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Decision Support System (DSS) on Pulses in India

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ABSTRACT

Pulses are popularly known as poor man's meat. Pulses mainly constituted of gram, arhar, mung, urad and lentil etc. The energy content of most pulses have been found to be between 300 and 540 Kcal/100g. India is the largest producer and consumer of pulses in the world contributing around 14.36% of the total global production. Decision support system (DSS) has been designed and developed using a visual basic platform for major pulse crops grown in India. The main objective is to provide decision support regarding recommended water, weed, pest and diseases management, state wise varieties and nutrient management based on the soil test value to the farmer, agriculture workers, students, research workers, extension workers and others, even in absence of the experts. The system is console application, menu driven and user friendly. A sincere effort has been made with the available data to develop the decision support system to bridge the gap between the farmers and the experts using visual basic platform.

Key words: Computer based System, Decision support system (DSS), Nutrient management, Pulses.

INTRODUCTION

Agriculture plays an important role in Indian economy, 58% of Indian population depend upon the agriculture and allied sector (GOI, 2015). About 17.80% (2013-14) Gross Domestic Product (GDP) of Indian economy is contributed by agriculture. In addition to cereals and oilseeds, pulses are one of the important contributors to Indian agriculture. Pulses are popularly known as poor man's meat. Pulses mainly constituted of chickpea, arhar, mung bean, urad bean and lentil etc. A large proportion of the Indian population is vegetarian and pulses are an important sources of protein in the daily diet, as they are as much as 18-25 percent protein, average cost of protein consumption will be Rs. 38/ 100g; while milk contains 3.2 percent (Rs. 75/100g), poultry meat contains 18-20 percent (Rs. 53/100g), eggs contains 14 percent (Rs. 42/100g) of protein (Vishwajith *et al.* 2019). The production of total pulses in India is about 16280 thousand tons from an area of about 25365 thousand hectare (http://faostat.fao.org, last accessed on 7-July-14). Even though India is the world largest producer of pulses, about 20 percent of the total pulses demands are met by imports only (Singh *et. al.,* 2015). Pulse crops improve soil health by enriching nitrogen status, long-term fertility and sustainability of the cropping system (Kannaiyan, 1999). Computers have been used in agriculture and allied fields for over thirty years. Areas of usages advanced from computing to the existing multitude of uses in agricultural research such as monitoring, evaluation and control, information management and dissemination, teaching, training and decision support systems. The use of computers has brought awareness and the potentialities of different disciplines due to possibility of storing and transmitting information. Information Technology (IT) is defined as the technologies involved in collecting, processing, storing, retrieving, disseminating and implementing data and information using microelectronics, optics, telecommunications and computers. The recent advance in computer and communication technology has made computer hardware and software more affordable and user-friendly and has resulted in faster movement of information and its utilization. Computer professionals have started writing programs, which mimic the human thinking. These programs are termed as Decision Support Systems.

The term "Decision Support System" was coined by Gorry and Mortan in 1971. The origin of word is simple.

Decision – emphasizes decision making in problem situations.
Support – required computer aided decision situation with enough "structure" to permit computer support.
System – emphasizes the integrated nature of problem solving, suggesting a combined man, machine and decision environment.

A typical early definition of Decision Support System, widely accepted in literature is "DSS are interactive computer-based systems that utilize data and models for aiding an organizational decision-maker in semi structured problem".The kind of systems ideally suited to aid important

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management decisions would seem to have great potential for decision makers. These systems could help to make non-domain knowledge more frequently available to farmers and farm managers. Further, the knowledge transfer in agriculture could be improved and the extension services be performed more effectively by using DSS. They can help by having the knowledge at a central place i.e. in DSS, which could be easily understood by different workers *viz*., farmers, students, researchers, breeders and planners.Information is a key input for an economic farming; information can efficiently be converted into economically rewarding opportunities. The success of any DSS in agriculture depends on the availability of situation specific information for different crops and its associated components. Attempts have been made under Indian context for development of crop specific and site specific DSS. Among these, the work of Vishwajith *et al.* (2014), Pal *et al.* (2007), Ganesan (2007) for the leading crops in Kerala, Rao and Kumar (2006) for important crops in Andhra Pradesh are few to mention. These DSS are limited to only nutrient management practices and does not provide the information about other aspects like water management, weed, pest and disease management and varieties recommendation. Hence an attempt has been made to develop the integrated DSS for important pulse crops of India with overcoming the drawback of limiting to only nutrient recommendation for the crops. Singh and Gupta (2016) reviewed different DSS system for Integrated Pest Management (IPM) in India. Larson *et al.* (2005) developed Cotton Yield Monitor Investment Decision Aid (CYMIDA) to aid for analyzing the cotton yield monitor Information System investment choice. Daniel (2011) developed “Crop nutrient management decision support system” for black gram and paddy in Tamil Nadu. Debeljak *et al*. (2019) studied the decision support system for Assessment and Management of Soil Functions.

