Journal of Plant Development Sciences

(An International Monthly Refereed Research Journal)

Volume 7 **Number 6** **June 2015**

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MODERN VARIETIES FOR SELF SUFFICIENCY OF RICE PRODUCTION IN ASSAM – AN ECONOMETRIC ANALYSIS

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Received-09.06.2015, Revised-22.06.2015

Abstract: Rice is the principal crop of Assam, which alone occupies nearly 70 percent of gross cropped area and cover around 80 percent of total food production in the state. Although, the production of rice has increased over the years especially during the recent decades, the productivity is very low as compared to other rice growing states of India. Increase in production through increase in area is not far fetching. Change in productivity is basically technological and hence, more promising. Probit model revealed that in Nagaon district co-efficient of per cent clay soil area (ha.), non-farm income (Rs.) and dummy for extension visit were positively significant. i.e., these factors had significant influence towards adoption of modern varieties in the district. While, in Golaghat district dummy for extension visit and NPK use (kg/ha) had shown significant influence towards adoption of modern varieties. Tobit model estimates revealed that dummy for extension visit and size of household had significant influence towards adoption of modern varieties in both the sample districts towards adoption of modern varieties. Factor analysis showed that amongst the factors considered in Nagaon district, dummy for credit used for production purpose, dummy for extension visit and per cent loamy sand area (ha) were the variables of importance in determining the adoption of modern varieties. Likewise, in Golaghat district Coefficient of Variation of yield (t/ha), dummy for extension visit and number of years in school attended by the household head emerged out to be the important variables in determining the adoption of modern varieties in the district.

Keywords: Modern varieties, Probit, Tobit model, Factor analysis

INTRODUCTION

Assam is one of the economically backward states of India. The state nested in the heart of India's North Eastern region has vast fertile land and plenty of natural resources providing immense potentiality for the development of agriculture. Among the food-grains, rice is the principal crop, which alone occupies nearly 70 percent of gross cropped area and cover around 80 percent of total food production in the state (Bhowmick and Borthakur, 2002). Almost 90 per cent of the population is rice eater. The agro-climatic suitability favours rice cultivation in the state. Hence, the state being one of the main rice growing states of India can contribute a lot to the national economy. In Assam, rice is mostly a rainfed crop, which largely depends on the vagaries of nature. Although, the production of rice has increased over the years especially during the recent decades, the productivity is very low (1.5 t/ha) as compared to other rice growing states of India and Indian average (2.06 t/ha). It is obvious that increase in area or productivity lead to increase in production. Nevertheless, increase in production through increase in area is not far fetching, as land is a limiting factor. Change in productivity is basically technological and hence, more promising. Hence, a quantitative assessment of adoption pattern of technologies assumes significance in the context of agricultural development.

METHODOLOGY

Database of the investigation

Cross section data pertaining to rice area and yield under different land type and soil type, input used in rice production and income obtained thereon etc. were collected from Nagaon and Golaghat districts of Assam through personal interview method for two consecutive agricultural years from a selected set of 150 households.

Analytical framework

Multivariate Probit and Tobit regressions

Multivariate Probit and Tobit regressions were conducted to identify factors determining adoption of modern variety. For the Probit model the dependent variable was adoption (Yes/No) of modern varieties in each plot. The plot-specific independent variables, land type and soil type, were specified as dummy variables. For the Tobit model the dependent variable was the percentage area planted to modern variety in each household. In this case, the land type and soil type variables were represented in terms of percentage area under each category. In both models same factors were considered in a district.

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Factor analysis

In order to identify the factor and their relationship in the influence of adoption of modern varieties, factor analysis had been performed. For the purpose SPSS 7.5 version was used. Factor analysis like principal component analysis seeks to provide reduction in dimensionality by parsimoniously explaining the entire covariance matrix. The essential purpose of factor analysis is to describe, if the covariance relationship among many variables in terms of a few underlying but unobservable random quantities called factors. Factor refers to a hypothetical, unobservable variable as in the phrase common factor. Factor analysis refers to all methods of data analysis, matrix factors, including component analysis and common factor analysis.

For the random variables $X_1, X_2, \ldots X_p$ the assumed factor analysis model is

$X_i = \mu_i + \lambda_{i1}Y_1 + \lambda_{i2}Y_2 + \ldots\ldots\ldots\ldots\ldots \lambda_{im}Y_m + Z_i$

Where, i = 1, 2 ….p

$Y_1, Y_2 \ldots\ldots\ldots Y_m$ are hypothetical unobserved random variable

$Z_1, Z_2 \ldots\ldots\ldots Z_p$ are p hypothetical unobserved random variable with Z_i specific to X_i

'λ_{ij}' (where ' i' goes from 1,2…….p and ' j'= 1,2 ……m) is the coefficient of Y_j in representing X_i .

The Y's are also called common factor and Z's are called specific factor or unique factor.

'm' is the number of common factor which is called complexity. Thus it seems that smaller the number of 'm' less complex the dimensionality of X_i

Co-efficient 'λ_{ij}' are called factor loading. So, 'λ_{ij}' is the loading of the original random variable X_i on the common factor Y_j

The whole thing is written in matrix form as follows

$X = \Phi + AY + Z$ ..... (A)

Assumptions: $E(Y) = 0, E(Z) = 0$

The specific factors had variance 'c_i^2' and co-variance zero. The variance of Z_i i.e. 'c_i^2' is called the specific variance i.e. V(Z) = C. The variance of Y is an identity matrix and this can be achieved by standardizing the common factor Y_i's. Thus from the relation (A) we have

$V(X) = V(AY) + V(Z)$

$\Sigma = AIA^{\wedge} + C$

$\Sigma = AA^{\wedge} + C$ ..... (B)

Σ = variance-covariance matrix of the original variable.

A = Factor loading matrix.

C = matrix of specific variance.

Then from relation (B) we get

Variance $(\sigma_i^2) = \lambda_{ij}^2 + c_i^2$

The 'λ_{ij}^2' i.e. the square of the loadings was described as the contribution of the standardization of the common factor Y_i to the variance of X_i.

$\lambda_{11}^2 + \lambda_{12}^2 + \lambda_{13}^2 + \ldots\ldots\ldots\ldots\ldots + \lambda_{1m}^2$ is called the communality of X^2.

