble topographies that simulate the leaf surface area, internal plumbing of plants which helps us to know how the pathogen invade the tissue (Mccandles 2005). Lithography was used to nanofabricate a pillared surface on silicon wafers. This lawn of miniature pillars was between 1.4 and 20 mm wide and spaced various distances apart. It was used to examine the movement across the surface by the fungus that mimicked some of the characteristics of the host plant. Images of the *Colletotrichum graminicola* crawling across the nanofabricated surface assisted the researchers to determine that the fungus needs to make a minimum contact of at least 4.5mm before it starts to develop appressoria. Using nanofabrication methods bacterial disease of grapevine (Pierce's) was studied in detail along with their infection process, the behaviour of a pathogen and developed resistant varieties (Meng *et al.,* 2005). To visualize and path the transport and deposition of nanoparticles inside the plant host at different levels of resolution through carbon-coated magnetic nanoparticles and microscopy techniques (Gonzalez-Melendi *et al.,* 2007). Nano diagnostic kits increase the pathogen detection speed as well as the certainty of diagnosis (Khiya *et al.,* 2014). Likewise, grouping of microfluidic systems with nanotechnology successfully utilized in plant pathology at molecular level and can be suited to detect not only specific plant pathogens but also toxins.

Dual Functional Salts as a Highly powerful Weapon Against Plant virus. In recent times, plant protection towards virus diseases is the difficult tasks encountered by modern agriculture. Utilization of systemic acquired resistance phenomenon is the possible way of plant protection (Marcin Smiglak 2017). Plant Immune system is activated against infections through different chemical and biological factors. Publications provide eleven of benzo[1.2.3]thiadiazole-7-carboxy-S-methyl ester ionic derivatives, an artificial inducer for plant resistance, with counterions specifically determined to enhance the natural and physical properties of the derived salts.

The biological and physical properties of 8 latest salts having anionic derivatives of BTH have been produced and also characterized (Lewandowski *et al.*, 2014). All these salts showed high property of systemic acquired resistance for instance [N4444] [BTHCOO] (Du, *et al*., 2011) and [N111010] [BTHCOO] which also shows complete inhibition of viral disease. Furthermore, resistance induction in plants was augmented with positive results of antibiocidal properties and with an increase in solubility of acquired salts.

Hierarchical self organizing classifiers for the detection of biotic and abiotic stresses in crops. Hyperspectral signatures offers ample info related to the health status of crops; but it is not so easy to segregate among abiotic and biotic stress. This method utilizes a classification scheme consisting of hierarchical self-organizing classifiers.

One of the important method to distinguish biotic stress of plants utilizing machine learning (Moshou *et al*., 2004). Recognized yellow rust of wheat on the premise of the coefficient of reflectance measurements applying NNs. Employing a sum of 5137 leaf spectra for analysis, a class performance between 95 and 99 % was acquired. Features for the advancement of an economically powerful optical device for the measurements of field (Moshou *et al*., 2005). This system acquires, multi-spectral images, hyperspectral and GNSS information of crop stands. A multisensory system based on NNs utilized to predicted diseases in the field (Moshou *et al*., 2011). By using NNs relevant regions of hyperspectral signatures of *Phytophthora infestans* on tomato has been predicted by Wang et al., (2008). When symptoms were first visible they identified the diseased tomato plants by employing PCA prior to NN classification hyperspectral detection of grey mould on eggplant leaves is vaible. In their study, initial signs and symptoms of grey mold were precisely noticeable on eggplant leaves. By combining PCA and following NN classification rice bract blight disease in panicles of rice can be differentiated between light, moderate, healthy and high infection levels. Yet it was experimented in controlled conditions and may not be possible to perform in the field. SVMs is used for initial identification of plant diseases prior to visible symptom appears (Rumpf *et al.,* 2010). Nine spectral plant life indices, related to physiological parameters have been used as options for automatic classification of relevant sugar beet diseases. By using high accurate (90%) a non-linear Support Vector Machine it is possible to differentiate among healthy and infected plants, as well as diseases. However extra analysis is needed to deliver the delineated ways into field application for precision plant protection.

Usage of Electronic traps for detecting and monitoring the population of insectpest. Electronic traps are adopted all through the previous years for observing the insect pest. Picture dependent e-traps have especially focused upon analyzing and trapping specific small insects. Those electronic traps are especially designed for protected cultivation. Electronic traps which depend on analysis of image was developed for moth pests recently (Cho *et al*., 2007) (Guarnieri *et al.,* 2011). Concerning FF, a wireless e- trap was created for the observance of *B. oleae* and *C. capitata* by adjusting a McPhail model. Here, a digital camera records photographs of bugs entering into the trap, software produces photos for FF identification (Philimis *et al*., 2013). A latest McPhail trap for FF depends on imagery and exclusively advance technology sensors are developed in Australia and McPhail trap supported on sensors discovering variations in light transmittance ensuing from entering insects into the trap was developed for B.oleae (Potamitis *et al.,* 2017) Another electronic trap for B.dorsalis employs a specific attractant and to count attracted male flies by an infrared disruption device (Deqin *et al.,* 2016; Jiang *et al.,* 2008).

CONCLUSION

Feeding a developing the world population despite global change in climate needs enhancing the responsibility, proper use of resources and environmental effects on the production of food. The best method for attaining these objectives is to utilize advance technologies like robotic control, remote sensing, nano-technology and incorporate useful microbiomes of plant i.e., which helps in improving growth of the plant, potential use of nutrient, disease resistance and abiotic stress tolerance into production of agriculture. This incorporation will need a huge effort among researchers and farmers to figure out and manage interactions of plant-microbiome within the framework of recent agricultural systems. Meeting these goals ought to increase our potential to design and implement efficient manipulations of agricultural microbiome and management methods, which, in turn, will pay rewards for both the producers and consumers of the world food supply.

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