MATERIALS AND METHODS

The Decision Support System was designed and developed using the information collected from various source mentioned earlier using Visual Basic 6.0 as platform. The DSS was developed to provide the information to the user about the nutrient, water, weed, pest and disease management practices and state wise recommended varieties. The DSS also provides the nutrient recommendation based on Soil Test Crop Response (STCR) approach.

Based on a very large number of complex field experiments on diverse soils at different centres of Soil Test Response studies (STCR) for major crops, fertilizer recommendations are provided for targeted yields based on soil tests. The fertilizer recommendation based on yield target concept have been tested in the follow up trials and in about 1800 frontline demonstrations in the farmers’ fields to verify the technology. The procedure provides a scientific basis for fertilization and balance between applied nutrients and nutrients available in the soil. Once this requirement is known for a given yield level, the fertilizer needed can be estimated taking into consideration the contribution from available nutrients in the soil. The essential basic data required for formulating fertilizer recommendation for targeted yield (T) are (i) nutrient requirement per unit of produce, grain or other economic produce, (ii) the percent contribution from the soil available nutrient, (iii) the percent contribution from the fertilizer nutrients (Ramamoorthy *et al*. 1967).

Nutrient requirement (NR) of N, P and K for grain productio:

$$NR = \frac{\lambda}{Y}$$

Where,
NR is the Kg of nutrients per quintal of grain,
λ is the total uptake of nutrients in Kg.
Y is the grain yield in quintal.

Percent contribution of nutrient from soil

$$CS = \frac{X}{Z} \text{ x100}$$

Where
X is the total uptake from the control plot in kg/ha.
Z is the soil test values of nutrients in control plots in kg/ha.

Contribution of nutrients from the fertilizer

$$CF = U - \frac{(F - CS)}{100}$$

Where
U is the total uptake in treated plots kg/ha.
F is the soils test values of particular nutrient kg/ha.

Percent contribution of nutrient from fertilizer

$$CF\ \% = \frac{CF}{F} \text{ x100}$$

Where,
CF is the percent contribution of nutrient from fertilizer.
F is the fertilizer dose applied in kg/ha.

Calculation of nutrient dose

The basic data are transformed into workable adjustment equation as follows:

$$ND = \frac{NR}{CF}\text{x.100x.}T - \frac{CS}{CF\ \%}\text{x.}STV$$

Where,
ND = Nutrient dose,
T= Targeted yield with in limit,
STV= soil test value.
Structurally the DSS developed is as shown in the flow chart (Fig 1).

RESULTS AND DISCUSSION

Decision support system

As far as agriculture is concerned, farmer is the ultimate decision maker, but attempts are being made to make him more knowledgeable by extension workers, technocrats and beaurocrats. He could be impressed and made to change his views, if he finds information readily available. This can be achieved in a computer-aided system. However, without proper decision or advice this vast information will confuse the farmer. Therefore, the system should also aid with proper