Hence, the variance of X_i is expressed by communality and the specific variance.

RESULT AND DISCUSSION

Multivariate probit and tobit analysis

Multivariate probit and tobit regression were carried out to identify the factors determining adoption of modern varieties and results are presented in Table 1. For the plot level analysis (Probit model), the dependent variable is adoption (Yes/No) of modern varieties. The plot specific independent variables i.e., land type and soil types are specified as dummy variables. For the Tobit model, the dependent variable is the percentage area planted to modern variety in each household and the land type and soil type variables were represented in terms of percentage area under each category. In both the model, same factors were considered in a district. In Nagaon district, area of low lying and medium land (ha), area under clay soil (ha), area under loam sand soil (ha), area under sandy loam soil (ha), off farm and non farm income (Rs.), total farm holding (ha), dummy for credit used for production purpose, dummy for extension visit, number of years in schools by the household head, size of household and NPK use (kg/ha) were used for the analysis. In Golaghat district, all the factors except dummy for credit used for production purpose and instead of area under loamy sand soil (ha), area under clay loam soil (ha) were used. As no credit was used for production purpose in Golaghat district, the factor dummy for credit used for production purpose had not been used in the models fitted for the district. Also depending on the dominance different soil type were considered.

The Probit model estimates revealed that in Nagaon district co-efficient of per cent clay soil area (ha.), non-farm income (Rs.) and dummy for extension visit were positively significant. i.e., these factors had significant influence towards adoption of modern varieties in the district. While, in Golaghat district dummy for extension visit and NPK use (kg/ha) had shown significant influence towards adoption of modern varieties.

Table 1. Probit and Tobit models determining the adoption of modern variety

Variable	Probit model estimates		Tobit model estimates	
	Nagaon	Golaghat	Nagaon	Golaghat
INTERCEPT	0.409959*	0.59615**	37.03832	0.911995
PLAND1	0.117074	-0.019499	-0.117754	0.279932*
PLAND2	-0.021984	0.004324	-0.109015	0.424318**
PSOIL1	0.185735*	0.016726	0.008414	-0.178422

PSOIL4	-0.020405	-	0.019743	-
PSOIL5	-	-0.002734	-	-0.126273
PSOIL6	-0.098540	-0.032837	-0.020178	-0.143185
VALUE	0.000003*	-0.00000007	0.000096*	0.000182*
AREAFARM	0.024436	0.008397	-1.120306	-2.437054
DCREDPRO	0.062034	-	-5.543424	-
DEXTEN	0.327615**	0.088339*	17.876008*	17.006184*
EDYEARS	-0.005827	-0.000891	0.136342	-0.0259621
SIZEFAM	-0.019451	0.005476	2.052302*	2.306651*
NPK	0.004360	0.313906**	18.81940*	0.274823
R-square	0.33312	0.40964	0.286138	0.38491

Note: Those with * are statistically significant at 5% and ** are statistically significant at 1% level of significance

PLAND1=% area, low-lying land in ha.
PLAND2=% area, medium lying land in ha.
PSOIL1=% area, clay soil in ha.
PSOIL2=% area, sandy soil in ha.
PSOIL3=% area, loamy soil in ha.
PSOIL4=% area, loamy sand in ha.
PSOIL5=% area, clay loam in ha
PSOIL6=% area, sandy loam in ha
VALUE=off-farm and non-farm income in Rs.
AREAFARM=total farm holding in ha.
DCREDPRO=dummy for credit used for production purpose: 1=has credit; 0=otherwise
CV=Coefficient of variation of yield (t/ha)
DEXTEN=Dummy for extension visit: 1=visited; 0=otherwise
EDYEARS=Number of years in school attended by the household head
SIZEFAM=Size of household
NPK=NPK use in kg/ha.
D1ACCESS=Dummy for poor access to market: 1=poor access; 0=otherwise
D2ACCESS=Dummy for medium access to market: 1=medium access; 0=otherwise

The Tobit model estimates also revealed that dummy for extension visit off-farm and non-farm income and size of household had significant influence towards adoption of modern varieties in both the sample districts. Besides, NPK use (kg/ha) in Nagaon district and area under medium as well as low lying land (ha) in Golaghat district had shown significant influence towards adoption of modern varieties.

Factor analysis

Factor analysis has been carried out using the SPSS package version 7.5, taking some factors *viz.*, different land and soil types prevalent in the districts, extension visit, farm size, household size, credit use, off-farm and non-farm income (Rs.), education level of household head, NPK use etc. Outcome of the analysis are presented in Table 2 & 3.

Factor loading

The coefficients in the factor equations are called "factor loadings". They appear in each factor column in the Table, corresponding to each variable. The factor equations for Nagaon district are:

$F_1 = -0.1115X_1 + 0.0222X_2 + 0.0330X_3 + 0.0751X_4 - 0.0603X_5 + 0.2186X_6 - 0.2238X_7 + 0.2381X_8 - 0.2236X_9 + 0.0632\ X_{10} + 0.2491X_{11} + 0.0666X_{12} + 0.0597X_{13}$

$F_2 = -0.4469X_1 + 0.4799X_2 + 0.0771X_3 + 0.0504X_4 + 0.0667X_5 + 0.1406X_6 + 0.1715X_7 - 0.1217X_8 + 0.0250X_9 + 0.0437X_{10} - 0.0085X_{11} - 0.2025X_{12} - 0.1296X_{13}$

$F_3 = -0.0291X_1 + 0.0288X_2 + 0.0301X_3 + 0.1268X_4 + 0.0204X_5 + 0.1829X_6 + 0.2367X_7 - 0.2374X_8 - 0.0572X_9 + 0.3230X_{10} - 0.0337X_{11} + 0.3881X_{12} + 0.4144X_{13}$

$F_4 = 0.1232X_1 - 0.1224X_2 + 0.2220X_3 + 0.5396X_4 + 0.5821X_5 - 0.1038X_6 + 0.0927X_7 - 0.0770X_8 - 0.2269X_9 + 0.1631X_{10} + 0.0396X_{11} - 0.1221X_{12} + 0.0453X_{13}$

$F_5 = 0.1231X_1 - 0.1623X_2 + 0.8254X_3 + 0.2824X_4 - 0.1203X_5 + 0.1766X_6 - 0.0001X_7 + 0.0071X_8 + 0.0704X_9 + 0.2050X_{10} - 0.0449X_{11} - 0.1404X_{12} - 0.2166X_{13}$

