DEVELOPMENT OF DECISION SUPPORT SYSTEM FOR COTTON AND SUGARCANE

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INTRODUCTION

Agriculture continues to remain the major sector of the Indian economy even after 63 years of independence. It contributes 30 per cent of GNP, provides 65 per cent of employment and continues to be source of living.

The green revolution has increased the overall production in the country but the increase in the production has been less than required, as the rate of adoption of Agriculture technology is slow. Extension support to the farmers is still descent. The ancillary role of supplying inputs and curbing out with subsides has become the main function of extension officials, relegating advisory, training and demonstration services to background. This needs rethinking as technological progress in agriculture is crucial for overall agricultural production of the country. Therefore, we need to revamp and revitalize the extension service in such a way that it reaches the farmers/field level more effectively. The development of "Decision Support System for Sugarcane and Cotton Crops" is an effort in this direction.

Computer algorithms have been used in agriculture and allied fields for over thirty years. Areas of usages dealt 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 computer algorithms 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 (DSS)" was coined by Gorry and Mortan (1971). The origin of word is highly informative.

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".

DSSs are information systems with an eye on decision-making based on knowledge stored in the form of a database. They rely on the man and machine working together for problem solving. In this sense they differ from Electronic Data Processing (EDP), where focus is only on data and automating routine processes. They also differ from Management Information Systems (MIS) wherein we focus on information. Many researchers flowed and not dealt with development of computer algorithms for agriculture experiments conducted globally. The present research is faint to attempt the development of algorithm model for cotton and sugarcane production. Our main objective is to provide information that can be useful to the management. Further, the Decision Support system provides an environment wherein a decision maker effectively applies various kinds of management methods and use quantitative analysis technique that would otherwise be too cumbersome to handle.

During early stages of development up to 1970, DDSs were classes of organizational information systems and were used for classifying the relationship between DSS, EDP and MIS, but after development of systems, attempts to make them behave as experts in different fields [Expert Systems (ES)] emerged.

Though ES and DSS share the same goal of enhancing human decision-making, but they are fundamentally different in their philosophies and analytical approaches. ESs are concerned with leveraging the expertise of an expert for use by non-experts, whereas DSSs are concerned with providing and intellectual support to capable decision makers so that they can effectively leverage their own skills.

Importance of DSSs and ESs in agriculture

The kind of analytical systems ideally more suited to aid important 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, breeders and planners. With all the above aspects in mind an attempt is made in the present dissertation to develop a decision support system for sugarcane and cotton crops. This is of vital importance, as any crop yield is dependent on weather parameters, diseases, pests and weed growth. In case of infestation of disease, pest and weed or variations in weather parameters, the plant will not be healthy. The important weather parameters are rainfall, relative humidity and temperature.

Cotton

Cotton (*Gossypium* spp.) is king of fibres, usually referred as white gold and considered as one of the important commercial crops. It plays an pivotal role in economic, political and social affairs of the world. It is cultivated in about 60 countries and 10 countries *viz.* China, India, USA, former USSR, Brazil, Pakistan, Turkey, Mexico, Egypt and Sudan account for nearly 85 per cent of total production. Its natural fibres are the most important to materials for comfort clothing production.

In Karnataka area, production and productivity during the year 2012-13 is 4.85 lakh hectares, 15 lakh bales and 526 kg/ha respectively. The area, production and productivity of cotton in India during the year 2012-13 is 116.14 lakh hectares, 334 lakh bales and 489 kg/ha respectively [Source: Anonymous, 2013c].

Cotton is a major cash crop of India and account for 65 per cent of the fibres used in the textile industry. India is the only country in world, where all the 4 cultivated species of cotton *viz. G. hirsutum* (American upland cotton), G. *arborium, G. herbaceum* (Asian cotton) *G. baradense* (Egyptian cotton) are cultivated on commercial scale, besides hybrids. Cotton (*Gossypium hirsutum* L.), enjoys a predominant position amongst all cash crops in India and cultivated since Indus valley civilization. Weeds have always been a bottleneck for crop production and also reduce the both yield and quality of agricultural produce to the tune of 30 to 70%. Cotton is a wide spaced and relatively slow growing crop during its initial stages. Weeds like *Parthenium hysterophorus, Cynodon dactylon*, *Cyperus rotundus* barnyard grass offer severe competition, causing considerable yield reduction.

Important diseases found in cotton crop are namely- angular leaf spot, rust, alternaria leaf spot, fusarium wilt, bacterial leaf blight *etc.*, pests- sucking pests, leaf hopper, mealy bug, boll worms, whitefly, leaf eating caterpillar *etc.* Apparently Cotton is warm season crop and requires an average temperature 21-32^{0}C. It gives an average yield of 15-20 q/ha.

Sugarcane

Sugarcane (*Saccharum spp.*) is the main sugar producing crop that contributes nearly 78.2 per cent to the total sugar production at the global level. It is the prime source of sugar and commercial cash crop in India. Production and yield of sugarcane in major growing states are Bihar, Gujarat, Haryana, Karnataka, Maharashtra *etc.*

India is second in area and production in world. Sugarcane favors warm and humid climate with an average annual rain fall between 75-120 cm. The best temperature suited for sugarcane is 28-32^{0}C. Critical weed competition period exists up to 4 months after planting of the crop. Important weeds found are *Parthenium hysterophorus, Cynodon dactylon*, *Cyperus rotundus, Alternanthera sessilis etc.* Major pests found in sugarcane are- shoot borers, leaf hopper, wooly aphid, root grub *etc.* Major diseases found are – ring spot, red rot, collar rot, whip smut, rust *etc.*

Importance of sugarcane

Sugarcane provides raw material for the second largest agro-based industry beside textile industry/sector.

Nutritional value of sugarcane

The juice Sugarcane course of 28.35 gms complement the Energy-111.13 kJ (26.56 kcal), Carbohydrates-27.51 g, Protein-0.27 g, Calcium 11.23 mg, Iron 0.37 mg, Potassium 41.96 mg, Sodium 17.01 mg. [Source: Anonymous, 2013a]

Important regions/ zones for sugarcane cultivation in India

Broadly there are two distinct agro-climatic regions of sugarcane cultivation in India, *viz.*, tropical and subtropical.

Demand and supply scenario of sugarcane produce

The area, production and productivity of sugarcane in India during the year 2012-13 is 5.31 mha, 360 mt and 67 tonnes/ha respectively [Source: Anonymous, 2013b].

Sugar is the major produce of sugarcane. Area, Production and productivity in Karnataka accounts 430000 ha, 38808000 tonnes and 90.2 tonnes per ha in the year 2011-12. The domestic demand of sugar is rotating around 22-23 million tonnes annually, whereas the production of sugar in India during last 5 years is rotating around 24.3 to 26.3 Million ton. Uttar Pradesh is the largest producer of sugar contributes about 37.62 per cent of sugar in the country followed by Maharashtra.

Reduction in yield of sugarcane due to rise in temperature

The sugarcane productivity and juice quality are profoundly influenced by weather conditions prevailing during the various crop-growth sub-periods. Sugar recovery is highest when the weather is dry with low humidity; bright sunshine hours, cooler nights with wide diurnal variations and very little rainfall during ripening period. These conditions favour high sugar accumulation. The climatic conditions like very high temperature or very low temperature deteriorate the juice quality and thus affecting the sugar quality. Favourable climate like warm and humid climate favour the insect pests and diseases, which cause much damage to the quality and yield of its juice and finally sucrose contents.

Fertilizer management

An average crop of sugarcane yielding 100 t/ha removes 208 kg of N, 53 kg of P, 280 kg of K, 30 kg of Sulphur, 3.4 kg of iron, 1.2 kg of manganese, 0.6 kg of copper respectively from the soil. Hence, soil has to be replenished to maintain the productivity of sugarcane with the said quantities of nutrients. If the soil test value is below the critical value, apply sulphate form of Zn, Cu, Fe and Mn through soil application and foliar spray (The total concentration of salt should be 0.5 per cent for young crop and 2.5 per cent for a grown up crop). The recommendation of NPK for sugarcane crop varies from state to state and varies from region to region.

Objectives of study

1. To study the impact of weather parameters on incidence of pest, disease and weed growth.
2. To estimate yield of crop infested by pest, disease and weed.
3. To develop DSS for yield of crops in response to disease pest and weed growth.

REVIEW OF LITERATURE

With the advent of agriculture as a feeding resource and profession mankind could settle and improve living conditions. The knowledge was gained by experience and passed from generation to generation by verbal communication and guidance. This propagation of knowledge has been improved when mankind started storing it in the form of books and research papers and communicating it through teaching. An explosive trend is started when computers and information technologies came into exist. In this aspect of communication many authors imply their own findings through research. The present chapter dealt with different literature propounded by different scholars

2.2 Decision support system

Broner *et al.* (1990) developed a system entitled "Barley Crop Management Expert". This system combined a numerical crop growth simulation model with crop-specific heuristic knowledge to provide decision support for malting barley growers.

Kandu (1991) developed a "Prototype Diagnosis System for Rice Insect, Pest and Diseases". Developer used Visual basic (v6) as a plat form for the developing the system.

Poonam (1991) developed a prototype "Decision Support System for Students PPW". Researcher used MS-excel, MS-access and visual basic as a plat form for the developing the system.

Avinish (1992) developed a Decision Support System for Micronutrient Management who used C language as a builder of the system. Six micronutrients were taken into consideration namely Zinc (Zn), Iron (Fe), Manganese (Mn), Copper (Cu), Boron (B) and Molybdenum (Mo). The system has provides the recommendation on micronutrient application in crops on the basis of soil test values. The system also provides the remedial measures for micronutrient deficiency of crops.

Edward (1992) A Decision Support System was made to aid weed control in sugar beet. The system has provides the information and assists in giving recommendation to sugar beet advisors on appropriate herbicides mixtures and sequences for the range of sugar beet weed problems in United Kingdom (UK).

Badge Ravikumar (1993) a decision support system was made in his dissertation entitled "Decision support system for orange growers of Maharashtra", using PROLOG as a programming language.

Gianluigi Gallenti (1997) was worked on "the use of computer for the analysis of input demand in farm management: A multicriteria approach to the diet problem". The aim of his work was to evaluate the feeding formulation of pigs using an operational research model with several conflicting criteria, economic and nutritional values. The multicriteria decision methods were used by using PC program (Excel). This is an operationally simple tool to solve the feed formulation problems.

Mathews (1999) developed a spatial Decision Support System for rural land use planning integrating Geographic Information System and environmental models with search and optimization algorithms. The Decision Support System fulfills all the need for a tool that allows rural land managers to explore their land use options and the potential impacts of land use change.

Meng Xianxere (2000) reviewed the construction and management of Agricultural Science & Technology database in China and the database development trends across the countries of the world, outlines the framework for the further development of agricultural Science & technology database.

Kjetil (2002) developed "A computer-based decision support system for vessel fleet scheduling-experience and future research." For vessel fleet scheduling in the tramp and industrial shipping segment. He used visual basic for the development of support system

Patil (2002) a developed "Decision Support System for Nutrient Management in Wheat, Mustard and Bajra". This provides an intellectual support for Farmers and Extension workers in applying nutrients to their crops, namely, wheat, mustard and bajra, on the basis of available nutrients in soil, the system provides the recommendation on how much of chemical fertilizers are to be incorporated into the soil. The system is also capable of providing remedial measures in case of nutrient deficiency in standing crops.

Hsien-Tzung Shih *et al.* (2003) developed an introduction to Taiwan Agricultural Pest Database, with the purpose to provide the BAPHIQ and other administrative and research bodies with an inquiry interface for formulating counter policies to pest status and with pest information of crop as requested by imported countries.

Sahadeb (2003) developed “A nutrient management decision support system for the United states” which is a response to the need to track nitrogen, phosphorous and potassium in livestock manure generated by the confined animal feeding operations. They used Microsoft visual basic (V. 6.0) for developing DSS.

Ochola (2004) developed A prototype interaction Spatial Decision Support System (SDSS) to assist Land use scientists, Agricultural extension support personnel and Farmers to classify and characterize land quality, assess sustainable land management and identify potential land use solutions at the farm recommendation unit and resource management domain levels in Kenya. The system implements a generic land quality assessment framework that integrates farmer-led participatory sustainability assessment with specialist input into a multi-disciplinary perspective.

Runs and Veronica (2004) developed spreadsheet-based decision support system for assessment of pest and diseases control measures based on the incidence of diseases for the paddy and maize. He used Microsoft excel 2007 for his decision support system.

Larson (2005) developed Cotton Yield Monitor Investment Decision Aid (CYMIDA) to aid for analyzing the cotton yield monitor Information System investment choice. The decision aid was developed to meet the need for better educational information about annual ownership costs and required returns for the cotton yield monitoring information investment decision.

Witt and Fairhurst (2005) developed nutrient decision support system software for irrigated rice.” It is part of an initiative by the irrigated rice research consortium to provide decision support on site-specific nutrient management in the irrigated lowlands. This system is developed by using visual basic as a platform.

Ganesh (2006) developed “Decision support system “Crop-9-DSS” for identified crop” for the leading crops in Kerala. Which encompass water management, fertilizer management and crop protection system. It was also developed with all modern features like graphics, photos, video clippings *etc.* and the system was developed using Microsoft visual basic as a plat from.

Surapong Dumrongkittikule (2006) developed the Agriculture Database and IT with a objective of providing reliable and timely information on food security and food agricultural practice process and artifact and safety product and traceability.

Ulla Dindrop and Peter Sestoft (2006) developed “system for organizing experimental dataset browser”. The SFD dataset browser is a tool for viewing and browsing SFD datasets on the World Wide Web, using a standard web-browser such as Netscape Navigator. SFD is a data storage format and associated tools developed for use within agricultural research. Researcher used HTML and CGI programs for the development.

Arthur Tatnall (2007) developed a decision support system entitled “Building decision support system for suitable crop can be grown based on present climatic condition.” He used Microsoft excel and ASP.NET as a programming language for his decision support system.