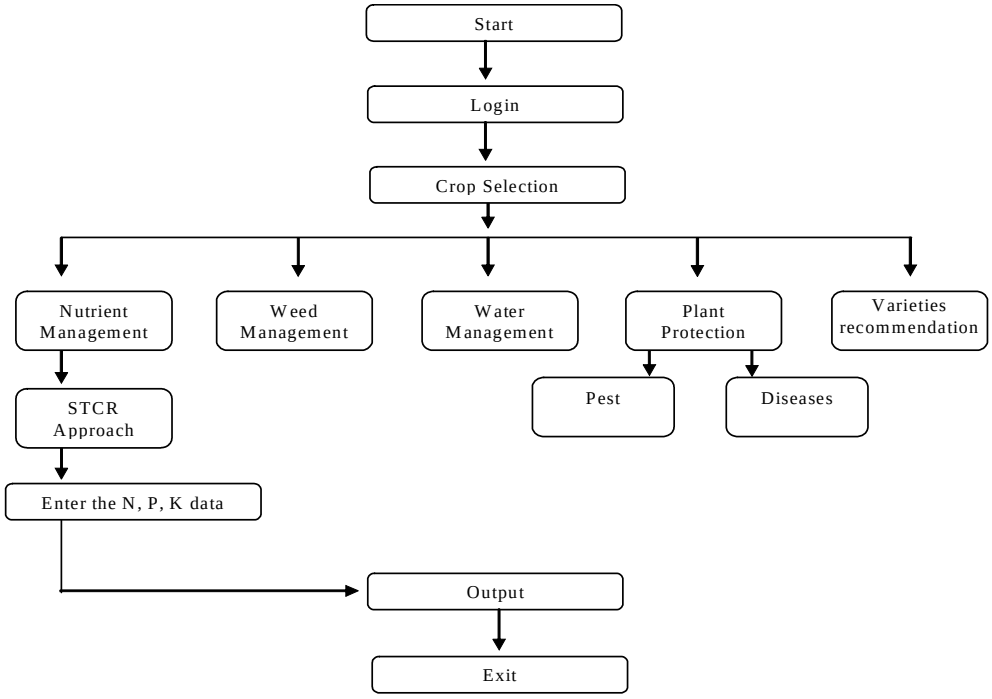


Fig 1: Flow chart showing the operational aspects of DSS.

decisions. In this direction, attempt has been made to design and develop the integrated decision support system to provide the support to the farmer regarding nutrient, water, weed, plant protection and recent varieties of major pulses of India.

The Decision Support System has been developed for the five major pulses grown in India *viz*., chick pea, arhar, mung, urad and lentil. The DSS is the console application or portable application so there is no need to install in the system. The decision system contains following windows and menu:

1) Login window
2) Crop selection window
3) Crop window
4) Nutrient management window
5) Water management window
6) Weed management window
7) Pest management window
8) Disease management window
9) State wise recommended varieties window

1. Login window

Once the user click and open the software, a login window (Fig 2) will appear on which the user has to enter the user name and password and then click on login, which displays the crop selection window.

2. Crop selection window

The second window is crop selection window (Fig 3) which contains the five buttons for five major pulse crops. User has to select the crop for which information are needed just by clicking on the crop name.

3. Crop window

After selecting the crop from the crop selection window, it will take user to crop window (Fig 4) which contains some basic information about crop like scientific name, recommended seed rate, spacing, depth of sowing and the major producing states of India. This window contains the various menu *viz*., nutrient management, water management, weed management, plant protection and state wise recommended varieties in the top of the window. Just by clicking on these menus it will take the user to selected window.

4. Nutrient management window

Clicking on nutrient management menu crop window will takes the user to the nutrient management window. This nutrient management window (Fig 5) contains the information on recommended nutrient management practices for selected crop. Also this window contains home menu, back menu and STCR approach menu. By clicking home and back it will take to crop selection window and crop window respectively. STCR approach menu contains various states as the sub menu. One needs to select the state sub menu for which nutrient recommendation is needed based on the soil test value. On selecting the state it will take to the STCR approach calculation window (Fig 6) where user needs to enter the value for targeted yield within provided range and soil test result value for nitrogen, phosphorus and potash in kg/ha. Once after entering the data, has to click on the calculate button, the amount of N, P and K required to be applied to get targeted yield for that soil condition which will be displayed in the form of message



Fig 2: Login window.



Fig 3: Crop selection window.

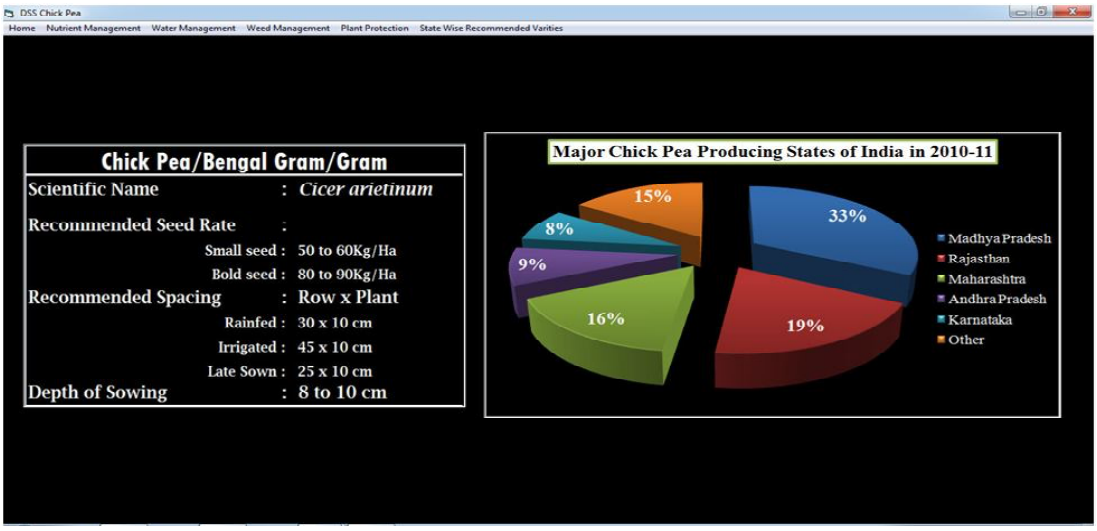


Fig 4: Crop window.