The factor equations for Golaghat district are:

$F_1 = 0.2292X_1 + 0.2180X_2 + 0.1551X_3 + 0.1660X_4 + 0.1067X_5 + 0.1228X_6 + 0.0289X_7 - 0.1868X_8 - 0.2478X_9 + 0.2367X_{10} + 0.1461X_{11} + 0.1300X_{12}$

$F_2 = 0.0660X_1 + 0.0877X_2 + 0.0039X_3 + 0.0344X_4 + 0.1731X_5 + 0.3758X_6 - 0.4260X_7 - 0.06427X_8 + 0.1757X_9 - 0.2763X_{10} - 0.0089X_{11} + 0.1290X_{12}$

$F_3 = 0.3575X_1 + 0.3611X_2 + 0.1082X_3 + 0.3184X_4 + 0.1143X_5 - 0.2210X_6 + 0.1683X_7 + 0.0819X_8 + 0.1973X_9 - 0.0803X_{10} - 0.0996X_{11} + 0.1293X_{12}$

$F_4 = 0.1898X_1 + 0.1178X_2 + 0.3333X_3 + 0.1145X_4 - 0.5403X_5 + 0.1134X_6 - 0.1455X_7 + 0.5424X_8 - 0.1322X_9 - 0.0787X_{10} + 0.2331X_{11} - 0.0061X_{12}$

$F_5 = -0.0092X_1 + 0.0105X_2 + 0.5627X_3 + 0.2151X_4 + 0.2753X_5 + 0.1031X_6 - 0.1383X_7 + 0.2871X_8 - 0.2017X_9 + 0.2151X_{10} + 0.4859X_{11} - 0.2575X_{12}$

The factor loading depicts the relative importance of each variable with respect to a particular factor. In all the five factor equations derived for Nagaon district, dummy for credit used for production purpose (X_3) dummy for extension visit (X_4) and per cent loamy sand area (ha) (X_{10}) appeared with positive loading indicating that they were the variables of importance in determining the adoption of modern varieties in the district. Likewise, in Golaghat district Coefficient of variation of yield (t/ha) (X_2), dummy for extension visit (X_3) and number of years in school attended by the household head (X_4) showed positive loading in all the five factor equations derived from the analysis indicating the importance the variables in determining the adoption of modern varieties in the district.

Table 2. Component Score Coefficient Matrix for Nagaon district

Factors	Factors					Communalities
	1	2	3	4	5	
AREAFARM (X_1)	-0.1115	-0.4469	-0.0291	0.1232	0.1231	0.7976
CVY (X_2)	0.0222	0.4799	0.0288	-0.1224	-0.1623	0.7732
DCREDPRO (X_3)	0.0330	0.0771	0.0301	0.2220	0.8254	0.8376
DEXTEN (X_4)	0.0751	0.0504	0.1268	0.5396	0.2824	0.6221
EDYEAR (X_5)	-0.0603	0.0667	0.0204	0.5821	-0.1203	0.5607
NPKUSE (X_6)	0.2186	0.1406	0.1829	-0.1038	0.1766	0.7289
PLAND1 (X_7)	-0.2238	0.1715	0.2367	0.0927	-0.0001	0.8111
PLAND2 (X_8)	0.2381	-0.1217	-0.2374	-0.0770	0.0071	0.8351
PSOIL1 (X_9)	-0.2236	0.0250	-0.0572	-0.2269	0.0704	0.6397
PSOIL4 (X_{10})	0.0632	0.0437	0.3230	0.1631	0.2050	0.4271
PSOIL6 (X_{11})	0.2491	-0.0085	-0.0337	0.0396	-0.0449	0.6890
SIZEFARM (X_{12})	0.0666	-0.2025	0.3881	-0.1221	-0.1404	0.6429
VALUE (X_{13})	0.0597	-0.1296	0.4144	0.0453	-0.2166	0.6283
Variance summarized (%)	25.4810	13.5588	12.9067	9.2526	7.9806	Average = 0.6918

Extraction Method: Principal Component Analysis

PLAND1 = % area, low-lying land in ha.

PLAND2 = % area, medium lying land in ha.

PSOIL1 = % area, clay soil in ha.

PSOIL4 = % area, loamy sand in ha.

PSOIL6 = % area, sandy loam in ha

VALUE = off-farm and non-farm income in Rs.

AREAFARM = total farm holding in ha.

DCREDPRO = dummy for credit used for production purpose: 1=has credit; 0=otherwise

CVY = Coefficient of variation of yield (t/ha)

DEXTEN = Dummy for extension visit: 1=visited; 0=otherwise

EDYEARS = Number of years in school attended by the household head

SIZEFAM = Size of household

Table 3. Component Score Coefficient Matrix for Golaghat district

Factors	Factors					Communalities
	1	2	3	4	5	
AREAFARM (X_1)	0.2292	0.0660	0.3575	0.1898	-0.0092	0.9087
CVY (X_2)	0.2180	0.0877	0.3611	0.1178	0.0105	0.8576
DEXTEN (X_3)	0.1551	0.0039	0.1082	0.3333	0.5627	0.7753
EDYEAR (X_4)	0.1660	0.0344	0.3184	0.1145	0.2151	0.6349
NPK (X_5)	0.1067	0.1731	0.1143	-0.5403	0.2753	0.7663
PLAND1 (X_6)	0.1228	0.3758	-0.2210	0.1134	0.1031	0.8954

PLAND2	(X_7)	0.0289	-0.4260	0.1683	-0.1455	-0.1383	0.9169
PSOIL1	(X_8)	-0.1868	-0.0642	0.0819	0.5424	0.2871	0.7848
PSOIL5	(X_9)	-0.2478	0.1757	0.1973	-0.1322	-0.2017	0.8199
PSOIL6	(X_{10})	0.2367	-0.2763	-0.0803	-0.0787	0.2151	0.8196
SIZEFARM	(X_{11})	0.1461	-0.0089	-0.0996	0.2331	0.4859	0.8034
VALUE	(X_{12})	0.1300	0.1290	0.1293	-0.0061	-0.2575	0.8135
Variance summarized (%)		22.5530	16.8689	15.4247	9.5529	8.8619	Average = 0.8164

Extraction Method: Principal Component Analysis

PLAND1 = % area, low-lying land in ha.