Sieglinde Hahn (2007) developed “Computer-aided generation of risk functions for agricultural modeling and decision” to show how different risk tools can help create convenient risk functions by using both empirical data based on the past and parameters subjectively set by experts. He used MS excel as a tool for development of ‘risk analysis and stimulation model add-in Microsoft excel.

Peter (2008) developed a decision support system entitled, “Developing of Computer based information system for assessing applicability of irrigation water depending on its quality.” The system uses laboratory analysis information, cultivated crops data, soil and agro-climatic characteristics of the region, irrigation technology and some other parameters to give quality of water. He used visual basic for the development of DSS.

Ramos (2008) developed Database management Tools available from FAO: the Agricultural information management standards (AIMS) website that will allow the sharing and promote the uptake of common methodologies, standards and applications. And also to facilitate collaboration, partnership and networking among partners by promoting information exchange and knowledge sharing.

Zhivko Zhivkov *et al.* (2009) developed software for applicability of irrigation water in conformity with its quality with salient objective of assessment of the water quality indicators for the efficient use of the water resources in accordance with the requirements of the water consumers.

Daniel Anand Raj (2011) developed “Crop nutrient management decision support system” for black gram and paddy in Tamil Nadu. He used the site specific nutrient management as the base for the system and the system was developed in visual basic.

2.2 Pest, disease, weed and yields of crops

Stoughton (1933) studied on ‘The influence of environmental conditions on the development of angular leaf spot disease of cotton. The influence of alternating and varying conditions on infection’, Analysis indicated that disease increased as either the minimum air temperature or average temperature increased for period of the 2 wk followed by inoculation.

Singh and Thapliyal (1977) reported that, the rust of soybean coincided with pod filling stage resulted with a drastic reduction in seed size and yield to the tune of 66 per cent in India.

Nakasuji and Kiritani (1978) studied the difference in corn yield, he was examined by comparing fields with varying level infestations. An empirical system model was constructed to forecast corn yield by means of the number of mites caught by pheromone traps. The control threshold, expressed in terms of the mean daily number of moths caught / trap were calculated for July and August generations, assuming a 10 per cent loss of the maximum yield as an acceptable threshold for yield loss.

Nagarajuan and Joshi (1978) fitted a linear model for a seven days forecast of stem rust severity on susceptible variety using input variables as mass disease severity a week earlier, mean weekly minimum temperature and mean maximum relative humidity for the period of prediction

Ogle *et al.* (1979) observed 60-70 per cent seed yield loss in severely infected fields. Sixty eight per cent yield reductions were found in most of the varieties of soybean due to *Phakopsora pachyrhizi* infection in Taiwan (Anon., 1975). In Southern china the yield loss was about 50 per cent in epidemic years and 10 to 30 per cent regularly in other years.

Gururaj (2013) reported that, the yield/plant and its major components (Boll number/plant, average boll weight and halo length) were negatively correlated with disease intensity; ginning outturn was not affected by disease.

Gyawali (1988) studied the damage and yield losses of soybean caused by *Spilosoma obliqua* in Nepal. The 6^{th} instar larva was the most damaging stage of the pest. Although yield loss was highest at high larval density, an increase in the density from 12 to 100 larvae/m^2 did not result in a proportional yield loss, indicating that compensation may occur with increasing larval density. Feeding by 6^{th} instar larvae for time interval 48 hr at a density of 124 larvae / m^2 produced a significantly greater loss in yield at the vegetative stage V4 than for any other growth stage.

Singh *et al.* (1988) explained logistic equations for brown rust of wheat disease (1983-85), he developed linear a regression equation for disease by using different parameter.

Sepswasdi *et al.* (1991) studied the yield loss relationships of major insect pests of mung bean in rice based cropping systems in Thailand during 1986 to 1987. Observations on damage and insect density were recorded at weekly interval on vegetative stage had no impact on yield. Infestation of the noctuid *Spodoptera litura* and *Megalurothrips usilatus* during the end of the vegetative stage to the pod filling stage were negatively correlated with grain yield resulted in a reduction of yield. Economic injury levels were established at 16 and 30 per cent infested leaves for *Spodoptera litura*.

Anandraj *et al.* (1992) observed a linear relationship between the number of trees that had been taken *Phytophthora areacae* areas infection and the total number of fruits that had dropped. A simple linear regression analysis showed a very good fit (r=0.81) between the two parameters.

Charles *et al.* (1992) evaluated cotton (*Gossypium hirsutum*) yield response to mechanical and chemical weed control systems, the study revealed that cotton yields were related to weed density and wee biomass in a hyperbolic relationship.

Dhir *et al.* (1992) carried out field studies in Orissa, India, during the *rabi* season 1990 to 1991 showed that one larvae of *S. litura* per groundnut plant at the seedling stage, one larva per consumed about 54.7 per cent leaf area and reduced pod yield by 25.8 per cent. At flowering, one larvae per plant consumed 49.1 per cent leaf area and reduced the yield by 19.0 per cent. At pegging, one larvae per plant consumed about 38.8 per cent leaf area and resulted in a yield loss of 5.7 per cent.

Hamid *et al.* (1992) studied tobacco yield reductions due to *Spodoptera litura* on the basis of models of larval survivorship, feeding on tobacco leaves and tobacco growth. By coupling larval survivorship and leaf consumption models with tobacco growth simulation, damage was estimated.

Singh and Sachan (1992) conducted field experiment during the rainy season of 1988 and 1989 to assess yield loss due to insect at different growth stages of groundnut in Uttar Pradesh, India. The crop was infested by thrips at the vegetative stage and the *Spilosoma oblique* at flowering stage and by *S. litura* and *S. oblique* at both podding and pod maturity. The greatest yield loss caused by insect pests at any crop stage was 31.48 per cent in 1988 and 23 per cent in 1989. Damage occurring during blooming and vegetative stages resulted in maximum yield loss. Thus, crop protection measures at vegetative and blooming stage were most effective in minimizing the yield loss due to insect pests in groundnut.

Luo (1993), in Pakistan developed and evaluated multiple linear regression models based on epidemiological factors to predict leaf rust on wheat. Stepwise regression model was developed by weekly maximum and minimum air temperature, rainfall, RH, wind spread and 24 hr. wind movement.

Delacueva *et al.* (1994) reported that, the disease was known in the Philippines since 1914 but has become economically important only in the last 20 years reducing the yield to the tune of 20 to 40 per cent annually.

Liu (1996) reported that annual loss of soybean from rust was estimated at 20 to 30 per cent of the total production in Taiwan. Early infection resulted in premature defoliation and decrease in seed yield. Phyloepidemiology has attracted people with different professional background such as statistician, pathologist, entomologist, mathematician, system analyst.

Anil Kumar *et al.* (1998) studied the Relationship between climatic factors and initiation of red rot infection in sugarcane and concluded that red rot initiation was significantly and negatively associated with maximum temperature and positively significant with the rainfall.

Prabhakaran *et al.* (1998) developed a statistical model for estimating yield loss results showed that the annual loss in yield of *Piper nigrum* in the Kannur district of Kerala, India due to pests, diseases and drought was approximately 26 per cent.

Singh *et al.* (1999) carried out an experiment to determine the relationship between severity of powdery mildew of ber (*Ziziphus mauritena*) and the weather parameters. Experiments were carried out over 7 years (1976-77 to 1982-83) in Hissar, India. Multiple regression model was fitted with the data to know the relationship between the different factors.

Pun and Sabitha Doraiswamy (2000) studied on “Influence of weather factors on the incidence of okra yellow vein mosaic virus disease”, results revealed that a highly significant positive correlation existed between sunshine hours and disease incidence, while morning relative humidity and wind velocity had a highly significant, negative association with the disease. Although non-significant, association of maximum temperature and total rainfall with the disease incidence was positive and negative, respectively. Simple correlation studies, however, showed that maximum and minimum temperature also exerted a highly significant positive effect on the disease incidence.

Gadre *et al.* (2002) studied the effect of weather parameters on leaf blight, white rust and powdery mildew of mustard. The results indicated that there was a positive correlation with maximum air temperature, minimum air temperature, sunshine period, crop age and PDIs of this disease except between minimum air temperature and leaf blight incidences. The multiple regression analysis showed that among the incidence of disease, sunshine and crop age were highly significant. Maximum and minimum and air temperatures were significant for powdery mildew only.

Luong Minh Chau *et al.* (2002) studied the interaction quantification between multiple pest injuries and rice yield, a collection of data based 200 rice hills was set up in a large field (1 ha) of CLRRI production farm during two dry seasons,1998-1999 and 1999-2000. The primary results showed that, the infestation of pests was a combination of 2-5 injuries caused by leaf folder, yellow stem borer, rice blast, brown spot, narrow leaf spot, rice bug which were more abundant in milky and ripening stages of rice plants. The yield loss was significantly interacted by stem borer dead hearts, leaves with streaked <50 per cent due to blast and grain damage by rice bugs in the ripening stage.

The evidences of compensation of rice plants to the attacks by yellow stem borer and leaf folder also proved by the differences in the slope of the regression lines.

Tamado *et al.* (2002) studied on "Germination Ecology of the Weed *Parthenium hysterophorus* in Eastern Ethiopia." Study revealed that, Seed germination can take place over a wide range of temperatures.

Singh *et al.* (2004) conducted study on "Control of Ragweed Parthenium (*Parthenium hysterophorus*) and Associated Weeds." He concluded that, the weed can grow over a wide range of moisture and temperature conditions but requires high soil moisture for seed germination.

Padmaja *et al.* (2005) studied on influence of weather on sorghum shoot fly, *Athergona soccata* (Rondani) and models for forewarning their incidence, correlations showed mean afternoon relative humidity in the previous week and mean maximum temperature two weeks before, to have significant negative influence on egg laying. In case of deadhearts, only the vapour pressure deficit showed significant positive correlation.

Gurbir Kaur *et al.* (2006) studied on dispersal of secondary inoculum of *Tilletia Indica* causing karnal bunt of wheat in relation to weather parameters, the study revealed that a significantly negative correlation was obtained with daily prevalent relative humidity, air and soil temperatures. And to some extent with sunshine hours and poorly correlated with minimum and maximum temperature and these factors are also known to affect the number of sporidia produced.

Hsieh *et al.* (2006) collected a total of 20 kg great northern bean seeds received from the dockage of the 2001 crops grown in southern Alberta, approximately 6 per cent of seeds showed various degrees of seed discoloration on the seed coat infected with bacterial wilt (*Curtobacterium flaccumfaceins* pv. *flaccumfaceins*). Among these discolored seeds, the percentage of seed showing 25-50 per cent (slight infection), 51-75 per cent (moderate infection) and 76-100 per cent (severe infection) of yellow patches on seed coat was 7%, 29 per cent and 64%, respectively.

Mandal *et al.* (2006) reported weather based forewarning of the incidence of insect pest and generation of information about critical weather sensitive phases in the life cycle of insect can guide operational and tactical strategy in insect pest management. A field experiment was conducted in Pusa, Bihar, India to study the 19 effects of weather variables on the population dynamics of shoot and fruit borer, *E. vittella* infesting okra (*Abelmoschus esculentus*) cv. Pusa Sawani during the summer of 2000 and 2001. With delay in sowing, the border attack increased. In the late sown crop (7^{th} April), nearly 31 per cent reduction in the yield of okra was observed. The production function studied by using step wise regression analysis explained 93.1 per cent of the variability in the percentage of damage fruits.

Medic-Pap *et al.* (2007) collected 75 seed lots of 2001 and 2002 and investigated for seed inhabiting fungi. They detected *Diaporthe/Phomopsis* (41 per cent of 2001 and 25 per cent of 2002). *Fusarium* (51 per cent of 2001 and 42 per cent of 2002), *Perenospora* sp (69 per cent of 2001 and 56 per cent of 2002). They also detected facultative parasites like *Aspergillus, Penicillium* and *Alternaria* sp.

Patel *et al.* (2007) conducted to develop the pre harvest forecasting model of rice yield using weather variables and technological advances, a 33 year yield data of Kheda district, Gujarat, India from 1967-68 to 2001-02 were collected. The weekly average of weather variables, namely bright sunshine hours (BSS), rainfall (RF), maximum (Tmax) and minimum temperature (Tmin) and morning relative humidity (MRH) from 23^{rd} to 42 and standard meteorological weeks (MSW) of the respective years, were considered. The week wise crop stage and generated weather variable (weighted) criteria were used. Time trend was considered as an independent variable in all the criteria. To provide pre harvest forecasts, different week intervals were considered.. The forecasting can be done four weeks before the expected harvest (*i.e.* 3^{rd} week of September or at the end of the 38^{th} MSW). The average absolute mean forecast errors of the selected model for the subsequent three years were 10.97 per cent. The pre harvest proposed forecast model accounted for 75.4 per cent variation in rice yield.

Dhaliwal *et al.* (2008) conducted the crop seasons to asses the yield losses due to mustard aphid in Indian mustard sown on different dates. The crop was sown on 5^{th} October, 30^{th} October and 25^{th} November during 2004-05 and 2005-06, the crop was sown on 30^{th} October and 25^{th} November during 2003-04 and seen yield decreased significantly with delay in sowing under both protected and unprotected conditions. On an average maximum seed yield of 1889 kg ha^{-1} was recorded when the crop was sown on 5^{th} October under protected conditions as compared to 1768 kg ha^{-1} in unprotected conditions. Yield attributes and seed yield decreased under unprotected conditions as compared to protected conditions under different sowing dates. Yield losses due to mustard aphid were highest (82 per cent) during third date of sowing in 2004-05.

Dutta *et al.* (2008) estimated the Effect of meteorological parameters on phenology and yellow rust of wheat and concluded that the disease was negatively correlated with maximum temperature and sunshine hours and was positively correlated with relative humidity during both the years.

Khan *et al.* (2008) studied on Weather based forewarning of mustard aphid [*Lipaphis erysimi* (Kalt.)], revealed that the previous weeks maximum, minimum and mean temperatures, growing degree days, wind speed and sunshine hours were showed negative correlation with aphid population.