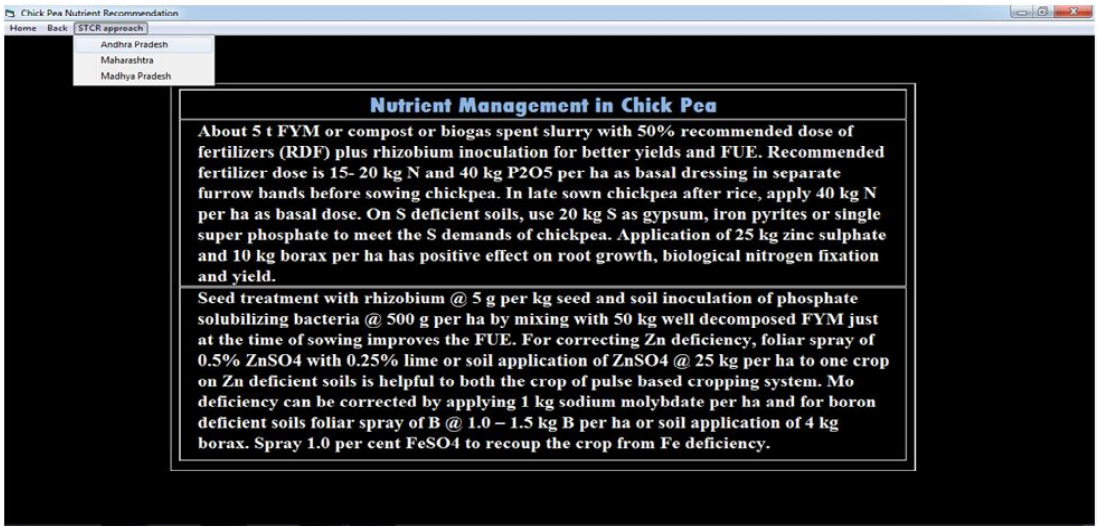


Fig 5: Nutrient management window.

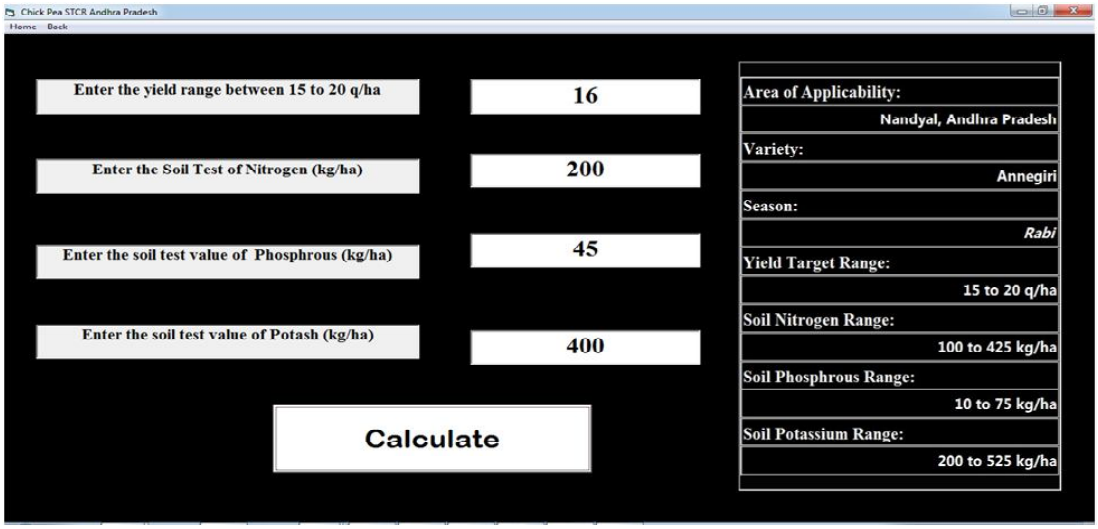


Fig 6: STCR approach window.