PLAND2 = % area, medium lying land in ha.

PSOIL1 = % area, clay soil in ha.

PSOIL5 = % area, clay loam in ha

PSOIL6 = % area, sandy loam in ha

VALUE = off-farm and non-farm income in Rs.

AREAFARM = total farm holding in ha.

CVY = Coefficient of variation of yield (t/ha)

DEXTEN = Dummy for extension visit: 1=visited; 0=otherwise

EDYEARS = Number of years in school attended by the household head

SIZEFAM = Size of household

NPK = NPK use in kg/ha.

Variance summarized

Factor analysis employs the criterion of maximum reduction of variance – variance found in the initial set of variables. Each factor contributes to the reduction of variance. After the analysis it was found that in Nagaon district the five factors (1 to 5) accounted for 25.48, 13.56, 12.91, 9.25 and 7.98 per cent of variance respectively; altogether explained more than 69 per cent of variance. While in Golaghat district, the five factors contributed 22.55, 16.87, 15.42, 9.55 and 8.86 per cent variance, respectively. The five factors together explained more than 81 per cent of the variances.

Communality

In an ideal solution the factors derived would explain 100 per cent of the variance in each of the original variables. "Communality" measures the percentage of the variance in the original variable that is captured by the combination of factors in the solution. Thus, communality is computed separately for each of the original variables. In each variable, communality might be thought of as showing the extent to which it is revealed by the system of factors. It was observed that in Nagaon district the average communality was more than 69 per cent, ranged from 42.71 per cent to 83.76 per cent. While, in Golaghat district the average communality was 81.64 per cent, which ranged from 63.49 per cent to 91.69 per cent. Thus, the five factors seem to capture the underlying dimensions involved in the variables considered in both the districts.

Summary

The Probit model revealed that in Nagaon district co-efficient of per cent clay soil area (ha.), non-farm income (Rs.) and dummy for extension visit were positively significant. i.e., these factors had significant influence towards adoption of modern varieties in the district. While, in Golaghat district dummy for extension visit and NPK use (kg/ha) had shown significant influence towards adoption of modern varieties. The Tobit model estimates also revealed that dummy for extension visit and size of household had significant influence towards adoption of modern varieties in both the sample districts. Besides, NPK use (kg/ha) in Nagaon district and area under medium as well as low lying land (ha) and off farm and non-farm income (Rs.) in Golaghat district had shown significant influence towards adoption of modern varieties. While, co-efficient for off-farm and non-farm income (Rs.) was found to be negatively significant in Nagaon district.

From factor analysis it was observed that the amongst the factors considered for Nagaon district, dummy for credit used for production purpose, dummy for extension visit and per cent loamy sand area (ha) were the variables of importance in determining the adoption of modern varieties in the district. Likewise, in Golaghat district Coefficient of Variation of yield (t/ha), dummy for extension visit and number of years in school attended by the household head emerged out to be the important variables in determining the adoption of modern varieties in the district.

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NUTRITIONAL STATE AND YIELD REGRESSION BY FOLIAR NUTRIENTS IN APPLE ORCHARDS OF WESTERN HIMALAYAS

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Received-15.06.2015, Revised-21.06.2015

Abstract: A nutritional survey was conducted in major apple growing belts of Western Himalayas *viz.* Jubbal-Kotkhai, Karsog, Kalpa, Kotgarh and Naggar areas of Himachal Pradesh (India) to study the nutritional wellbeing and effect of foliar nutrient concentrations on influencing yield. The foliar macro-nutrients, N, P, K, Ca, Mg in different locations were found in the range 1.71-2.31, 0.13-0.28, 1.18-1.82, 1.19-1.83 and 0.18-0.41 percent, respectively while the micro-nutrients Fe, Zn, Cu and Mg varied from 186.8-378.2, 17.67-61.01, 7.52-15.78 and 42.33-182.53 ppm. Multiple regressions have been calibrated for predicting apple yields at different locations and for low and high yielding (>150 kg/tree) trees where the models were found to have a high and significant predictability value. Using the data, fertilizer adjustment equations can be developed for prescribing optimum fertilizer doses for attaining high yields in the apple production areas in the Western Himalayas and indeed elsewhere with similar c1imatic and soil conditions.

Keywords: Nutrition, Apple, Essential nutrients, Regression plane, Sufficiency range

INTRODUCTION

Apple (*Malus x Domestica* Boorkh.) has immense nutritional value amongst fruits and is advised on daily basis in diet by dieticians. Owing to its chilling requirement, apple is cultivated in temperate regions of the world in an area of 4.8 million hectares with 76.7 MT production (FAO, 2015). In India, it is cultivated in high reaches of Himalayan region mainly in the states of Jammu & Kashmir, Himachal Pradesh, Uttaranchal and Arunachal Pradesh. In Himachal Pradesh it is a leading fruit crop cultivated on 107.7 thousand ha with 6.9 MT/ha productivity (NHB, 2014). The low productivity as compared to 15.9 MT/ha on world basis has been ascribed to various factors such as varietal, soil fertility, topography of land and incidence of pests and diseases. Providing adequate nutrition to fruit trees is the utmost concern among farmers for enhancing growth, yield and quality of apple which is mandatory for sustainable production. The fertilizer schedule should be holistic in nature because there are synergistic and antagonistic effects in relative availability of different essential nutrients from soil. Fertilizer is one of the costliest inputs in agriculture and the use of right amount of fertilizer is fundamental for farm profitability and environmental protection (Kimetu *et al.*, 2004). An increasing fertilizer price and growing awareness on environmental impact has increased interest in the optimal use of fertilizer for crop production. To enhance farm profitability under different soil-climate conditions, it is necessary to have information on optimum fertilizer doses for crops and it is important to provide to the farmer appropriate decision support tools that will allow them access to better fertilization (Robertson and Vitousek, 2009). Keeping this in view, the present survey was undertaken to study the nutritional wellbeing and effect of foliar nutrient concentrations on influencing yield in major apple growing areas and in the low and high yielding populations.