Maji *et al.* (2008) studied on Role of meteorological factors on the incidence of mulberry diseases, Simple correlation coefficient (r) between disease severity and meteorological factors revealed that, the bacterial leaf spot has significant correlation with minimum relative humidity, minimum temperature and number of rainy days. Powdery mildew was found to have positive correlation with maximum relative humidity and negative with minimum temperature. However *Myrothecium* and *Pseudocercospora* leaf spot not showed significant correlation with any other meteorological factors studied. Step-down multiple regression analysis revealed that prediction of bacterial leaf spot could best for minimum relative humidity (R^2=0.36). In case of powdery mildew, minimum relative humidity, maximum and minimum temperatures and number of rainy days were found to be the most influencing combination (R^2=0.28). Maximum relative humidity, minimum temperature and rainfall were found to be the factors influencing *Myrothecium* leaf spot disease severity (R^2=0.20)

Mukunthan *et al.* (2008) assessed woolly aphid impact on growth, yield and quality parameters of sugarcane. He concluded that, the incremental growth was significantly lower in infested canes in the initial stages whereas in the later stages the differences became non-significant. Aphid abundance in the early stage and its subsequent abrupt disappearance were showed correspondence with the observed pattern of incremental growth.

Nandagopal *et al.* (2008) estimated Influence of weather parameters on the population dynamics of sesbania thrips (*Caliothrips indicus* Bagnall) in groundnut in Saurashtra region, There was minimum deviation between the actual and predicted values of thrips population during certain months, indicating the feasibility of predicting the population occurrence using the prevailing weather factors.

Prasad *et al.* (2008) studied on Seasonal abundance of sesbania thrips, *Caliothrips indicus* Bagnall in groundnut, Correlation studies between weather parameters and C. indicus population revealed that, maximum and minimum temperature showed significant positive correlation morning and evening relative humidity showed significant negative correlation during *rabi*. In summer, morning and evening relative humidity showed significant negative correlation during *kharif*, only morning relative humidity showed significant negative correlation while the remaining parameters fail to show any significant correlation with the thrips population. The coefficient of determination (R^2) between weather parameters and thrips population during *rabi*, summer and *kharif* seasons was found to be 11.97%, 9.05 per cent and 8.03 per cent respectively over seven years of study suggesting the importance of these parameters in influencing the abundance of C. indicus.

Samui *et al.* (2008) studied on Population dynamics of stem borer in relation to inter and intraseasonal variation of weather and operational rice protection at Pattambi, Kerala, the study revealed that, the stem borer outbreak occurred in moderate to severe intensity in Gujarat, Orissa Andhra Pradesh, Assam, Hariyana and Punjab.

Sharanabasappa *et al.* (2008) studied on Population Dynamics of Sugarcane Woolly Aphid, *Ceratovacuna lanigera* Zehntner and its Natural Enemies, the correlation studies revealed that, the pest grade was significant and it was positively correlated with evening relative humidity whereas, highly significant negative correlation was observed with maximum temperature.

Shovan *et al.* (2008) collected 33 soybean seed samples from four different locations namely Gazipur (BARI), Mymensingh (BAU), Meherpur (local farmer) and Noakhali (local farmer) representing three varieties and 16 genotypes. Blotter method was used for detection of the associated fungi of soybean seeds. Altogether, ten fungi comprising nine genera namely *Alternaria alternata, Aspergillus flavus,Aspergillus niger, Chaetomium globosum, Colletotrichum dematium, Curvularia lunata, Fusarium oxysporum, Macrophomina phaseolina, Penicillium sp. and Rhizopus stolonifer* were found to be associated with the tested soybean seed samples. The germination of seed samples varied from 16-98 per cent. Germination of seeds was directly related to the prevalence of fungi associated with the seed.

Singh *et al.* (2008) studied on Influence of weather parameters on zonate leaf spot (*Gloeocercospora sorghi*) development on sorghum, in India the results revealed that zonate leaf spot started appearing during first week of August when the maximum temperature (31.4 to 34.7o C), morning relative humidity (>90%) and evening relative humidity (54%) prevailed. Weather- disease interaction study revealed that preceding one week maximum temperature (r=0.52), evening relative humidity (r= 0.54) and sunshine hours (r= 0.67) contribute positively, for the diseases incidence whereas, minimum temperature (r= -0.79) contribute negatively towards disease development. Step-wise linear multiple regression analysis was done to derive disease prediction equation. The multiple regression model developed between the disease severity and meteorological parameters explained 76 per cent variation of the zonate leaf spot disease during the crop growth period.

Varma *et al.* (2008) studied on Forecasting population of brown plant hopper, *Nilaparvata lugens* (Stal.), Results revealed that, among the weather parameters, rainfall of preceding month was showed significant positive influence on BPH light trap population *viz*., rainfall of August vs. BPH of September, rainfall of September vs. BPH of October, rainfall of October vs. BPH of November Maximum temperature of June had significant negative correlation with BPH of August and Maximum temperature of May had significant positive correlation with BPH of September. Morning relative humidity (RH I) of June had significant negative correlation with BPH of October and November. The linear and non-linear regression models were fitted for predicting the populations of BPH using significant weather data of preceding months. Results of the regression equation revealed that, per cent accuracy in prediction of population was less when linear regression was fitted (55- 70%) and accuracy increased to 60-75 per cent when non-linear regressions were fitted. Since first peak of BPH in *kharif* is noticed during September, attempt was made to forecast BPH light trap population (1993-2006) of September. Cumulative August rainfall was identified as the most significant factor responsible for increase in BPH population during September. Using cumulative August rainfall, BPH population in September as a whole, September 3rd and 4th weeks were predicted with an good accuracy of 80, 83 and 67 per cent, respectively.

Asis Mukherjee and P. Bhowmik (2009) estimated the Incidence of cotton bollworm (*Helicoverpa armigera* Hibner) in relation to meteorological parameters in the saline zone of West Bengal. Result revealed that, the *H. armigera* population has significantly negative correlation with maximum temperature (Max-T, r =-0.78) and significantly positive correlation with afternoon relative humidity (Min-RH, r = 0.80), 30.5 to 32.5^{0}C maximum temperature coupled with 65 to 77 per cent Afternoon-RH caused heavy infestation of the insect in cotton crop.

Chahal *et al.* (2009) studied on influence of yellow mosaic virus as influenced by weather in moong, whitefly population was positively correlated with maximum temperature, whereas morning relative humidity showed the inverse relationship with whitefly population. Maximum and minimum temperatures correlated negatively and morning relative humidity correlated positively with the disease percentage in both the varieties during both the sowing times. Step-wise multiple regression analysis showed higher R^2 values when maximum weather parameters were involved.

Chaudhary and Sahu (2009) studied on association of weather parameters with population fluctuations of tea mosquito bug of cashew in Bastar region of Chhattisgarh and he concluded that, the Maximum temperature had positive influence and relative humidity (evening) had significant negative influence on TMB damage on shoot.

Dhawan *et al.* (2009) studied on Distribution of mealybug, *Phenacoccus solenopsis* Tinsley in cotton with relation to weather factors in south-Western districts of Punjab' and he reported that, the positive correlation between mealy bugs and maximum temperature and negative impact of humidity and rainfall in Punjab.

Gud *et al.* (2009) studied on influence of weather parameters on *Alternaria* leaf spot of safflower; Concluded that, rains receive coupled with high humidity above 80 per cent and temperature in the range of 21 to32^{o}C favoured the infection and development of disease.

Singh, *et al.* (2009) studied on influence of meteorological parameters on the incidence and development of white rust and Alternaria blight in mustard (*Brassica juncea* L.) crop in the south-western region of Punjab, study revealed that significant positive correlation between maximum temperature and disease index was observed except in the crop sown on 20th October. Maximum temperature of 18-25^{0}C, minimum temperature of 7-13^{0}C and average relative humidity more than 65 per cent were found to be favorable for the development of Alternaria blight disease and white rust disease.

Singh *et al.* (2009) worked on crop-weather-disease interaction studies for the prediction of leaf virus disease in cotton crop at Hisar and concluded that the maximum temperature (-0.45), minimum temperature (-0.56), wind speed (-0.69), evaporation (-0.53) and rainfall (-0.34) showed a negative correlation with disease development, whereas morning relative humidity (0.26), evening relative humidity (0.28), bright sunshine hours (0.42) and cumulative rainfall (0.59) showed a positive correlation.

Ram Niwas *et al.* (2009) estimated sucking pest population in relation to meteorological parameters in cotton crop under different sowing environments in Hisar, Haryana and he concluded that leafhopper population was negatively correlated with temperature and positively associated with humidity, whereas whitefly was negative response with both temperature and relative humidity. Both microclimatic parameters temperature and humidity collectively explained variability in pest population upto 88 and 72 per cent in the case of leafhopper and whitefly, respectively.

Sikora *et al.* (2009) conducted a survey in the year 2008, where 40 commercial fields were surveyed in August or September. The study reported that, 72.5 per cent of the field to be infected with downey mildew (*Peronospora mansurica*), *Cercospora kikuchii* and *Corynespora cassicola* were observed in 45 per cent of the fields respectively. 12 per cent was infected with charcoal rot (*Macrophomina phaseolina).* Bean mottled virus, 58 per cent and tomato spotted wilt, 26 per cent were surveyed respectively and Reniform nematode (*Rotylenchus reniformis)* was found to be 32 per cent of the fields. Soybean cyst (*Heterodera glycines*) and lesion nematode (*Pratylenchus*) were detected in 11-12 per cent of the fields surveyed.

Singh *et al.* (2009) studied on effect of weather parameters and plant geometry on sucking pest dynamics in Bt and non-Bt cotton, study concluded that the peak population was correlated with the corresponding weather parameters by using the step-wise regression procedures. The relative humidity was found to be the vital weather parameter which contributed to the infestation of all the three sucking pests.

Akashe *et al.* (2010) estimated Population dynamics of safflower aphid, *Uroleucon compositae* (Theobald) as influenced by weather parameters. The results revealed that, the safflower aphid (*Uroleucon compositae* Theob.) was active during 47th to 1st SMW on elongation and branching stages of safflower crop, but its appearance on crop totally depends upon prevailing climatic conditions. Low temperature and high humidity were highly conducive for the multiplication of this pest.

Singh *et al.* (2010) studied on “Effect of weather parameters on karnal bunt disease in wheat in Karnal region of Haryana”, the frequency of disease intensity and weather parameters indicated that when the maximum temperature exceeded normal accompanied by little or poor rainfall during 6 to 8th SMW, the disease intensity was low. Rainfall during the 3rd week of January showed strong relationship indicating favourable role in the formation and further multiplication of secondary spordia. However, during 9th SMW, maximum temperature, relative humidity, rainfall and sunshine duration showed considerably high correlations, whereas remaining parameters had weak correlation coefficients. Meteorological parameters during 6 to 12 SMW satisfactorily explained the occurrence of Karnal bunt disease with R^2 values of 0.84 that indicated only 16 per cent variation of disease remains unaltered.

Sabale *et al.* (2010) analysed the Influence of weather factors on light trap catches of green leaf hopper at Pattambi, Kerala, The correlation studies between light trap net sweep collection with weather parameters on population build-up showed that lower minimum temperature, low rainfall and abundant sunshine had major impact on population build up of green leaf hopper for both the species.

Sahu *et al.* (2010) studied on Impact of climatic factors on infestation of leaf eating caterpillar (*Mentrysia hyrtica*) of cashew in Chhattisgarh, The experiment reveals that climatic factors minimum temperature, relative humidity (evening) and rainfall positively influenced the variation in leaf caterpillar damages. The multiple regression analysis indicated that maximum temperature negatively contributed 27 per cent towards incidence of leaf caterpillar damages.

Tomar and Singh (2010), studied on Impact of Weather Parameters on Aphid Population in Cotton, study revealed that maximum and minimum temperature and relative humidity showed positive correlation with aphid population, The direct contribution of minimum temperature was substantially positive and highest (0.510) followed by maximum temperature (0.281). Most of the weather parameters exerted their indirect contribution to the aphid population through minimum temperature.

Zagade and Chaudhari (2010) studied on Impact of meteorological parameters on population dynamics of mango hopper in high rainfall zone of Konkan region and concluded that all the three weather parameters *viz.*, maximum temperature (r=-0.525*), minimum temperature (r=0.561**) and afternoon relative humidity (r=-0.556*) had a significant negative correlation with the average population of mango hopper.

Chowdhury and Hossain (2011) studied on Effects of Temperature, Rainfall and Relative Humidity on Leaf Spot of Jackfruit Seedling and its Eco-friendly Management, The results revealed that weather parameters have profound effect on the prevalence of seedling disease of jackfruit and the effect differs significantly in different weather conditions.

Dutta *et al.* (2011) studied on prediction of black rot disease progression of cabbage based on Weather parameters and concluded that the rate of disease increment was found to be positively correlated with maximum and minimum RH, rainfall and negatively correlated with maximum, minimum and mean air temperature. Among weather variables the correlation coefficient of rainfall and maximum RH with rate of disease increment was found to be significant at 1 per cent and 0.5 per cent levels, respectively. Average temperature 27-30^{0}C and average RH more than 85 per cent and rainfall found to be mainly associated with the disease.

Livinder Kaur *et al.* (2011) studied on Correlation between weather variables and ascochyta blight disease of chickpea, results revealed that Minimum temperature (Tmin), morning relative humidity (RHmax), rainy days exhibited positive correlation with DI, however maximum temperature and the sunshine hours showed negative correlation.

Shivanna *et al.* (2011) studied on 'impact of abiotic factors on population dynamics of sucking pests in transgenic cotton', revealed that Simple correlation analysis revealed that maximum temperature showed significant positive effect on all the sucking pests. The minimum temperature showed negative effect on aphid population and non-significant effect on leafhopper, whitefly and thrips population. The relative humidity was non-significant effect, whereas precipitation was negative effect on all the sucking pests.