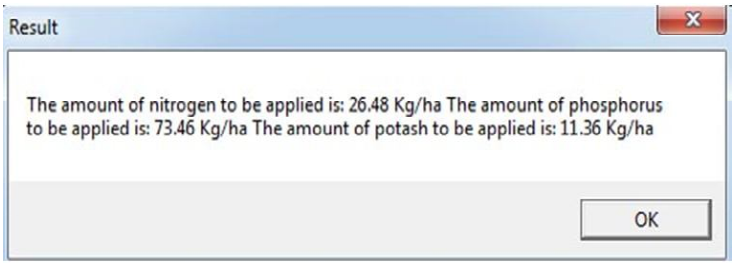


Fig 7: Result box.

box (Fig 7). It is important to note that the entered yield level and N, P and K value of soil entered should be in the range provided in left down corner of the window. This STCR approach is crop specific and region specific. Information about the region of applicable is also mentioned in the STCR approach window Nagendra and Kumar (2006) developed menu based user friendly "Nutrient management decision support system for appropriate use of fertilizer and amendments in agriculture.

5. Water management window

Clicking on water management menu in the crop selection window will take the user to the water management window (Fig 8). This window will provides the recommended water management practices for the selected crop like crop growing season, importance of the irrigation, stage of crop at which irrigation is needed, amount of irrigation and also the advantage of giving the irrigation at proper crop stage.

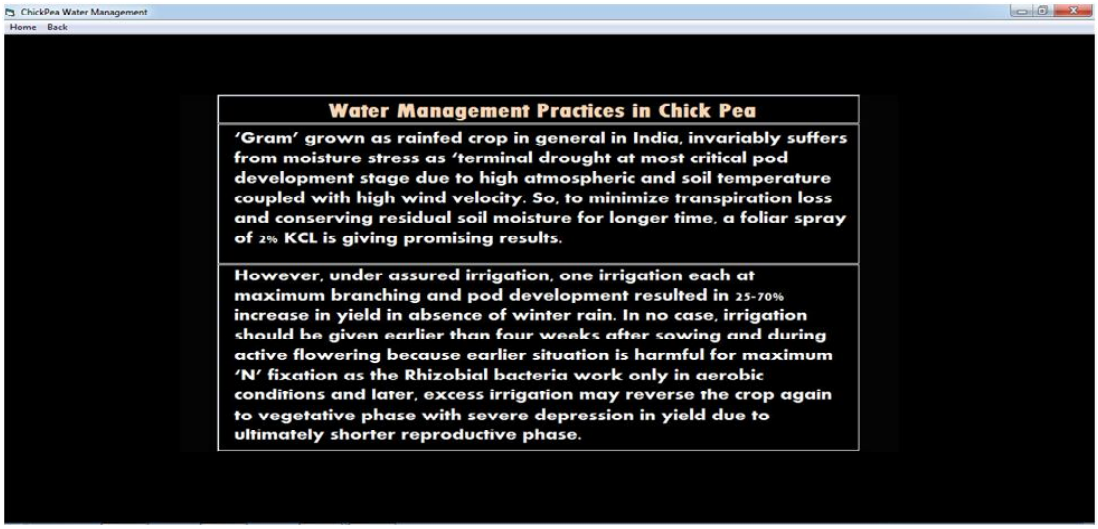


Fig 8: Water management window.

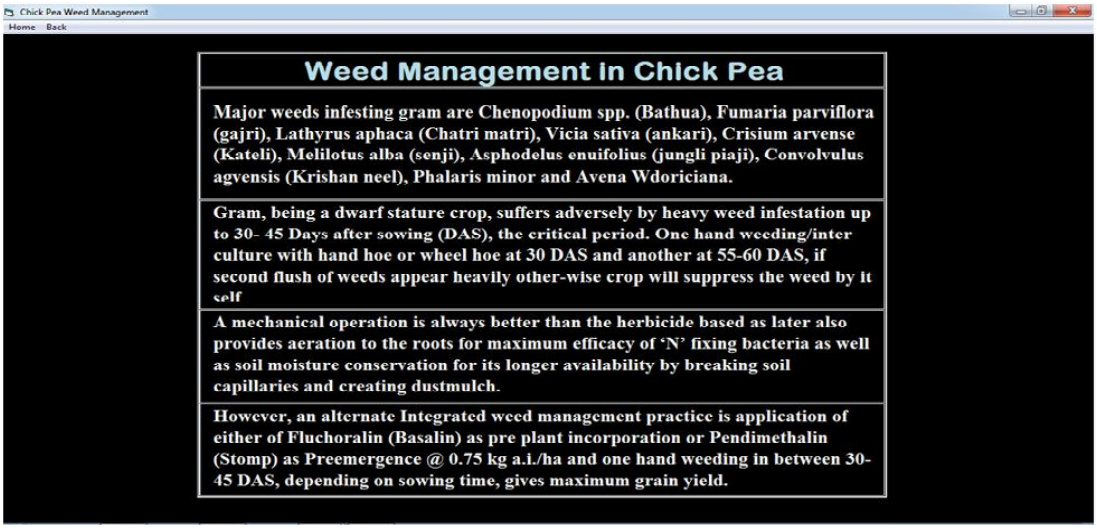


Fig 9: Weed management window.