MATERIAL AND METHOD

The present studies were undertaken in major apple growing areas of Himachal Pradesh namely Jubbal-Kotkhai, Karsog, Kalpa, Kotgarh and Naggar which contributes to more than 80% of states production. Starking Delicious, which has a characteristic conical shape with deep red blush, is the main variety grown by farmers, hence was chosen for the study. At each location, five orchards (15-20 years old) were selected and in each orchard, twenty uniform and healthy trees were observed for two years. Leaf samples were collected from middle of terminal shoots of current year growth in the periphery of tree from 15th July to 15th August as suggested by Kenworthy (1964) and cleaning, drying, grinding and storage of samples was in accordance with Chapman (1964). Leaf samples were washed with deionized water, dried at 65°C, weighed and milled to 20 mesh for mineral analysis. Micro-Kjeldahl method was followed for estimation of total nitrogen and for estimation of other elements the samples were digested in di-acid (nitric and perchloric acid in the ratio 4:1). Phosphorus was estimated by vanado-molybdophosphoric yellow colour method using spectronic 21 while, potassium was estimated by flame photometric method. Calcium, magnesium, iron, manganese, copper and zinc content were determined by atomic absorption spectrophotometer

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ECIL model AAS 4129. The data of two years was pooled and analyzed in Randomized Block Design (RBD) with 5 replications (orchards) and 5 locations as treatments in accordance to Panse and Sukhatme (1985). Multiple regression planes were sought out taking fruit yield as dependant variable and nutrient concentration in leaf as independent variable.

RESULT AND DISCUSSION

The overall range and mean of foliar nutrient concentrations and yield of apple orchards at different locations is presented in Table 1. In the present survey, the mean of foliar macro-nutrients N, P, K, Ca and Mg were recorded to be 1.99, 0.20, 1.57, 1.51 and 0.29 per cent while micro-nutrients Fe, Zn, Cu and Mn concentrations was 278.1, 38.21, 10.67 and 119.58 ppm, respectively. Maximum concentrations of leaf N, P, K, Ca, Mg, Fe, Zn, Cu and Mn were recorded at Jubbal-Kotkhai, Kalpa, Kotgarh, Naggar, Jubbal-Kotkhai, Karsog, Naggar, Naggar and Kotgarh, respectively. The locations varied significantly with respect to concentrations of K, Zn, Cu and Mn in the leaves of apple. When the orchards were diagnosed by Shear and Faust (1980) sufficiency ranges (Table 2), the leaf N status was found optimum in 100 % of the orchards because farmers apply enough nitrogenous fertilizers (Rana *et al.* 1984), 4 % of the orchards were deficient in P which has been attributed to fixation of phosphorus in the form of iron and aluminium phosphate resulting in poor availability (Sharma, 1994) while, 4 % of the orchards were deficient in K suggesting a need to incorporate of murate of potash in fertilizer schedule (Sharma *et al.*, 1982). Fifty two percent of the orchards were categorized as low in leaf Ca which confirms the earlier results (Bhandari and Sharma, 1981; Das, 1999) who argued that there is abundant leaching of $CaCO_3$ due to heavy rainfall and Ca has tendency of lesser translocation in plant system from soil, thus suggesting application of Ca based fertilizers and foliar sprays. Twenty eight and twelve per cent of the orchards were found to be in deficient and in excess for leaf Mg, respectively. Low Mg status has been explained by antagonistic effect of soil Ca on Mg uptake by plants (Singh, 1996), while slightly acidic soils present in some of the orchards favour high availability of Mg making it excessive (Yadav, 1967), moreover heavy crop load has also been reported to increase leaf Mg (Cain and Boynton, 1948). All the orchards were adequate in Fe and Zn because their availability has been reported to increase in slightly acidic soil reaction prevalent in these areas (Sharma and Bhandari, 1992). Twenty two per cent of the orchards had excess Cu concentration in leaves as there is abundant use of micronutrient fertilizers and Cu based pesticides (Singh, 1987). Manganese was found in excess in 16 % of the orchards as the soils of these areas are rich in Mn and there is considerable use of micronutrient fertilizers (Sharma, 1994; Das 1999).

Multiple regression planes (Table 3) show that 61.2, 57.33, 60.35, 54.43 and 68.11 per cent variability in yield was observed due to different essential nutrients involved in the plane at Jubbal-Kotkhai, Karsog, Kalpa, Kotgarh and Naggar, respectively. It can be inferred that apart from nutrient content, yield is being limited by other residual factors like moisture status of soil, management practices, pollination intensity and environment conditions. Availability of nutrients to the plant is affected by complex situations in the soil such as fixation, antagonism, synergism, volatilization, immobilization, mineralization etc. (Mamgain, 1990; Sharma, 1994; Das, 1999). The regression planes further reveal that leaf P, K, Mg and Fe content in leaf affected yield positively while Mn content affected yield negatively and significantly at all the locations.

For low and high yielding trees (Table 4) 29.50 and 22.51 per cent of variability in yield was observed due to different foliar nutrients. Leaf N, K, Mg, Fe, Zn and Cu showed positive and highly significant effects on yield in low productive trees, whereas in case of high productive trees, only P had a positive and highly significant effect while Cu exhibited negative and highly significant effect on yield. From these observations, it can be inferred that in low productive trees maximum number of nutrients are significantly and positively controlling the yield indicating that a unit increase in particular nutrient will lead to increase in yield as compared to high productive tree which already have enough supply of nutrients for better yield. The importance of leaf nutrient contents for increase in fruit yield stands by the fact that a certain level of vegetative and reproductive growth is essential for optimum production, which is only attainable by supply of nutrients in adequate amount and proportion (Campbell and Bould, 1970). The significant and negative association of some nutrients especially Cu and Mn indicate that these nutrients are present in adequate to high range and further maybe counteracting the effect of other nutrients towards yield, because of an imbalance in nutrient ratios (Mamgain, 1990).