Jagtap *et al.* (2012) surveyed 69 soybean fields for eight districts of Marathwada region for recording the severity and incidence of soybean blight (*Psuedomonas syringae*). They were reported average incidence (14.5%) in Marathwada region, highest incidence in Parbhani (23%) followed by Hingoli (20%), Nanded (17%), Latur (15%) and Beed (13%) and the lowest incidence (7%) in Jalna.

Sharma and Singh (2012) estimated the effect of varieties, seasons and weather on population buildup of leaf hopper (*Amrasca devastans* Distant) on potato crop and revealed that a positive correlation between leaf hopper and relative humidity (morning and evening) was observed in both early and main crop season

METHODOLOGY

The design of the study is an important component of research. To realize the various objectives of the study, an appropriate methodology describing sampling designs, data collection and tools of analysis for the conduct of the study are inevitable.

Insect pest is only able to progress if the conditions provided by the host plants and the environment are favorable. The relevant components of the microenvironment are largely depending upon weather. In the present study, these issues were dealt in details, taking in to account the various weather variables and date of sowing in response to the development of insect pest.

3.1 Description of study area

Present study is based on the available secondary data of two years for insect pests, diseases and weeds for the years 2012 to 2013. The experimental data was collected from the project entitled ‘e-pest surveillance’, in selected crop ecosystems operated at Directorate of Extension UAS, Dharwad. The data was collected for insect pests, diseases and weeds in selected talukas of Dharwad and Haveri districts for cotton and Bagalkot and Belgaum districts for sugarcane crop

Weather data was collected from Karnataka State Natural Disaster Management Center, Bangalore. Yield data of sugarcane and cotton crop were collected from farmers of 16 villages in each taluka.

The data was collected on the following variables:

1. Insect pest
2. Diseases
3. Weeds
4. Yield
5. Weather factors

3.1.1 Insect pest

The incidence of pest on cotton and sugarcane was recorded in accordance with the scale given by Niles (1980), the per cent values of score were used for the analysis purpose.

3.1.2 Disease

The severity of diseases on cotton and sugarcane was recorded according to the 0 to 9 scale given by Mayee and Datar (1986), the per cent values of scale were used for analysis.

3.1.3 Weeds

The observation on weed count in cotton and sugarcane crops for the study area was used

3.1.4 Yield data

The yield data of cotton and sugarcane for selected talukas of districts Dharwad, Haveri and Belgaum, Bagalkot respectively were collected from the formers of respective fields for the years 2012 and 2013.

3.1.5 Weather data

Weather data was collected on seasonal basis for period of two years (2012 and 2013) from Karnataka State Natural Disaster Management Center, Bangalore, for the following weather parameters.

a) Maximum Temperature (Max-T) in degree Celsius (0℃).

b) Minimum Temperature (Min-T) in degree Celsius (0℃).

c) Relative Humidity morning (RH-M) in percentage (%).

d) Relative Humidity evening (RH-E) in percentage (%)

e) Rainfall (RF) in millimeter (mm)

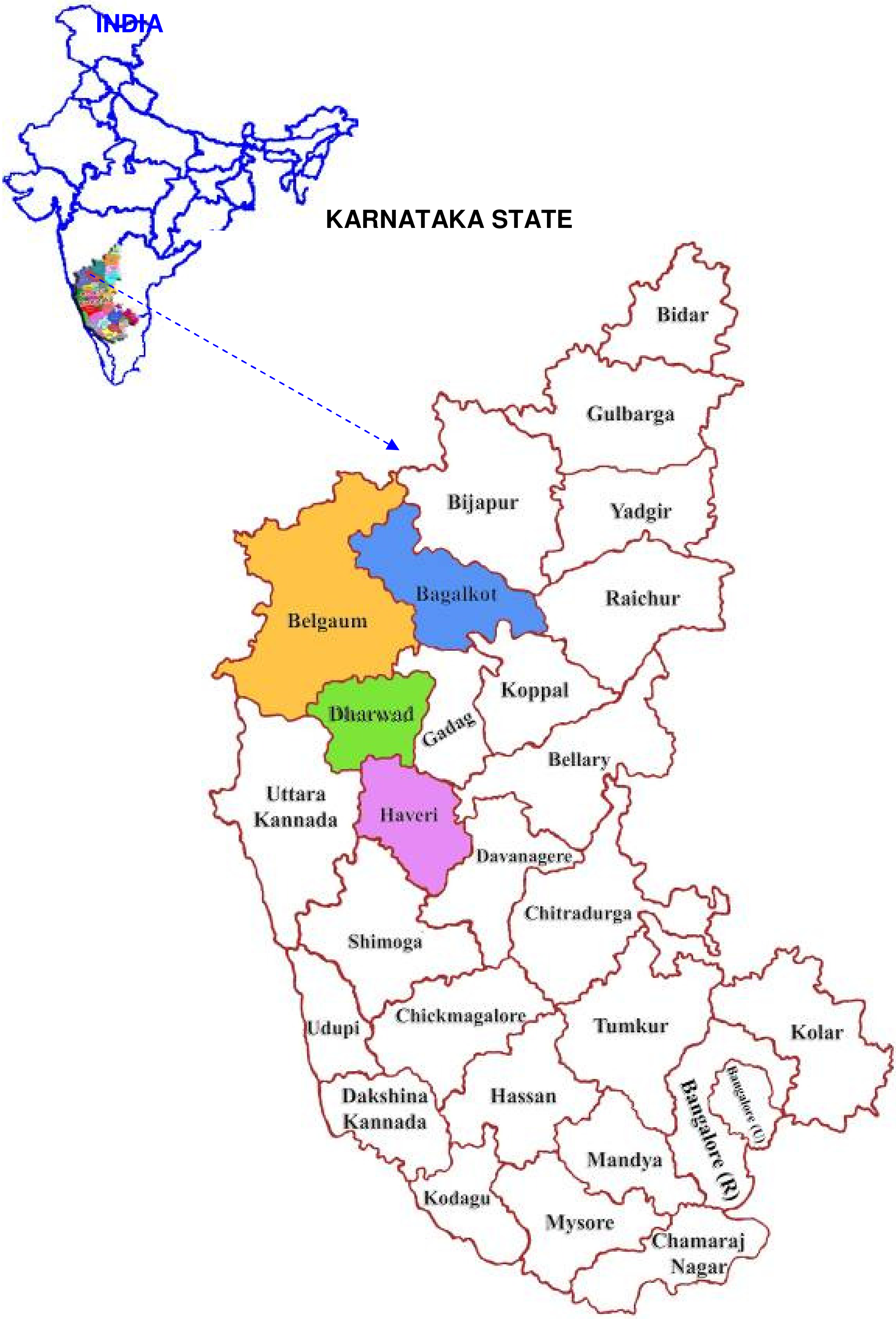


Fig. 3.1: Geographical map of Karnataka showing the study areas

3.2 Statistical tools employed

The following statistical methods were employed to analyse the data, interpret the results, to draw inferences and to design policy options for adoption by farmers, researchers and government. The details of the methods are given below

- Preliminary analysis.
- Correlation analysis.
- Multiple linear regression analysis

3.2.1 Preliminary analysis

The preliminary analysis was done by using the observations given in materials, *viz.*, on insect pest, disease, weed and yield as variables observations. For sugarcane crop the per cent observations of insect pests, diseases, weed growth and yield were transformed to log values using natural logarithm. Because the observations in sugarcane crop violates normality distribution with mean 0 and common variance it is needed to transfer data using suitable transformation.

3.2.1.1 Insect pests

For sugarcane crop the per cent of insect pest incidence was used. For each insect, average seasonal insect pest incidence of two years for selected talukas of Belgaum and Bagalkot districts was done. For cotton crop the per cent of insect pest incidence was used. For each insect, average seasonal insect incidence of two years for selected talukas of Dharwad and Haveri districts was done.

3.2.1.2 Disease

For sugarcane crop the per cent disease infestation was used. For each disease, average seasonal disease infestation for two years for selected talukas of Belgaum and Bagalkot districts was done. For cotton crop the per cent infestation of disease was used. For each disease, average seasonal disease infestation for two years for selected talukas of Haveri and Dharwad districts was done.

3.2.1.3 Weeds

For sugarcane crop the average weed count per square meter area was used. For each weed, average seasonal weed growth for period of two years for selected talukas of Belgaum and Bagalkot districts was done. For cotton crop the average weed count per square meter area was used. For each weed, average seasonal weed growth for two years for selected talukas of districts, Haveri and Dharwad districts was done.

3.2.1.4 Weather variables

Similarly, the weather variables of talukas of Belgaum and Bagalkot districts for sugarcane were used. The weather variables of talukas of Haveri and Dharwad districts concerning cotton were used.

3.2.2 Correlation analysis

Correlation measures the degree of closeness or association between two variables and the strength of the relationship between different parameters. Variables like biotic stresses (Insect pest incidence, diseases and weed growth), weather parameters and crop yield were considered to know the possible association between them.

Correlation coefficient

Correlation coefficient measures the strength of the linear relationship between two variables X and Y.

It is calculated by using following formula,

$$r = \frac{n\sum X_i Y_i - \sum X_i Y_i}{\sqrt{[n\sum X_i^2 - (\sum X_i)^2][n\sum Y_i^2 - (\sum Y_i)^2]}}$$

Testing correlation coefficient

The significance of Correlation coefficient (r) is tested using t-test.

Hypothesis is set as

H_0: $\rho = 0$

H_1: $\rho \neq 0$

Test statistic is as follows,

$$t = \frac{|r - 0|}{\sqrt{\frac{1 - r^2}{n - 2}}}$$

Where,

r- Sample Correlation coefficient.

n- Sample size.

Calculated t-value is compared with critical t-value for (n-2) degrees of freedom for drawing the significant inference.

However to carry out the Karl Pearson's correlation, SPSS 16.0 (Statistical Tool for Social Sciences) was used.

3.2.3 Multiple Regression

When the numbers of variables which explain the dependent variable are more than one, multiple linear regression can be used. Here, the model is,

$$Y = \propto + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_p X_p + \varepsilon$$

Where, Y is the dependent variable and X_i's are independent variables with β_i's as the partial regression coefficients of Y on X_i's where i=1,2,…P.

In the present study, Y considered as incidence of pests and diseases and X_i's were weather parameters *viz.*, rainfall, temperature and relative humidity.

However to carry out the multiple regression analysis, SPSS 16.0 (Statistical Tool for Social Sciences) was used.

3.3 Decision Support System (DSS)

This Decision Support System is based on the multiple regression equation for yield of crop based on the pests, diseases and weeds. The essential basic data required for estimating the yield are (i) pest incidence in percentage (ii) disease infestation in percentage and (iii) average weed count per square meter area. The Decision Support System has been developed in the visual basic V.06.

Estimation of sugarcane yield by using the multiple regression equation

Y = 5.035 – 0.126 (WA) – 0.14 (TSB) – 0.175 (RG) – 0.072 (RS) – 0.047 (RR) – 0.105 (RUST) – 0.103 (PH) – 0.034 (CD) - 0.083 (AS) + ε

Y = Yield of crop *i.e.* dependent variable

WA = Wooly aphid: Congregation of large number of white colored nymphs and adults on the under surface of leaves and on nodal and intermodal regions.

TSB = Top shoot borer: It is a insect pest in sugarcane crop which causes bore holes at the top of the shoot and shows bunchy top appearance of plant.

RG = Root grub: the insect which causes yellowing (chlorosis) of the leaves. This is usually followed by stunted growth, dense browning, lodging, plant uprooting, and death of sugarcane plants.

RS = Ring spot: well-defined circular lesions which are straw-colored in the centre with a dark-brown margin on older leaves.

RR = Red rot: disease which cause yellowing, drying, longitudinal discoloration spots / ribs and shrinkage internode region with rupture of tissue in the eye region. When the affected cane is split opened, the inner region is reddish in color with intermittent white tinges across the cane length.

RUST= Small, elongated yellowish pustules that are visible on both leaf surfaces.

PH = *Parthenium* hysterophorus: It is annual weed; Grows up to one meter height, during early stages leaves are like leaves of marigold plant, flower is white coloured and pentagonal in shape.

CD = *Cynodon dactylon*: It is perennial weed, having spreading nature, it can grow from seeds and underground stems also.

AS = *Alternanthera sessilis*: The leaves are oppositely arranged. The inflorescence is a spike or a rounded head occurring in the ends of branches

Estimation of cotton yield by using the multiple regression equation

$$Y = 13.396 - 0.198\ (A) - 0.092\ (MB) - 0.067\ (LH) - 0.070\ (ALS) - 0.054\ (RUST) - 0.003\ (PH) - 0.055\ (CD) - 0.044\ (CR) + \varepsilon$$

Y = Yield of crop *i.e.* dependent variable

A = Aphid: Aphids are normally found on the underside of leaves, but they can be present on branches, stems and fruit bracts.

MB = Mealy bugs: sucking pest which cause Crinkled and twisted leaves, fewer flowers and fewer bolls, smaller bolls, and distorted and stunted plants

LH = Leaf Hopper: Yellowing of leaves, followed by crinkling around the margins and upward curling of leaves

ALS = Angular leaf spot: disease which cause Small, pale to brown, angular or irregular spots measuring 0.5 - 3 mm in diameter, drying and falling off of leaves. The infection spreads to the bolls and finally falls off.

RUST= appearance of bright yellow to orange pustule on the upper and lower leaf surfaces.

PH = *Parthenium* hysterophorus: It is annual weed; Grows up to one meter height, during early stages leaves are like leaves of marigold plant, flower is white coloured and pentagonal in shape.

CD = *Cynodon dactylon*: It is perennial weed, having spreading nature, it can grow from seeds and underground stems also.

CR = *Cyperus rotundus*: Nutsedges are grass-like plants with narrow, linear, folded 4–12 inches long by 0.1–0.4 inch wide leaves.