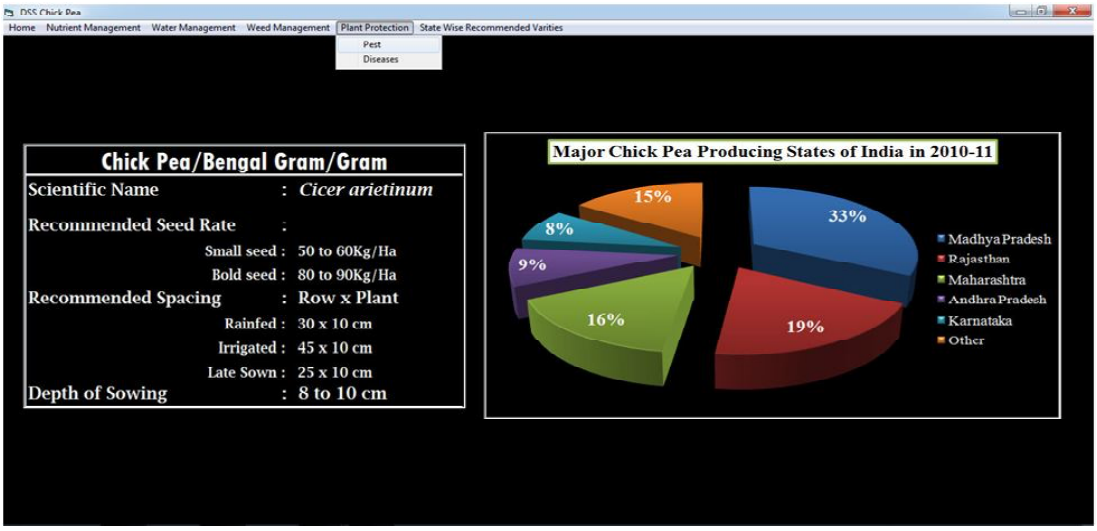


Fig 10: Crop window showing the submenus of the plant protection menu.

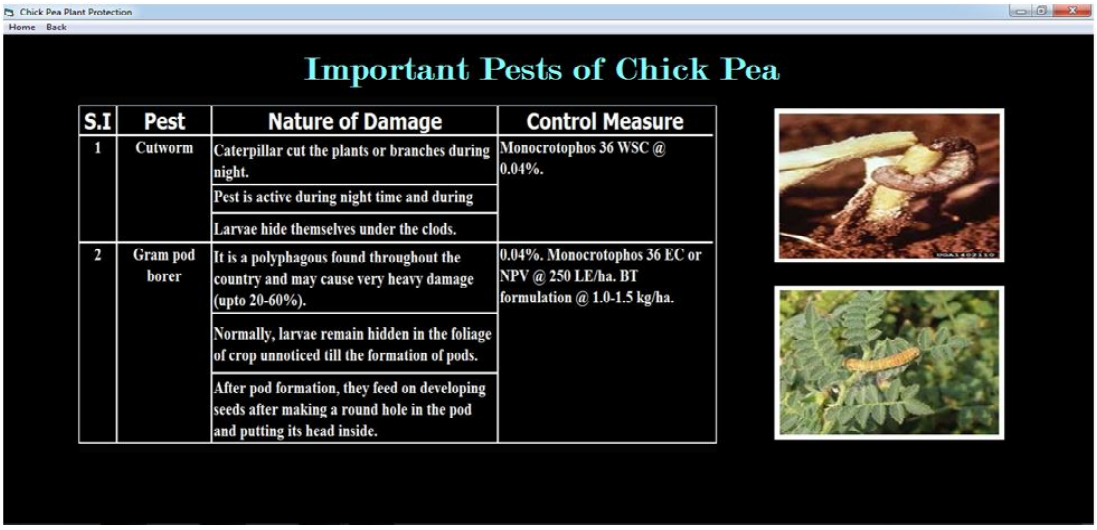


Fig 11: Pest management window.