Location/Orchard		Macronutrients (%)					Micronutrients (ppm)				Yield (kg/tree)
		N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	
Jubbal-Kotkhai											
	1	2.15	0.18	1.57	1.67	0.39	355.1	32.27	7.52	108.13	103.20

	2	1.98	0.23	1.66	1.42	0.33	319.5	23.54	9.53	115.78	107.80
	3	2.08	0.22	1.52	1.48	0.37	288.2	27.63	8.02	122.56	140.50
	4	2.20	0.19	1.41	1.54	0.41	248.4	33.41	10.15	143.82	112.50
	5	1.82	0.20	1.50	1.47	0.32	295.8	30.35	8.85	132.95	127.30
	Mean	2.05	0.20	1.53	1.52	0.36	301.4	29.44	8.81	124.65	118.26
Karsog											
	1	1.98	0.17	1.68	1.37	0.18	335.3	40.27	8.97	66.68	117.80
	2	2.11	0.13	1.78	1.26	0.23	378.2	47.38	11.57	89.73	97.30
	3	1.89	0.15	1.52	1.19	0.25	312.1	39.42	15.78	72.12	85.70
	4	1.77	0.19	1.37	1.36	0.22	288.6	51.11	12.09	42.33	106.50
	5	1.93	0.16	1.66	1.41	0.24	325.4	44.17	10.12	82.18	112.10
	Mean	1.94	0.16	1.60	1.32	0.22	327.9	44.47	11.71	70.61	103.90
Kalpa											
	1	1.73	0.25	1.34	1.58	0.23	220.3	22.21	8.12	98.13	113.50
	2	1.89	0.20	1.18	1.78	0.18	232.2	28.37	11.13	123.73	127.30
	3	1.95	0.28	1.56	1.33	0.26	205.3	17.67	9.52	135.44	82.50
	4	2.17	0.24	1.42	1.31	0.30	186.8	25.32	10.11	112.59	108.30
	5	1.78	0.25	1.29	1.52	0.21	256.4	28.42	9.88	88.92	102.10
	Mean	1.90	0.24	1.36	1.50	0.24	220.2	24.40	9.74	111.76	106.70
Kotgarh											
	1	2.02	0.18	1.82	1.79	0.31	220.8	38.10	11.82	112.18	138.10
	2	2.31	0.22	1.78	1.83	0.33	188.9	41.25	9.15	148.68	143.50
	3	2.05	0.21	1.67	1.55	0.28	245.3	44.21	12.13	182.53	101.40
	4	2.11	0.17	1.75	1.48	0.35	213.5	33.78	8.48	164.87	103.10
	5	1.71	0.19	1.48	1.41	0.29	232.3	28.89	10.13	135.92	127.80
	Mean	2.04	0.19	1.70	1.61	0.31	220.1	37.25	10.34	148.84	122.80
Naggar											
	1	2.17	0.20	1.69	1.57	0.29	319.3	54.92	14.12	101.22	113.40
	2	1.86	0.22	1.74	1.66	0.31	309.8	61.01	8.96	148.15	152.20
	3	2.11	0.26	1.81	1.72	0.32	373.2	46.18	15.12	168.12	146.00
	4	1.89	0.18	1.66	1.61	0.26	274.4	57.01	11.15	154.13	127.50
	5	2.08	0.20	1.41	1.48	0.31	327.5	58.24	14.50	138.48	104.50
	Mean	2.02	0.21	1.66	1.61	0.30	320.9	55.47	12.77	142.02	128.70
Overall Range		1.71-2.31	0.13-0.28	1.18-1.82	1.19-1.83	0.18-0.41	186.8-378.2	17.67-61.01	7.52-15.78	42.33-182.53	82.50-152.20
Overall Mean		1.99	0.20	1.57	1.51	0.29	278.1	38.21	10.67	119.58	116.10
$CD_{0.05}$ Location		0.03	0.008	0.03	0.02	0.01	5.38	0.47	0.34	1.23	4.76
$CD_{0.05}$ Location x Orchard		0.06	0.02	0.05	0.04	0.02	11.32	1.06	0.76	2.83	10.65

Table 2. Leaf nutrient status of apple orchards diagnosed by Shear and Faust (1980) sufficiency range standards

Nutrient	Nutritional level (per cent orchards)		
	Low	Adequate	Excess
N	-	100	-

P	4	96	-
K	4	96	-
Ca	52	48	-
Mg	28	60	12
Fe	-	100	-
Zn	-	100	-
Cu	-	76	24
Mn	-	84	16

Table 3. Regression equations of yield (Y) on leaf nutrient contents at different locations

Location	Regression plane	Coefficient of determination (R^2)
Jubbal - Kotkhai	Y = -562..47 +103.14N* +127.12P +50.13K* +103.11Ca* +304.83Mg* +0.19Fe +1.98Zn* -6.48Cu* -0.94Mn* (45.12) (98.13) (21.09) (51.15) (121.11) (0.13) (1.09) (1.78) (0.19)	61.32
Karsog	Y = -161.07 -44.57N +268.32P +72.12K* -68.13Ca* +326.03Mg* +0.29Fe* +0.70Zn -I.68Cu -I.27Mn* (36.91) (151.23) (26.89) (28.94) (143.18) (0.11) (1.35) (1.60) (0.72)	57.33
Kalpa	Y = -182.11 -31.42N +271.11P** +31.52K +59.18Ca +371.58Mg* +0.35Fe* +2.53Zn** +3.12Cu -1.0IMn* (26.52) (193.21) (26.42) (37.12) (152.53) (0.15) (1.17) (1.57) (0.39)	60.35
Kotgarh	Y = -672.51 +98.75N* + 78.19P +111.53K** +111.08Ca** +126.13Mg +0.31Fe* -0.41Zn -2.32Cu -1.37Mn** (32.39) (36.59) (30.85) (39.89) (91.33) (0.15) (0.99) (1.12) (0.27)	54.43
Naggar	Y = -813.07 +88.24N* +171.28P +110.49K** +117.88Ca** +117.08Mg +0.27Fe +2.35Zn* +1.86Cu -0.73Mn* (27.23) (112.18) (30.85) (39.89) (80.53) (0.12) (0.93) (1.61) (0.17)	68.11

Values in the parenthesis are standard errors
* Significant at 5% level of significance
** Significant at I % level of significance

Table 4. Regression equations of yield (Y) on leaf nutrient contents of low & high productive trees