The following algorithm was used to develop the decision support system

3.3.1 Program for the Login

```
Private Sub Command1_Click ()
If txtuser = "vistic" And txtPwd = "vistic" Then
Me.Hide
form2.Show
Else
MsgBox "Invalid User"
End If
End Sub
Private Sub Command2_Click ()
End
```

```
End Sub
```

3.3.2 Programme for crop selection

```
Private Sub Command1_Click ()
Zone31.Show
Me.Hide
End Sub
Private Sub Command2_Click ()
Zone51.Show
Me.Hide
End Sub
Private Sub Command7_Click ()
End
End Sub
```

3.3.3.1Programme for selection of biotic stress of sugarcane

```
Private Sub Command1_Click (Index As Integer)
Zone61.Show
Me.Hide
End Sub
Private Sub Command10_Click ()
Sunflower5.Show
Me.Hide
End Sub
Private Sub Command11_Click ()
Sunflower4.Show
Me.Hide
End Sub
Private Sub Command12_Click ()
Soybean5.Show
Me.Hide
End Sub
Private Sub Command13_Click ()
Redgram5.Show
Me.Hide
End Sub
Private Sub Command14_Click ()
Ragi7.Show
Me.Hide
End Sub
```

```
Private Sub Command15_Click ()
Ragi6.Show
Me.Hide
End Sub
Private Sub Command2_Click (Index As Integer)
Zone71.Show
Me.Hide
End Sub
Private Sub Command3_Click (Index As Integer)
Zone81.Show
Me.Hide
End Sub
Private Sub Command4_Click ()
Chilli8.Show
Me.Hide
End Sub
Private Sub Command8_Click ()
form2.Show
Me.Hide
End Sub
Private Sub Command7_Click ()
End
End Sub
Private Sub Label1_Click ()
Form5.Show
Me.Hide
End Sub
```

3.3.3.2 Programme for selection of biotic stress of cotton

```
Private Sub Command1_Click (Index As Integer)
Paddy3.Show
Me.Hide
End Sub
Private Sub Command10_Click ()
Ragi5.Show
Me.Hide
End Sub
Private Sub Command12_Click ()
Paddy7.Show
Me.Hide
End Sub
```

```
Private Sub Command13_Click ()
Form3.Show
Me.Hide
End Sub
Private Sub Command14_Click ()
Form4.Show
Me.Hide
End Sub
Private Sub Command15_Click ()
Jowar4.Show
Me.Hide
End Sub
Private Sub Command2_Click (Index As Integer)
Paddy6.Show
Me.Hide
End Sub
Private Sub Command3_Click (Index As Integer)
Maize8.Show
Me.Hide
End Sub
Private Sub Command4_Click ()
Cowpea4.Show
Me.Hide
End Sub
Private Sub Command7_Click ()
End
End Sub
Private Sub Command8_Click ()
form2.Show
Me.Hide
End Sub
Private Sub Label1_Click ()
Form5.Show
Me.Hide
End Sub
```

3.3.3.3 Programme for contact address for more information

```
Private Sub Command7_Click ()
End
End Sub
```

```
Private Sub Command8_Click ()
form2.Show
Me.Hide
End Sub
```

3.3.4 Programme for selection of calculation window

3.3.4.1 Programme for calculation of cotton yield

```
Private Sub Command1_Click ()
Dim n, p, k, a, c, d, e, f, n1 As Double
n = Val (txtnitrogen)
p = Val (txtphosphorus)
k = Val (txtpotash)
a = Val (txtabc)
c = Val (txtghi)
d = Val (txtklm)
e = Val (txtxyz)
f = Val (txtvis)
n1 = 13.396 - 0.198 * n - 0.092 * p - 0.0673 * k - 0.07 * a - 0.054 * c - 0.003 * d - 0.055 * e - 0.044 * f
MsgBox "Depending on the biotec stress, on an average the farmer would get: " & n1 & " q/ha", vbOKOnly, "Result"
End Sub
Private Sub Command2_Click ()
End
End Sub
Private Sub Command3_Click ()
form2.Show
Me.Hide
End Sub
```

3.3.4.2 Programme for calculation of sugarcane yield

```
Private Sub Command1_Click ()
Dim n, p, k, a, b, c, d, e, f, n1 As Double
n = Val (txtnitrogen)
p = Val (txtphosphorus)
k = Val (txtpotash)
a = Val (txtabc)
b = Val (txtdef)
c = Val (txtghi)
d = Val (txtklm)
e = Val (txtxyz)
f = Val (txtvis)
```

```
If n = "0" Then
n = 1
Else: n = n
End If
If p = "0" Then
p = 1
Else: p = p
End If
If k = "0" Then
k = 1
Else: k = k
End If
If a = "0" Then
a = 1
Else: a = a
End If
If b = "0" Then
b = 1
Else: b = b
End If
If c = "0" Then
c = 1
Else: c = c
End If
If d = "0" Then
d = 1
Else: d = d
End If
If e = "0" Then
e = 1
Else: e = e
End If
If f = "0" Then
f = 1
Else: f = f
End If
n1 = 5.035 - 0.126 * Log (n) - 0.14 * Log (p) - 0.175 * Log (k) - 0.072 * Log (a) - 0.047 * Log (b) -
    0.105 * Log (c) - 0.103 * Log (d) - 0.034 * Log (e) - 0.083 * Log (f)
MsgBox "Depending on the biotec stress, on an average the farmer would get: " & Exp (n1) & " t/ha",
vbOKOnly, "Result"
```

```
End Sub
Private Sub Command2_Click ()
End
End Sub
Private Sub Command3_Click ()
form2.Show
Me.Hide
End Sub
```

RESULTS

The experimental data was collected on major pests, diseases and weeds from –e-pest surveillance project, University Of Agricultural Sciences, Dharwad. The parameter details were discussed in the chapter 3. *i.e.* material and methods. Weather data was collected from Karnataka state natural disaster management center, Bangalore. Yield data of sugarcane and cotton crop were collected from farmers of respective places in study area. In this chapter some of the main points of statistical models are presented in the form of results under the following sub headings.

4.1 Relationship between weather parameters and incidence of pest, disease and weed growth

4.2 Impact of weather parameters on incidence of pest, disease and weed growth.

4.3 Relationship between yield and pest, disease and weed.

4.4 Impact of pest, disease and weed on yield of crop

4.5 Decision support system (DSS)

4.1 Relationship between weather parameters and incidence of pest, disease and weed growth

Correlation analysis was used to know the degree of linear relationship between weather parameters on incidence of pests, diseases and weed growth in cotton and sugarcane crops.

4.1.1 Correlation in cotton crop between weather parameters and incidence of pest, disease and weed growth.

The Table 4.1.1 revealed that, among important pests of cotton, incidence of aphid population was positively significantly correlated with morning relative humidity ($r=0.654^{**}$) at 1 per cent level of significance and positively significantly correlated with evening relative humidity ($r=0.500^{*}$) at 5 per cent level of significance. Mealy bug population was positively significant with minimum temperature ($r=0.552^{*}$) at 5 per cent level of significance. Evening relative humidity was positively significant with leaf hopper at 1 per cent level of significance ($r=0.664^{**}$).

Among important diseases of cotton crop, the angular leaf spot had significant positive correlation with rain fall ($r=0.614^{*}$), maximum temperature ($r=0.526^{*}$), morning relative humidity ($r=0.573^{*}$) and evening relative humidity ($r=0.601^{*}$) at 5 per cent level of significance. Rust was negatively significant with maximum temperature ($r= -0.776^{**}$) at 1 per cent level of significance.

Among important weed flora of cotton crop, the *Parthenium hysterophorus* was positively significant with rain fall ($r=0.500^{*}$) at 5 per cent level of significance and negatively significant with maximum temperature ($r= -0.727^{**}$) at 1 per cent level of significance. *Cynodon dactylon* was positively significant with rain fall ($r=0.674^{**}$) and negatively significant with maximum temperature ($r= -0.742^{**}$) at 1 per cent level of significance. *Cyperus rotundus* was positively significant with rain fall ($r=0.801^{**}$) and negatively significant with maximum temperature ($r=-0.692^{**}$) at 1 per cent level of significance.

4.1.2 Correlation in sugarcane crop between weather parameters and incidence of pest, disease and weed growth.

Table 4.1.2 revealed that, among important pests of sugarcane crop, the wooly aphid was negatively significantly correlated with rain fall ($r= -0.509^{*}$) and positively significantly correlated evening relative humidity ($r=0.575^{*}$) at 5 per cent level of significance. Incidence of mealy bugs was positively significantly correlated with rain fall ($r=0.865^{**}$) at 1 per cent level of significance and maximum temperature ($r=0.568^{*}$) at 5 per cent level of significance. Incidence of top shoot borer was negatively significantly correlated with rain fall ($r=-0.655^{**}$) at 1 per cent level of significance and minimum temperature ($r=0.580^{*}$) at 5 per cent level of significance. Incidence of root grub was positively significantly correlated with rain fall ($r=0.597^{**}$) and minimum temperature ($r=0.681^{**}$) at 1 per cent level of significance.

Among important diseases of sugarcane, incidence of red rot was positively significantly correlated with rain fall ($r=0.646^{**}$) at 1 per cent level of significance. Incidence of rust was positively significantly correlated with rain fall ($r=0.499^{*}$) and maximum temperature ($r=0.547^{*}$) at 5 per cent level of significance.

Table 4.1.1: Karl Pearson's Correlation coefficients for cotton crop

Biotic stress variables		RF	Max-Temp	Min-Temp	Rh-M	Rh-E
(Pests)	Aphid	0.471	-0.272	0.219	0.654**	0.500*
	Mealy bugs	0.631	0.104	0.552*	0.664	0.250
	Leaf Hopper	0.499	-0.346	0.165	0.061	0.651**
(Diseases)	Angular leaf spot	0.614*	0.526*	-0.247	0.573*	0.601*
	Rust	0.203	-0.776**	0.127	0.047	0.095
(weeds)	*Parthenium hysterophorus*	0.500*	-0.727**	-0.425	0.173	0.239
	Cynodon dactylon	0.674**	-0.742**	-0.212	0.401	0.449
	Cyperus rotundus	0.801**	-0.692**	-0.200	0.031	0.366

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.1.2: Karl Pearson's Correlation coefficients for sugarcane crop

Biotic stress variables		RF	Max-T	Min-T	Rh-M	Rh-E
(Pests)	Wooly aphid	-0.509*	-0.395	-0.279	-0.409	0.575*
	Top shoot borer	-0.655**	0.324	0.580*	0.227	0.258
	Root grub	0.597**	0.681**	-0.318	0.152	0.077
(Diseases)	Ring spot	0.399	-0.039	0.219	0.086	0.345
	Red rot	0.646**	0.151	0.102	0.024	-0.027
	Rust	0.499*	0.547*	0.284	0.348	0.432
(Weeds)	*Parthenium hysterophorus*	0.692**	0.185	-0.112	-0.156	-0.317
	Cynodon dactylon	0.505*	0.153	-0.123	0.212	0.073
	Alternanthera sessiis	0.582*	0.239	-0.007	0.078	0.393

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.2.1.1: Impact of weather parameters on incidence of aphid in cotton

N=16

Weather parameters	Coefficients		t-value	Sig. level
	b	S.E		
(Constant)	61.479	55.468	1.108	0.294
RF	-0.007	0.005	-1.326	0.214
Max-Temp	**5.378**	1.869	-2.878	0.016
Min-Temp	1.476	0.683	2.159	0.056
Rh-M	**1.004**	0.284	3.536	0.005
Rh-E	0.091	0.113	0.812	0.436

Table 4.2.1.2: Impact of weather parameters on incidence of Mealy bugs in cotton

N=16

Weather parameters	Coefficients		t-value	Sig. level
	b	S.E		
(Constant)	-10.529	45.231	-0.233	0.821
RF	0.000	0.004	-0.063	0.951
Max-Temp	-1.760	1.524	-1.155	0.275
Min-Temp	0.590	0.557	1.059	0.315
Rh-M	**-0.745**	0.232	3.215	0.009
Rh-E	-0.044	0.092	-0.482	0.640

Table 4.2.1.3: Impact of weather parameters on incidence of leaf hopper in cotton

N=16

Weather parameters	Coefficients		t-value	Sig. level
	b	S.E		
(Constant)	14.222	10.960	1.298	0.224
RF	0.001	0.001	0.084	0.934
Max-Temp	-0.587	0.369	-1.590	0.143
Min-Temp	0.206	0.135	1.529	0.157
Rh-M	-0.032	0.056	-0.578	0.576
Rh-E	**0.053**	0.022	2.375	0.039

Table 4.2.1.4: Impact of weather parameters on incidence of Angular Leaf spot in cotton

N=16

Weather parameters	Coefficients		t-value	Sig. level
	b	S.E		
(Constant)	4.788	15.695	0.305	0.767
RF	0.000	0.001	-0.551	0.594
Max-Temp	-0.796	0.529	-1.506	0.163
Min-Temp	-0.112	0.193	-0.577	0.577
Rh-M	**0.272**	0.080	3.390	0.007
Rh-E	0.048	0.032	1.505	0.163

Table 4.2.1.5: Impact of weather parameters on incidence of rust in cotton

N=16

Weather parameters	Coefficients		t-value	Sig. level
	b	**S.E**		
(Constant)	-53.405	48.440	-1.102	0.296
RF	0.004	0.005	0.786	0.450
Max-Temp	1.927	1.632	1.181	0.265
Min-Temp	-0.340	0.597	-0.570	0.581
Rh-M	-0.314	0.248	-1.267	0.234
Rh-E	**0.401**	0.098	4.077	0.002

Table 4.2.1.6: Impact of weather parameters on growth of *Cynodon dactylon* in cotton

N=16

Weather parameters	Coefficients		t-value	Sig. level
	b	**S.E**		
(Constant)	60.720	28.751	2.112	0.061
RF	0.000	0.003	-0.139	0.892
Max-Temp	**-3.120**	0.969	-3.222	0.009
Min-Temp	**0.859**	0.354	2.424	0.036
Rh-M	0.190	0.147	1.290	0.226
Rh-E	0.115	0.058	1.977	0.076

Table 4.2.1.7: Impact of weather parameters on growth of *Cyperus rotundus* in cotton

N=16

Weather parameters	Coefficients		t-value	Sig. level
	b	**S.E**		
(Constant)	32.469	24.240	1.339	0.210
RF	**0.005**	0.002	2.381	0.039
Max-Temp	-0.895	0.817	-1.096	0.299
Min-Temp	-0.010	0.299	-0.032	0.975
Rh-M	-0.107	0.124	-0.858	0.411
Rh-E	0.047	0.049	0.949	0.365

Among important weed flora of sugarcane, incidence of *Parthenium hysterophorus* was positively significantly correlated with rain fall (r=0.692**) at 1 per cent level of significance. Incidence of *Cynodon dactylon* (r=0.505*), *Alternanthera sessilis* (r=0.582*) positively significantly correlated with rain fall at 5 per cent level of significance.