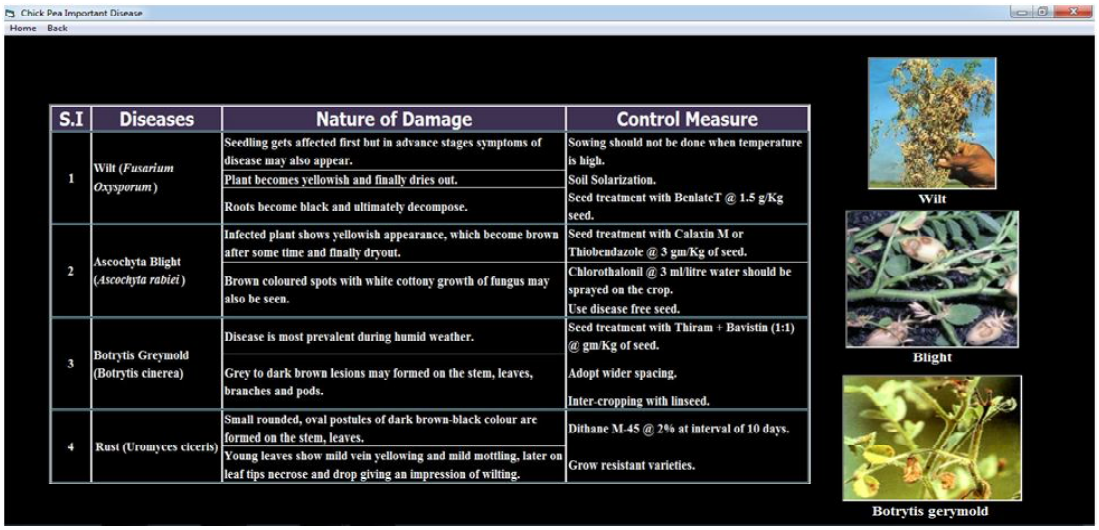


Fig 12: Diseases management window.

6. Weed management window

The user has to click on weed management menu of the crop window to get access into the weed management window (Fig 9). This window provides the information for user about the major weeds infesting the selected crop, the critical period at which the crop will suffer more from weeds and the various recommended weed management practices to overcome the problem of weeds. Parsons *et al.* (2008) considered a model-based decision support system to assist arable farmers and advisers in weed control decisions on two time scales: within a single season and over several years in a rotation. Neeser *et al.* (2004) developed the decision support system that was developed to help farmers and consultants in Nebraska with the selection of optimal weed management strategies.

7. Pest management window

The user needs to select the plant protection menu in the crop window and again the submenu 'Pest' (Fig 10) to get access into the pest management window (Fig 11). This window contains the information about important pests infesting the selected crops, nature of damage and the measures to controlling the pest. The good quality of photographs of the pests is also given in this window to facilitate the user to identify the pest. Singh and Gupta (2016) evaluated ICT based decision support systems for Integrated Pest Management (IPM) in India.

8. Disease management window

The user needs to select the plant protection menu in the crop window and again the submenu 'Disease' (Fig 10) to get access into the disease management window (Fig 12). This window contains the information about important diseases affecting the selected crops, nature of damage and the control measures for diseases. The good quality of photographs of the crop infested with the disease is also given in this window to facilitate the user to identify the