Yield group	Regression plane	Coefficient of determination (%)
Low productive population (<150 kg/tree)	Y = -124..3 +27.23N** +72.13P +56.58K** -11.12Ca +162.53Mg** +0.31Fe** +0.56Zn** -1.62Cu** -0.18Mn** (10.13) (36.59) (7.11) (6.91) (33.12) (0.03) (0.17) (0.73) (0.04)	29.50
High productive population (>150 kg/tree)	Y = 73.01 -6.86N +21.86P** -4.13K +2.02Ca +52.71Mg +0.05Fe -1.01Zn* -2.13Cu** -0.23Mn* (14.13) (76.77) (15.56) (11.12) (61.63) (0.07) (0.45) (0.88) (0.08)	22.51

Values in the parenthesis are standard errors
* Significant at 5% level of significance
** Significant at I % level of significance

CONCLUSION

The present survey included the major quality apple producing areas of Western Himalayas and provides an insight into the nutritional health of orchards. The orchards and locations varied significantly with respect to foliar nutrient status and yield. Although most of the orchards were diagnosed were optimal in foliar status of essential nutrients but there is a need to concentrate on fertilization of secondary nutrients Ca and Mg either by foliar sprays or more soil soluble amendments. The regression equations developed in the study can be used to predict yields on the basis of nutrient concentrations and can also be used to advise fertilizer schedule for apple orchardists of the area.

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Table 1: Foliar nutrient status of apple orchards at different locations.

ESTIMATION OF COMPONENTS OF GENETIC VARIANCE AND GRAPHICAL ANALYSIS IN FIELD PEA (*PISUM SATIVUM* (L.) VAR. *ARVENSE*)

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Received-07.06.2015, Revised-15.06.2015

Abstract: Genetic analysis was carried out by 8 x 8 diallel analysis (excluding reciprocals) of Field pea (Pisum sativum (L.) *var arvense*) genotypes. The results of t^2 test indicated the fulfillment of assumptions required under diallel analysis for all the characters under study except number of primary branches, grain yield (g) and harvest index (%). Narrow sense heritability was low for number of seeds per pod and most of the other trait except Days to 50% flowering and plant height which had moderate to high heritability. A higher proportion of dominant genes were observed in parent PRAKASH for affecting number of pods per plant. The parental line ADARSH was found having maximum recessive gene for increasing the protein content.

Keywords: Degree of dominance, Dialle, Fieldpea, Gene action

INTRODUCTION

For improving the genetic yield potential of the varieties and hybrids, choice of right type of parents for hybridization is important. The development of high yielding varieties with good processing quality is of immense importance. In case of grain legumes, it is not only the yield but quality parameters are also of prime concern for overcoming the protein malnutrition. Appreciable genetic diversity is the backbone of any successful hybrid/ variety development programme. The diallel analysis provides a systematic approach for identification of superior parents and crosses which is the basic material. Several reports in past have appeared which indicate that diallel analysis is the quickest method of understanding the genetic nature of quantitatively inherited traits and to ascertain the prepotency of parents. Kearsey (1965) noted that Hayman and Jinks' diallel analysis provide more information than other methods, but has more necessary assumptions. The analyses proposed by Griffing (1956a) do not provide any test to detect epistasis or linkage. Hayman and Jinks' analysis does provide such test, developed a graphical approach, using second order statistics for estimation of genetic components of variance in diallel crosses. When using Griffing's analysis to estimate variance components, it has been suggested that simple tests, such as the Wr-Vr evaluation found in Haymans' (1954b) model. The regression of array covariance (Wr) on array variance (Vr) provides geometric representation of the degree of dominance free from spurious dominance caused by non-allelic interactions.

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MATERIAL AND METHOD

The present investigation consisted of eight diverse parental lines of Field pea *[Pisum sativum (L.) var arvense]* and their twenty-eight F_1s (excluding reciprocals). The parental lines *viz*., DF-1, KPMR 400, VIKAS, PRAKASH, ADARSH, IPFD 10-13, NDP-1, APARNA were selected from germplasm maintained at Centre of Excellence for Research on pulses, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, District: Banaskantha, during *rabi*, 2012 to create a diallel set. The complete set of 36 genotypes comprising eight parental genotypes and 28 F_1's were evaluated in Randomized Block Design (RBD) with three replication. The seeds of 28 F_1 hybrids were produced by hand pollination. For male and female parents, self seeds were collected during the same season. The observations were recorded both as visual assessment (Days to 50% flowering, days to maturity) and measurement on randomly selected five competitive individual plants (plant height, number of primary branches per plant, number of pods per plant, number of seeds per pod, Grain yield per plant (g), test weight (g), protein content (%), harvest index (%).

RESULT AND DISCUSSION

The analysis of variance for parents and their hybrids for different characters revealed that the variances due to genotypes were highly significant for all the characters. This indicated the presence of considerable genotypic diversity for all the characters. The parents and hybrids variances were highly significant for all the traits. The variances due to parents vs. hybrids were significant for all the traits except for days to 50% flowering, days to

maturity and plant height indicated that F1's had heterotic effects (Table 1).

The non-significant t^2 value indicates that the additive-dominance model was adequate to explain the variation. The results of t^2 test indicated the fulfillment of assumptions required under diallel analysis for all the characters under study except number of primary branches, grain yield (g) and harvest index (%). Non-fulfillment of assumptions in these traits indicated the invalidity of the hypothesis of simple additive – dominance model of gene action and involvement of epistasis and/or linkage disequilibrium.

The estimates of D which measure the variance due to additive gene effects were significant for Days to 50% flowering, days to maturity, plant height, number of pods per plant, grain yield per plant (g) and test weight (g). Thus additive gene effects were significant for these characters. This was reflects in high heritability of Days to 50% flowering and plant height.

The H1, which measure the variance due to non-additive effects, was significant for all the characters. This clearly indicates the predominance of non-additive gene action for all the characters under study. The estimates of dominance ratio $(H1/D)^{0.5}$ greater than unity for all the traits indicating over dominance for all of the characters. Similar findings were reported by Kosev *et al*. (2013), Punia *et al*. (2013), Dalia and Naseef (2013) observed the similar findings for grain yield per plant.

The equal distribution of positive and negative genes in the parents helps the breeder in selecting particular desirable trait without loosing any other desirable traits. In the present study more or less symmetrical distribution of genes in the parental lines was observed for plant height, number of seeds per pod and test weight in present study as the value H2/4H1 was closer to 0.25. Mather and Jinks (1971) while discussing the short comings of numerical component analysis suggested that $(H1/D)^{0.5}$ at each locus is true for major degree of dominance only, where the distribution of dominance and recessive genes is symmetrical. Asymmetrical distribution of genes for may influence of over estimation of mean degree of dominance.