4.2 Impact of weather parameters on incidence of pest, disease and weed growth

4.2.1 Important pest, disease and weeds in cotton

Among important weather parameters which are having significant impact on incidence of pests, from Table 4.2.1.1 the maximum temperature (5.378) had significantly positive influence at 5 per cent level of significance and morning relative humidity (1.004) had significantly positive influence at 1 per cent level of significance on incidence of aphid population.

Table 4.2.1.2 indicates that Morning relative humidity (0.745) had significantly negative influence on incidence of mealy bugs population at 1 per cent level of significance.

From Table 4.2.1.3 evening relative humidity (0.053) had significantly positive influence on incidence of leaf hopper population at 5 per cent level of significance.

Among important weather parameters which have impact on incidence of diseases of cotton, the morning relative humidity (0.272) had significantly positive influence at 1 per cent level of significance on incidence of angular leaf spot (Table 4.2.1.4). From Table 4.2.1.5 evening relative humidity (0.401) had significantly positive influence at 1 per cent level of significance on incidence of rust disease in cotton crop.

Among important weather parameters which have impact on growth of weeds in cotton, the maximum temperature (-3.120) had significantly negative influence at 1 per cent level of significance and the minimum temperature (0.859) had significantly positive influence at 5 per cent level of significance on growth of *Cynodon dactylon* (Table 4.2.1.3). From Table 4.2.1.6 rain fall (0.005) had significantly positive influence at 5 per cent level of significance on growth of *Cyperus rotundus*.

Among important weather parameters which having impact on incidence of pests, the rain fall (-0.405) and minimum temperature (-1.462) had significantly negative influence at 5 per cent level of significance and evening relative humidity (-0.934) had significantly negative influence at 1 per cent level of significance on incidence of wooly aphid population (from Table 4.2.2.1).

Similarly from Table 4.2.2.2 maximum temperature (23.863) had significantly positive influence at 5 per cent level of significance on incidence of root grub population

From Table 4.2.2.3 rain fall (0.753) had significantly positive influence at 5 per cent level of significance on incidence of red rot disease in sugarcane. Similarly Table 4.2.2.4 indicated that the rain fall (1.234) and minimum temperature (3.848) had significantly positive influence at 5 per cent and evening relative humidity (2.721) at 1 per cent level of significance on incidence of rust disease.

Table 4.2.2.5 indicated that the rain fall (1.086) had significantly positive influence at 5 per cent level of significance on growth of *Parthenium hysterophorus*. From Table 4.2.2.6 rain fall (0.294) had significantly positive influence at 5 per cent level of significance on growth of *Alternanthera sessilis* in sugarcane.

4.3 Relationship between yield and pest, disease and weed

4.3.1 Relationship between yield and pest, disease and weed in cotton crop

From Table 4.3.1, Among important pests the aphid (r= -0.547*) was negatively significantly correlated to yield at 5 per cent level of significance, in the same way leaf hopper was negatively significantly correlated to yield at 1 per cent level of significance. It was noticed that angular leaf spot (r= -0.804**) and rust were negatively significantly correlated to yield at 1 per cent and 5 per cent level of significance respectively. Similarly *Parthenium hysterophorus* (r= -0.618*) and *Cynodon dactylon* (r= -0.695**) were negatively significantly correlated to yield at 5 per cent and 1 per cent level of significance respectively.

Table 4.2.2.1: Impact of weather parameters on incidence of Wooly aphid in sugarcane

N=16

Weather parameters	Coefficients		t-value	Sig. level
	b	S.E		
(Constant)	33.987	10.537	3.226	0.007
RF	**-0.405**	0.167	-2.417	0.033
Max-T	-5.752	2.945	-1.953	0.075
Min-T	**-1.462**	0.548	-2.669	0.020
Rh-M	-0.395	0.815	-0.485	0.637
Rh-E	**-0.934**	0.295	-3.169	0.008

Table 4.2.2.2: Impact of weather parameters on incidence of Root grub in sugarcane

N=16

Weather parameters	Coefficients		t-value	Sig. level
	b	S.E		
(Constant)	-92.953	36.898	-2.519	0.027
RF	0.838	0.586	1.429	0.178
Max-T	**23.863**	10.313	2.314	0.039
Min-T	0.668	1.918	0.348	0.734
Rh-M	0.673	2.854	0.236	0.817
Rh-E	0.073	1.032	0.070	0.945

Table 4.2.2.3: Impact of weather parameters on incidence of Red rot in sugarcane

N=16

Weather parameters	Coefficients		t-value	Sig. level
	b	S.E		
(Constant)	11.586	17.673	0.656	0.524
RF	**0.753**	0.281	2.680	0.020
Max-T	-6.270	4.940	-1.269	0.228
Min-T	0.728	0.919	0.792	0.444
Rh-M	0.948	1.367	0.694	0.501
Rh-E	-0.157	0.494	-0.317	0.757

Table 4.2.2.4: Impact of weather parameters on incidence of rust in sugarcane

N=16

Weather parameters	Coefficients		t-value	Sig. level
	b	S.E		
(Constant)	-92.400	31.862	-2.900	0.013
RF	**1.234**	0.506	2.436	0.031
Max-T	18.187	8.906	2.042	0.064
Min-T	**3.848**	1.656	2.324	0.039
Rh-M	0.074	2.464	0.030	0.976
Rh-E	**2.721**	0.891	3.053	0.010

Table 4.2.2.5: Impact of weather parameters on growth of *Parthenium hysterophorus* in sugarcane

N=16

Weather parameters	Coefficients		t-value	Sig. level
	b	S.E		
(Constant)	8.463	26.822	0.316	0.758
RF	**1.086**	0.426	2.548	0.026
Max-T	-3.823	7.497	-0.510	0.619
Min-T	0.048	1.394	0.035	0.973
Rh-M	-0.353	2.074	-0.170	0.868
Rh-E	-0.573	0.750	-0.763	0.460

Table 4.2.2.6: Impact of weather parameters on growth of *Alternanthera sessilis* in sugarcane

N=16

Weather parameters	Coefficients		t-value	Sig. level
	b	S.E		
(Constant)	-1.531	8.450	-0.181	0.859
RF	**0.294**	0.134	2.191	0.049
Max-T	0.032	2.362	0.014	0.989
Min-T	0.505	0.439	1.150	0.272
Rh-M	-0.491	0.654	-0.751	0.467
Rh-E	0.382	0.236	1.616	0.132

Table 4.3.1: Karl Pearson's correlation Coefficients for Yield Vs. pests, diseases and weeds in cotton crop

Biotic stress variables		Correlation coefficient
(Pests)	Aphid	-0.547*
	Mealy bugs	-0.291
	Leaf Hopper	-0.683**
(Diseases)	Angular Leaf Spot	-0.804**
	Rust	-0.565*
(Weeds)	*Parthenium hysterophorus*	-0.618*
	Cynodon dactylon	-0.695**
	Cyperus rotundus	-0.490

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.3.2: Karl Pearson's correlation Coefficients for Yield Vs. pests, diseases and weeds in sugarcane crop

N=16

Biotic stress variables		Correlation coefficient
(Pests)	Wooly aphid	-0.514*
	Top shoot borer	-0.632**
	Root grub	-0.250
(Diseases)	Ring spot	-0.805**
	Red rot	-0.283
	Rust	-0.442
(Weeds)	*Parthenium hysterophorus*	-0.231
	Cynodon dactylon	-0.324
	Alternanthera sessiis	-0.543*

Table 4.4.1 impact of pests, diseases and weeds on yield of cotton

N=16

Biotic stress variables	Coefficients		t-value	Sig. level
	b	S.E		
(Constant)	13.396	0.738	18.162	0.000
(Pests) Aphid	-0.198	0.372	0.533	0.611
Mealy bugs	-0.092	0.354	0.542	0.604
Leaf Hopper	**-0.0673**	1.480	-2.482	0.042
(Diseases) Angular leaf spot	**-0.070**	0.748	-2.766	0.028
Rust	-0.054	0.246	-0.221	0.832
(Weeds) *Parthenium hysterophorus*	-0.003	0.628	-1.038	0.334
Cynodon dactylon	-0.055	0.335	-1.059	0.325
Cyperus rotundus	-0.044	0.309	-0.465	0.656

Yield of cotton = 13.396-0.198 (Aphid)-0.092 (Mealy bugs) -0.067 (Leaf Hopper) -0.070 (Angular leaf spot) -0.054 (Rust) -0.003 (*Parthenium hysterophorus*) -0.055 (*Cynodon dactylon*) -0.044 (*Cyperus rotundus*)

Table 4.4.2: Impact of pests, diseases and weeds on yield of sugarcane crop

N=16

Biotic stress variables	Coefficients		t-value`	Sig. level
	b	S.E		
(Constant)	5.035	0.373	12.181	0.000
(Pests) Wooly aphid	**-0.126**	0.134	-2.433	0.041
Top shoot borer	-0.14	0.025	-0.565	0.588
Root grub	-0.175	0.017	-1.072	0.315
(Diseases) Ring spot	**-0.072**	0.024	-3.046	0.016
Red rot	-0.047	0.039	-1.217	0.258
Rust	**-0.105**	0.038	-2.750	0.025
(weeds) *Parthenium hysterophorus*	-0.103	0.032	-0.091	0.930
Cynodon dactylon	-0.034	0.074	-0.463	0.656
Alternanthera sessiis	-0.083	0.102	0.812	0.440

Yield of SC = 5.035-0.126 (wooly aphid)-0.14 (top shoot borer)-0.175 (root grub)-0.072 (Ring spot) -0.047 (Red rot) -0.105 (Rust)-0.103 (*Parthenium hysterophorus*) -0.034 (*Cynodon dactylon*) -0.083 (*Alternanthera sessiis*)

4.3.2 Relationship between yield and pest, disease and weed in sugarcane crop

From Table 4.3.2, among important pests the wooly aphid (r= -0.514*) was negatively significantly correlated to yield at 5 per cent level of significance. Ring spot (r= -0.805**) was negatively significantly correlated to yield at 1 per cent level of significance, in the same way *Alternanthera sessilis* was negatively significantly correlated to yield at 5 per cent level of significance.

4.4 Impact of pest, disease and weed on crop yield

4.4.1 Impact of pest, disease and weeds on yield in cotton crop

From Table 4.4.1 results revealed that, the leaf hopper (r= -0.0673) and angular leaf spot (r= -0.070) were contributing negatively significantly to the yield at 5 per cent level of significance.

4.4.2 Impact of pest, disease and weeds on sugarcane crop yield

Similarly from Table 4.4.2 it was noticed that, the wooly aphid (-0.126), ring spot (-0.072) and rust (-0.105) were contributing negatively significantly to the yield at 5 per cent level of significance.

4.5 Decision Support System (DSS)

The Decision Support system has been developed in the visual basic V.06. There are five windows or section in the software which are discussed under following sub heading.

4.5.1 Login window.

4.5.2 Crop selection window.

4.5.3 Biotic stress selection window.

4.5.4 Calculation of Biotic stress window.

4.5.5 Result box (Message box).

4.5.1 Login window

In this window user has to enter the user name and password which is being same *i.e.*, “vistic” and then click on login (Fig. 4.3.1) which displays the crop selection window.

Fig. 4.5.1: Login window

4.5.2 Crop selection window

In this window user has to select the crop of his interest by clicking on crop listed, it will take to the Biotic stress selection window (Fig. 4.3.2).

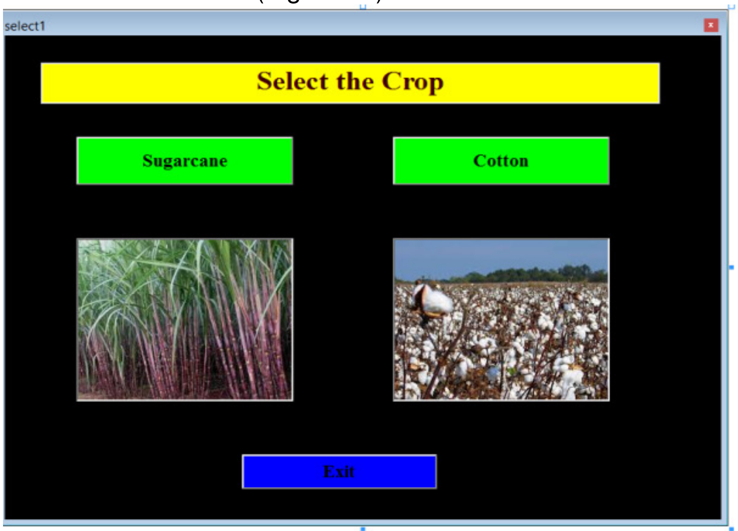


Fig. 4.5.2: Crop selection window

4.5.3 Biotic stress selection window

In this window user has to select the 'estimation of yield based on pests, diseases and weed' by clicking on 'Estimation of yield based on pests, diseases and weed' it will take to the calculation window. This window contains list of pests, diseases and weed, clicking on each pests, diseases and weeds will take to the window having some minor information about each pest, diseases and weed respectively. This window also contains another option named 'for more information please contact' clicking in this will take user to the window having contact address of Entomologist, Pathologist and Weed scientist of University of Agricultural Sciences, Dharwad.