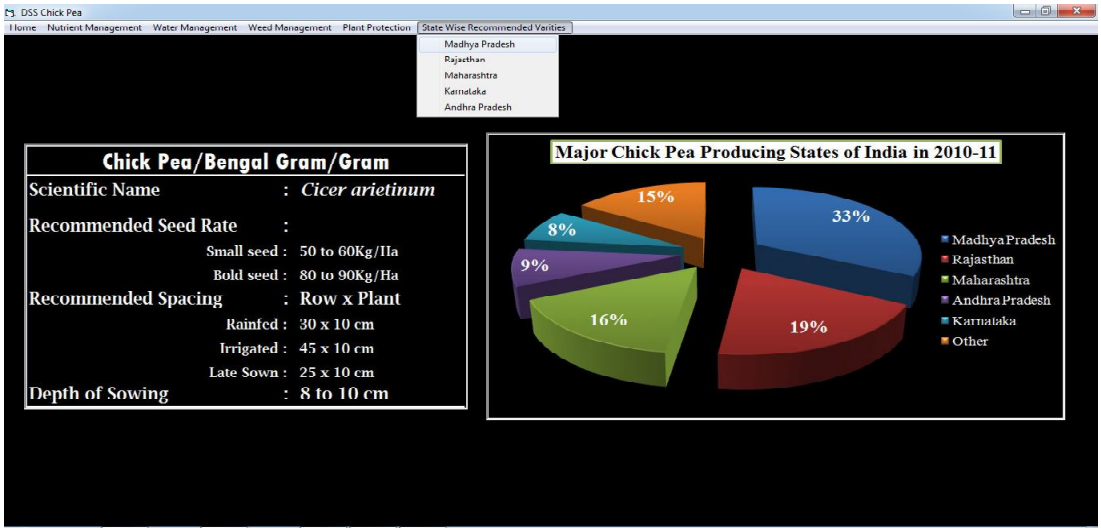
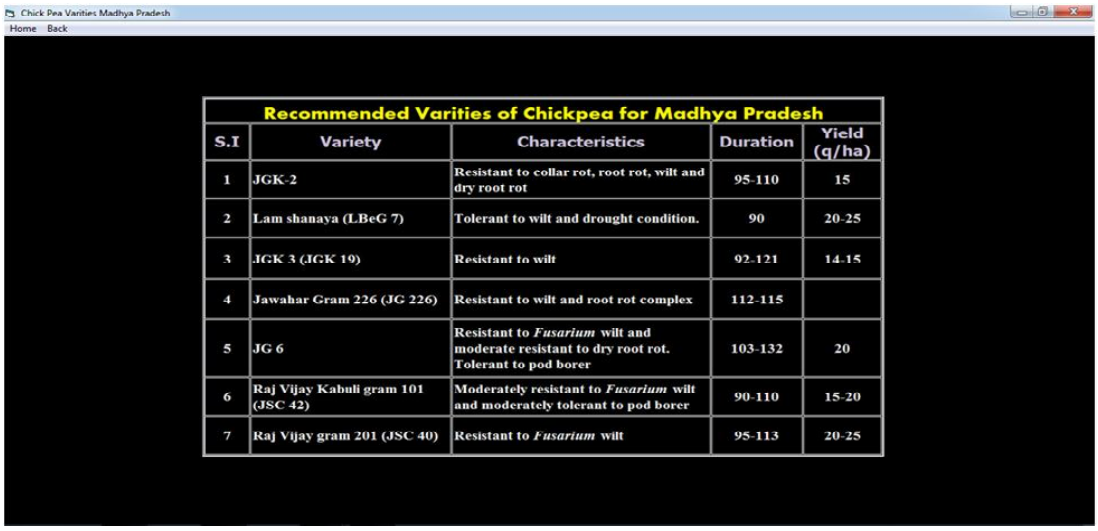


Fig 13: Crop window showing the submenus of the state wise recommended varieties menu.



Recommended Varities of Chickpea for Madhya Pradesh

S.I	Variety	Characteristics	Duration	Yield (q/ha)
1	JGK-2	Resistant to collar rot, root rot, wilt and dry root rot	95-110	15
2	Lam shanaya (LBeG 7)	Tolerant to wilt and drought condition.	90	20-25
3	JGK 3 (JGK 19)	Resistant to wilt	92-121	14-15
4	Jawahar Gram 226 (JG 226)	Resistant to wilt and root rot complex	112-115	
5	JG 6	Resistant to *Fusarium* wilt and moderate resistant to dry root rot. Tolerant to pod borer	103-132	20
6	Raj Vijay Kabuli gram 101 (JSC 42)	Moderately resistant to *Fusarium* wilt and moderately tolerant to pod borer	90-110	15-20
7	Raj Vijay gram 201 (JSC 40)	Resistant to *Fusarium* wilt	95-113	20-25

Fig 14: State wise recommended varieties window.

diseases. Carisse *et al*. (2010) identified disease management decision making and the usefulness of DDSS in identifying the key time for applying fungicides.

9. State wise recommended varieties window

To get access into state wise recommended varieties window (Fig 14), first user need to click on the state wise recommended varieties menu from which one has to selected the states listed as sub menu (Fig 13). This window contains the information about the important and recent varieties recommended for selected crop and the state, important characteristics, duration and the expected yield of the varieties.

The DSS has been developed with an objective to provide help farmers for decision with respect to this or crop but this is equally good and applicable for their respective benefits by the, agriculture workers, students, research workers, extension workers and others, even in absence of the experts. The system is menu driven and user friendly. Hopefully, the use of this system will provide intellectual support to user in proper management of pulses crops.

CONCLUSION

The decision support system has been designed and developed using the visual basic as a platform for five major pulses crop grown in India with an objective to provide decision support to the farmers, agriculture workers, students, research workers, extension workers and others, even in absence of the experts. The developed DSS is a integrated system which provides the information to user about the recommended weed, water, plant protection management practices, state wise varieties recommendation and general nutrient management practices including the nutrient recommendation based on Soil Test Crop Response (STCR) approach. The system is console application, menu driven and user friendly. Hopefully, the use of this system will provide intellectual support to user in proper

management of pulses crops. The developed DSS can be extended to any number of crops provided the information's are available. Quire based decision support system can be developed.

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