By selecting the crop it will take to calculation window (Fig. 4.3.3).

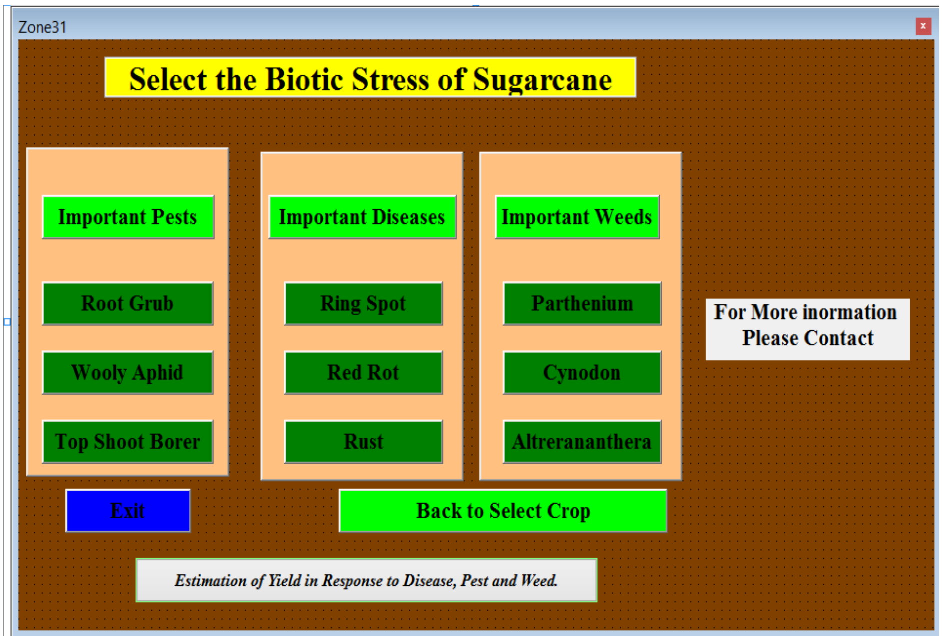


Fig. 4.5.3: Biotic stress selection window

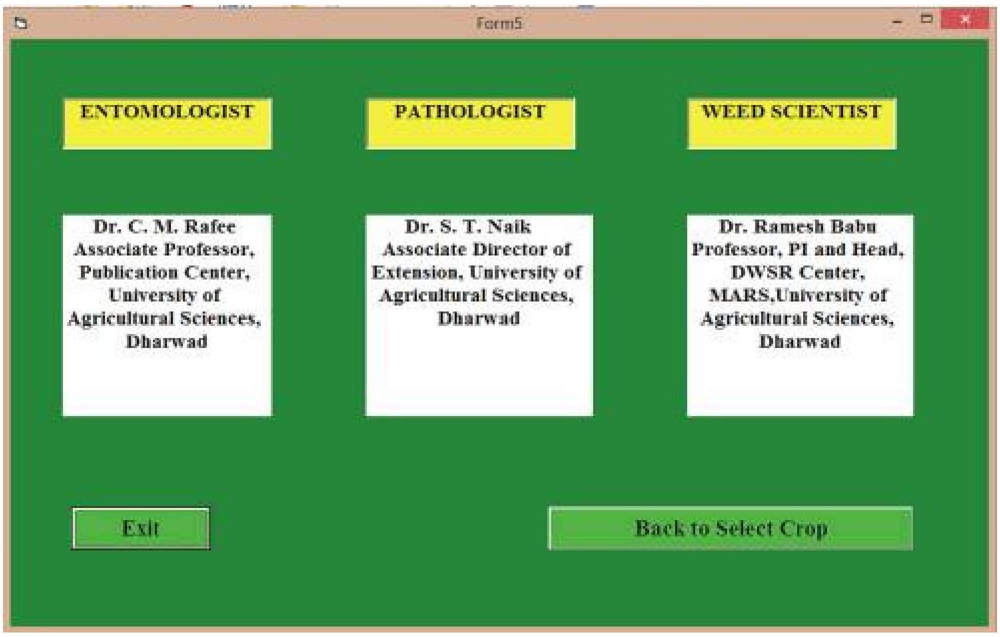
4.5.3.1 Window of Information on Biotic Stresses

There are some buttons of biotic stresses in biotic stress selection window, selection of each button will take to the windows containing the brief information about respective biotic stress. Each window of biotic stress contains information regarding symptoms or characteristics and management practices to biotic stresses (Fig 4.3.3.1)

Fig 4.5.3.1. Window of Information on Biotic Stresses

4.5.3.2 Window for more Information on Biotic Stresses

This window has included the name and address of Pathologist, Entomologist and Weed Scientist, that user may contact for more information on interested biotic stress in the window. (4.5.3.2)



4.5.3.2 Window for more Information on Biotic Stresses

4.5.4 Calculation of Biotic stress window

This section contains list of pests, diseases and weeds and blank space at opposite of each. User has to enter the incidence level of each pests, diseases and weed growth in percentage. Then click on the calculate (Fig. 4.3.4).

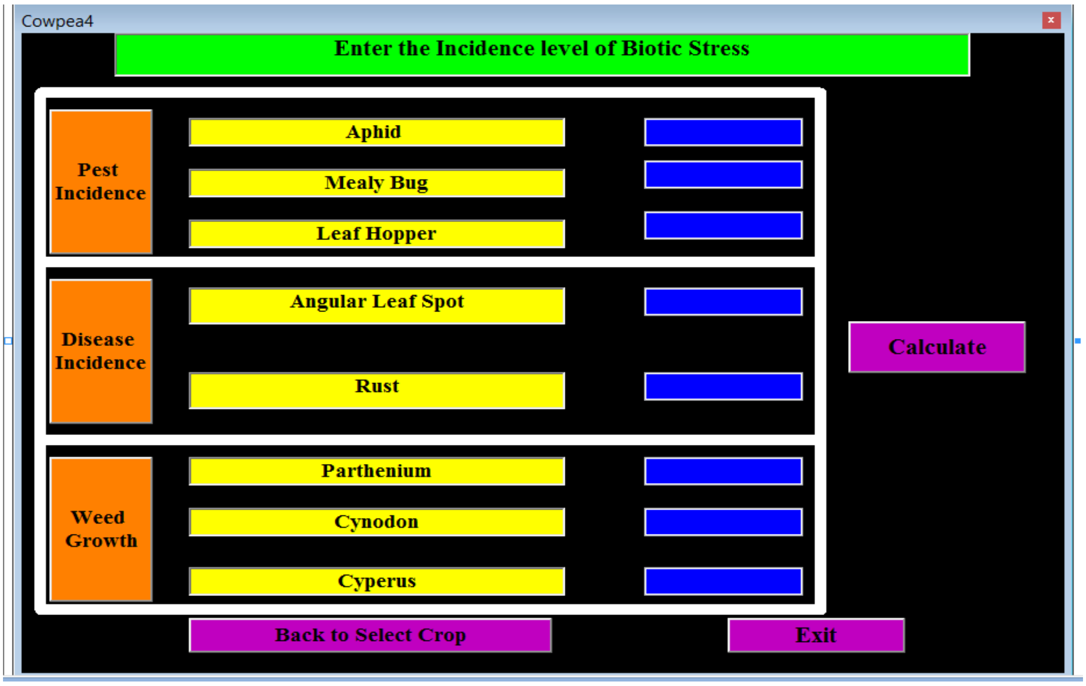


Fig. 4.5.4: Calculation of Biotic stress window

4.5.5 Result box

After clicking on calculate button, it will give the average amount of yield in the form of message box (Fig. 4.3.5). In all the windows there is facility for go back to previous window.

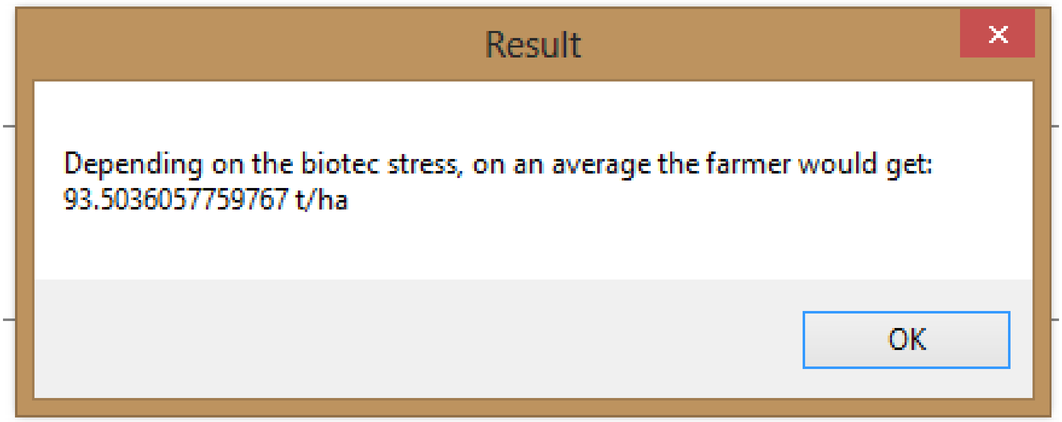


Fig. 4.5.5: Result box

DISCUSSION

The present investigation is subjected to some of the statistical analysis *viz.,* correlation analysis, regression analysis and cluster analysis. The results of the analysis which is presented in the previous chapter with cross references done under review of literature, to highlight the major trends observed and some of the reasons responsible for the findings have been discussed under the following headings

5.1 Correlation analysis

5.2 Regression analysis

5.3 Decision Support System

5.1 Correlation analysis

The knowledge regarding association of various parameters among themselves is necessary to know the nature and degree of relationship. Correlation studies gave way to know the association prevailing between pests, diseases and weeds of cotton and sugarcane crops and weather parameters which give better understanding of the contribution of each weather parameter to the pests, diseases and weeds, with this view the pests, diseases and weeds and weather parameters were subjected to correlation analysis and the results are discussed.

An attempt to correlate between important weather parameter and biotic stresses (pests, diseases and weed growth) of cotton crop was done. The results of investigation were presented in the Table form under chapter 4. *i.e.* Results. It was observed that among important pests of cotton (table 4.1.1) the incidence of aphid population is positively significantly correlated with morning relative humidity ($r=0.654^{**}$) and positively significant with evening relative humidity ($r=0.500^{*}$). It means that as morning and evening relative humidity increase there is increase in incidence of aphid. Rain fall and minimum temperature are positively correlated and maximum temperature is negatively correlated which is in association with the findings of Tomar and Singh (2010). From the results presented in the Table 4.1.1, the incidence of Mealy bug population was positively correlated with minimum temperature ($r=0.552^{*}$). Similarly other parameters like rainfall, maximum temperature and morning relative humidity are positively correlated but not significant. These findings are supported by the results of Dhawan *et al.* (2009). There is positive correlation between incidence of leaf hopper and evening relative humidity ($r=0.664^{**}$) which is similar to results obtained by Sharma and Singh (2012).

An attempt to correlate important diseases of cotton crop to the weather parameters was done and the results are presented in the Table 4.1.1. It reveals that angular leaf spot is positively correlated with rain fall ($r=0.614^{*}$), morning relative humidity ($r=0.573^{*}$), maximum temperature ($r=0.526^{*}$) and evening relative humidity ($r=0.601^{*}$). It indicates that there is a significant cause and effect relationship between the incidence of angular leaf spot and above weather parameters. Minimum temperature is negatively correlated but does not have the significant influence on incidence of angular leaf spot disease. These reveals are in association with findings of Stoughton (1933). Similarly rust is negatively significant with maximum temperature ($r= -0.776^{**}$), indicating increase in maximum temperature leads to decrease in rust incidence and is similar to findings of Dutta *et al.* (2008).

In the same way important weed flora of cotton crop was correlated with weather parameter, the results are presented in the Table 4.4.1. The *Parthenium hysterophorus* ($r=0.500^{*}$), *Cynodon dactylon* ($r=0.674^{**}$) and *Cyperus rotundus* ($r=0.801^{**}$) were positively significantly correlated with rain fall. It indicates that there is more growth of weeds as rainfall increases. Because, like crop plants, weeds require sufficient water, humidity and other favourable environment for the germination of weed seeds. Similarly, *Parthenium hysterophorus* ($r= -0.727^{**}$) *Cynodon dactylon* ($r= -0.742^{**}$) and *Cyperus rotundus* ($r= -0.692^{**}$) were negatively significantly correlated with maximum temperature. This relation indicates that as temperature increases the growth of weeds is declined which is not favourable condition for growth of weeds which was in association with the findings of Singh *et al.,* 2004.

The correlation study carried out between important pests of sugarcane and weather parameters the results are presented in the Table 4.1.2. The results reveal that among weather parameters, the rainfall has negative significance on incidence of woolly aphid ($r= -0.509^{*}$) and top shoot borer ($r= -0.655^{**}$), positive significance on root grub ($r=0.597^{**}$) which is in association with the findings of Sharanabasappa *et al.* (2008). Woolly aphid, top shoot borer and root grubs were positively significantly correlated with the evening relative humidity, minimum and maximum temperature respectively.

Among important diseases of sugarcane, some diseases were used in the correlation study with the weather parameters the results are presented in the Table 4.1.2. As per the results, the incidence of red rot and rust were positively significantly correlated with rain fall (r=0.646**).It indicates increase in incidence level with increase in rainfall. Except evening relative humidity all other weather parameters are positively correlated but they are not significant. For rust no other parameters were influencing significantly, these findings are supported by the findings of Anil Kumar *et al.* (1998)

Similarly correlation study was carried out for growth of weeds in relation to the weather parameters, the results are presented in the Table 4.1.2. Among important weed flora of sugarcane, growth of *Parthenium hysterophorus* (r=0.692**), *Cynodon dactylon* (r=0.505*) and *Alternanthera sessilis* (r=0.582*) were positively significantly correlated with rain fall. It reveals that for growth of weeds sufficient rainfall is required and temperature is positively correlated but is not significant, the findings of this investigation are similar to the reveals of Singh *et al.* (2004).

In the Table 4.3.1 the results of correlation study between yield of cotton crop and pests, diseases and weed growth are presented. The Table reveals that occurrence of pests, diseases and weed growth were showed negative correlation with the cotton yield. Among important pests the aphid (r= -0.547*) and (r= -0.683**) leaf hopper were negatively significantly correlated and is in association with the findings of Singh and Sachan (1992). It was also noticed that, the angular leaf spot (r= -0.804**) and rust were negatively significantly correlated to crop yield. Which implies that there is a negative influence of diseases on yield level of the crop and is supported by the results of Gururaj (2013). *Parthenium hysterophorus* (r= -0.618*) and *Cynodon dactylon* (r= -0.695**) are also have negative relationship with the yield of cotton. As there exist a competition for nutrient among crop plants and weeds, since weeds absorb nutrients there will be shortage of nutrient for growth and development of crop plants. Hence as a result yield levels were declined. This investigation is similar to the outcomes of Charles *et al.* (1992).

For understanding the relationship between yield of sugarcane and pests, diseases and weed growth correlation was carried out and results are presented in Table 4.3.2. Among important pests the woolly aphid (r= -0.514*) and top shoot borer (r= -0.632**), among diseases Ring spot (r= -0.805**) was negatively significantly correlated to yield. It implies that, there is a lesser yield as there is a more incidence of pests and diseases which is supported by the findings of Mukunthan *et al.* (2008). *Alternanthera sessilis* (r= -0.543*) showed significant negative relationship with the total yield of sugarcane. *Parthenium hysterophorus* and *Cynodon dactylon* also have negative relationship but they were not significant might be due to management practices carried out by the farmers. Always there exist a competition for nutrient among crop plants and weeds, as weeds absorb nutrients there will be shortage of nutrient for growth and development of crop plants. Intern yield level were decreased, this investigation is similar to the outcomes of Charles *et al.* (1992)

5.2 Regression analysis

To study the functional relationship of several independent variables on a dependent variable multiple regression is used. In the present investigation impact of weather parameters on pests, diseases and weed growth is analysed as well as yield of crops is estimated based on pests, diseases incidence and weed growth.

An attempt to estimate the contribution of weather parameters on pests, diseases and weed growth in cotton was made and the results were given under chapter 4. *i.e.* Results and are discussed below.

The contribution of different weather parameters on incidence of aphid in cotton was represented in the form of table. From the Table 4.2.1.1, the maximum temperature and morning relative humidity had significant positive impact on the incidence of aphid, the results are in association with the findings of Tomar and singh (2010),

From the results presented in the Table 4.2.1.2, among weather parameters the morning relative humidity (-0.745**) has negative impact on incidence of mealy bugs. The Maximum temperature and evening relative humidity also have negative impact but not significant, these findings are supported by the results of Dhawan *et al.* (2009).

There was a significant positive contribution of evening relative humidity to the population of leaf hopper in cotton. The maximum temperature and morning relative humidity have negative impact and minimum temperature showed positive impact but they are not significant. The results are presented in the Table 4.2.1.3 and are in association with the findings of Sharma and Singh (2012).

The results of impact of weather parameters on angular leaf spot of cotton are presented in the Table 4.2.1.4. Results reveals that, the morning relative humidity has significant positive impact on incidence of disease. Temperature showed positive impact but is not significant; these results are supported by findings of Stoughton (1933).

From the results presented in the Table 4.2.1.5, the contribution of evening relative humidity was positively significant to the incidence of rust of cotton. The Maximum temperature and morning relative humidity have negative impact and minimum temperature and rain fall have positive impact but they were not shown significant contribution, these outcomes are in association with findings of Dutta *et al.* (2008).

Similarly weed flora of cotton also estimated based on prevailing weather parameters. Parthenium has significant correlation with weather parameters but in the present study any weather parameters did not showed linear significant contribution to the growth of Parthenium. From the Table 4.2.1.6 Results revealed that, maximum temperature has significant positive and minimum temperature has significant negative impact on growth of *Cynodon dactylon.* Similarly from Table 4.2.1.7 depicted that there is significant positive contribution of rainfall to the growth of *Cyperus rotundus,* the reveals from the investigation are in association with the findings of Charles *et al.* (1992).

An attempt to estimate the population of pests, incidence of diseases and weed growth in sugarcane based on prevailing weather parameters was done and the results are presented in the form of tables. From the Table 4.2.2.1 it is noticed that the population of woolly aphid contributed negatively from all the weather parameters. Among which rainfall, maximum temperature and evening relative humidity were showed significant impact and the outcome is supported by reveals of Sharanabasappa *et al.* (2008). In the present study weather parameters did not show direct linear relationship with the population of top shoot borer. From Table 4.2.2.2 the incidence of root grub in sugarcane was significantly contributed by the maximum temperature

From Table 4.2.2.3 the infestation of red rot of sugarcane was significantly positively contributed by the rainfall. Minimum temperature and morning relative humidity also contribute positively and maximum temperature and evening relative humidity have negative impact but they were not significant. This reveal is supported by the outcomes of Anil Kumar *et al.* (1998).

Per cent incidence of rust in sugarcane was estimated based on weather parameters the results are presented in the Table 4.2.2.4. All the weather parameters were contributed positively but only rainfall, minimum temperature and evening relative humidity have significant impact, the results are in association with the findings of Singh, *et al.* (2009).

Similarly, among weed flora of sugarcane, *Parthenium hysterophorus,* was significantly contributed by rainfall. Maximum temperature, morning relative humidity and evening relative humidity were contributed negatively and minimum temperature contributed positively however they are not significant. The results are presented in the Table 4.2.2.5; these results are supported by the results of Tamado *et al.* (2002) and Singh *et al.* (2004). In the same way the Table 4.2.2.6 reveals that the growth of *Alternanthera sessilis* was significantly positively contributed by rainfall.

Yield of cotton was predicted based on biotic stress consisting of important pests, diseases and weed growth; results are presented in the Table 4.4.1. In the present study, the leaf hopper among pests and angular leaf spot among diseases shown significant negative impact on yield of cotton. All other pests, diseases and the weeds also showed negative non-significant impact on yield. The results are in association with the findings of Charles *et al.* (1992) and Gururaj (2013).

An attempt to estimate the yield of sugarcane depending on biotic stress, which includes pests, diseases and weed growth, results are presented in the Table 4.4.2. Woolly aphid among pests, ring spot and rust among diseases has significant negative impact on yield. All the pests, diseases and weeds have negative impact but not significant. These results are in association with the findings of Mukunthan *et al.* (2008) and Ogle *et al.* (1979).

5.3 Decision Support System

The Decision Support System has been developed in the visual basic V.06. There are five windows or section in the software which are discussed under following sub heading.

5.3.1 Login window.

5.3.2 Crop selection window.

5.3.3 Biotic stress selection window.

5.3.4 Calculation of Biotic stress window.

5.3.5 Result box (Message box).

5.3.1 Login window

In this window user has to enter the user name and password which is being same *i.e.*, “vistic” and then click on login (Fig. 4.5.1) which displays the crop selection window.

5.3.2 Crop selection window

In this window user has to select the crop of his interest by clicking on crop listed, it will take to the Biotic stress selection window (Fig. 4.5.2).

5.3.3 Biotic stress selection window

In this window user has to select the ‘estimation of yield based on pests, diseases and weed’ by clicking on ‘Estimation of yield based on pests, diseases and weed’ it will take to the calculation window. This window contains list of pests, diseases and weed, clicking on each pests, diseases and weeds will take to the window having some minor information about each pest, diseases and weed respectively. This window also contains another option named ‘for more information please contact’ clicking in this will take user to the window having contact address of Entomologist, Pathologist and Weed scientist of University of Agricultural Sciences, Dharwad.

By selecting the crop it will take to calculation window (Fig. 4.5.3).

5.3.4 Calculation of Biotic stress window

This section contains list of pests, diseases and weeds and blank space at opposite of each. User has to enter the incidence level of each pests, diseases and weed growth in percentage. Then click on the calculate (Fig. 4.5.4).

5.3.5 Result box

After clicking on calculate button, it will give the average amount of yield in the form of message box (Fig. 4.5.5). In all the windows there is facility for go back to previous window.

SUMMARY AND CONCLUSIONS

Weather parameters play a unique role in the growth and development of crops. Weather parameters affect the biotic stresses (pests, diseases and weed growth) of crop during different stages of growth and development. Distribution pattern of weather parameters over the crop season is important.

There is a need to nurture the farmers to select the crops and cultural activities, in order to mitigate food scarcity. Comprehensive research studies that focus on weather parameters and the biotic stresses had to be carried out. With this view, the present study was under taken with the below mentioned objectives. The results obtained from statistical evaluation of biotic stress, weather parameters and yield as well as impact studies would help in learning and drawing policy guidelines for the future investments planned.

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.

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.

“DSS are interactive computer-based systems that utilize data and models for aiding an organizational Decision-maker in semi structured problem”.

The present study was taken up in selected talukas of Dharwad, Haveri, Bagalkot and Belgaum districts of Karnataka state with the following objectives

1. To study the impact of weather parameters on incidence of pest, disease and weed growth.
2. To estimate yield of crop infested by pest, disease and weed.
3. To develop DSS for yield of crops in response to disease pest and weed growth.

The present study was purposively undertaken in the Dharwad, Haveri, Bagalkot and Belgaum districts since these districts having more area under rain fed as well as irrigated, different cropping system. The secondary data on pests, diseases and weeds of the study area was collected from the project titled ‘e-pest management surveillance’, university of agriculture sciences, Dharwad. Weather parameter of the study area was collected from Karnataka state natural disaster management center, Bangalore. Yield data was collected from the farmers of respective study area.

The techniques of correlation and multiple regression analysis were adopted. The relationship between biotic stresses and weather parameters was studied. The yield of crops was estimated based on biotic stresses.

The summery of the study is presented in the following headings

6.1 Impact of weather parameters on incidence of pest, disease and weed growth.

For cotton crop

1. The maximum temperature and morning relative humidity were showed significant positive impact on aphid population.
2. The morning relative humidity has significant negative impact on mealy bug population and evening relative humidity has significant positive impact on leaf hopper population.
3. Morning relative humidity has significant positive impact on incidence of angular leaf spot disease.
4. Evening relative humidity has significant positive impact on incidence rust of disease.

5. The maximum temperature has negative and minimum temperature has significant positive impact on growth of *cynodon dactylon*.
6. Rain fall has significant positive impact on growth of *cyperus rotundus.*

For sugarcane crop

7. The rain fall, minimum temperature and evening relative humidity has significant negative impact on woolly aphid population.
8. Maximum temperature has significant positive impact on incidence of root grub.
9. The rain fall has significant positive impact on incidence of red rot.
10. The rain fall, minimum temperature and evening relative humidity has significant positive impact on infestation of rust.
11. The rain fall has significant positive impact on growth of *Parthenium hysterophorus* and *Alternanthera sessilis.*

6.2 Estimate yield of crop infested by pest, disease and weed

1. The yield of cotton crop had negatively correlated with aphid, leaf hopper, angular leaf spot, rust, *Parthenium hysterophorus* and *Cynodon dactylon.*
2. The yield of sugarcane crop had negatively significantly correlated with Wooly aphid, Top shoot borer, Ring spot and *Alternanthera sessilis.*
3. For cotton crop, yield had significant negative contribution of leaf hopper and angular leaf spot in the present study.
4. For sugarcane crop, yield had significant negative contribution of Wooly aphid ring spot and rust in the present study.

6.3 Future Line of Work

1. The biotic stresses shown negative impact on the yield of crops. Therefore in order to increase the yield of the crops, farmers will need to be adapt the pest, disease and weed management practices.
2. By knowing the trends of weather parameters on biotic stresses, farmers will need to be adapt pests and disease management practices to optimize the yield.
3. This DSS can be extended to all other major crops, globally
4. This DSS can be further extended with method of application of fertilizers and other package of practices of different crops.
5. This study can help to develop new large data matrix model for agriculture and allied sciences
6. DSS can helps to the farmers, scientists,, young researchers, innovatore and policy maker for implementation of innovative and technological programme.

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DEVELOPMENT OF DECISION SUPPORT SYSTEM FOR COTTON AND SUGARCANE

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ABSTRACT

The Decision Support System has been developed in the visual basic V.06. Software includes five windows, user has required to feed the per cent incidence level to get estimated yield of crops based on incidences of biotic stress. DSS includes the information about biotic stresses and also contact address of specialists. Come back facility has been provided in each window to get back into previous window. Statistical investigation was carried out on relationship between weather parameters and biotic stresses, biotic stresses and crop yield. Correlation and regression analysis were used as tools. In case of cotton crop, the maximum temperature and morning relative humidity have significant positive impact on the incidence of aphid. The morning relative humidity has negative impact on incidence of mealy bugs. There was a significant positive contribution of evening relative humidity to the population of leaf hopper in cotton. The morning relative humidity and evening relative humidity has significant positive impact on incidence of angular leaf spot and rust respectively. Maximum temperature has significant positive and minimum temperature has significant negative impact on growth of *Cynodon dactylon.* There was significant positive contribution of rainfall to the growth of *Cyperus rotundus*. The leaf hopper and angular leaf spot showed significant negative impact on yield of cotton. Similarly in case of sugarcane crop, the population of woolly aphid contributed negatively from all most all the weather parameters. The incidence of root grub was significantly contributed by the maximum temperature. There was significant positive contribution of rainfall on infestation of red rot. Maximum temperature and morning relative humidity have significant positive contribution on incidence of rust. *Parthenium hysterophorus* and *Alternanthera sessilis* were significantly contributed by rainfall. Woolly aphid, ring spot and rust have significant negative impact on yield.