The values of component KD/KR indicated unequal frequency of dominant and recessive genes with higher frequency of dominant genes for all the characters studied except number of seeds per pod. Knowledge of number of genes/group of genes responsible for particular traits is important for the genetic progress through selection. The value h_2/H_2 indicated at least one group of gene was operating for all the traits of present study. Estimated narrow sense heritability was low for number of seeds per pod and most of the other trait except Days to 50% flowering and plant height which had moderate to high heritability.

The correlation between parental order of dominance (Vr + Wr) and parental mean (Yi) was positive and significant for number of pods per plant which indicated involvement of recessive alleles for increasing the mean values. Thus, recessive genes were responsible for increasing number of pods per plant. For number of seeds per pod the correlation was negative indicating role of dominant genes for increasing mean values.

The regression of Wr on Vr was desirable and near unity for number of pods per plant validity of simple additive-dominance hypothesis of gene action for this character. Whereas significant t^2 value for number of primary branches, grain yield (g) and harvest index (%) leads to failure of hypothesis for these characters. The graphical presentations for these traits were therefore not attempted.

In graphical analysis the regression line intercepted Wr axes below the origin indicated over dominance for all the characters. The wide scattering of parental array points along the regression line in the Wr-Vr graph for Days to 50% flowering, days to maturity and protein content indicated considerable genetic diversity among the parents for these traits. In graphical analysis, a higher proportion of dominant genes were observed in parent PRAKASH for affecting number of pods per plant. The parental line ADARSH was found having maximum recessive gene for increasing the protein content (Table:2).

Table 1. Analysis of variance (mean squares) for parents and hybrids for different characters in fieldpea

Source of variation	d.f.	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of primary branches per plant	Number of pods per plant	Number of seeds per pod	Grain yield per plant (g)	Test weight (g)	Protein content (%)	Harvest index (%)
Replications	2	6.75	29.06	127.92	0.1	4.33	0.29	1.99	0.91	0.36	4.40
Genotypes	35	61.61**	105.36**	5613.5**	1.49**	523.96**	4.29**	256.38**	7.78**	2.72**	328.15**

Parents	7	49.08**	139.59**	5335.9**	0.54**	378.31**	0.55**	148.27**	7.87**	2.79**	142.30**
Hybrids	27	67.14**	99.98 **	5891.9**	1.76**	501.34**	5.28**	252.95**	7.94**	2.42**	366.74**
Parents vs. Hybrids	1	0.14	10.83	40.89	0.82**	2154.2**	3.78**	1105.6**	2.93*	10.21**	587.10**
Error	70	3.26	13.35	69.36	0.06	11.26	0.18	4.94	0.48	0.17	7.51

Table 2. Estimation of genetic component of variance and other parameters for various characters in Fieldpea

	Parameters	**Days to 50% flowering**	**Days to maturity**	**Plant height (cm)**	**Number of primary branches per plant**	**Number of pods per plant**	**Number of seeds per pod**	**Grain yield per plant (g)**	**Test weight (g)**	**Protein content (%)**	**Harvest index (%)**
1	b (Wr, Vr)	0.10	0.19	0.22	0.32	0.80	-0.03	0.47	0.12	0.12	0.12
2	t_{b-0}	-0.37	-0.58	-1.08	-2.06	-2.97*	0.14	-4.13**	-0.59	-0.55	-1.74
3	t_{1-b}	3.08*	2.43*	3.71*	4.24**	0.72	4.37*	4.65**	4.05**	3.97**	12.35**
4	t^2	0.70	0.20	2.72	5.47*	0.023	1.97	9.48**	2.68	2.45	45.23**
5	D	15.24*	41.93**	1754.94*	-	122.41*	0.12	-	2.45*	0.87	-
6	H_1	85.31**	125.72**	4717.07*	-	676.96**	6.09**	-	11.10**	3.86*	-
7	H_2	44.33*	69.13*	4122.08*	-	506.69**	5.80**	-	9.25**	2.98*	-
8	F	32.53*	62.78*	207.76	-	167.97*	-0.10	-	3.33	1.38	-
9	h^2	-0.46	-0.23	-3.64	-	351.82**	0.59	-	0.40	1.64*	-
10	E	1.12	4.59	23.66	-	3.69	0.06	-	0.16	0.05	-
11	$(H_1/D)^{0.5}$	2.36	1.73	1.63	-	2.35	7.10	-	2.12	2.10	-
12	$H_2/4H_1$	0.13	0.13	0.21	-	0.18	0.23	-	0.20	0.19	-
13	KD/KR	2.64	2.52	1.07	-	1.82	0.88	-	1.93	2.21	-
14	h^2/H_2	-0.01	-0.003	-0.001	-	0.69	0.10	-	0.04	0.55	-
15	r(P, Wr +Vr)	0.15	0.23	0.40	-	0.77*	-0.05	-	0.23	0.22	-
16	Heritability	0.49	0.45	0.50	-	0.32	0.14	-	0.16	0.18	-

* and ** indicates significant at P = 0.05 and P = 0.01 levels, respectively.

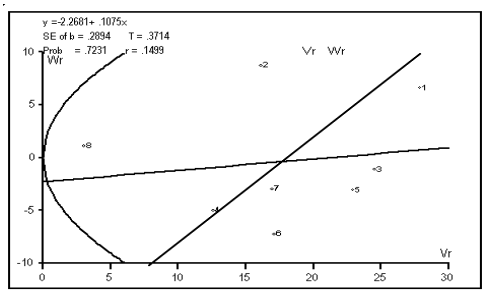

Fig 1. Wr, Vr graph for days to 50% flowering

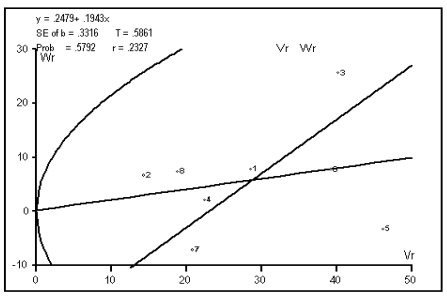

Fig 2. Wr, Vr graph for days to maturity

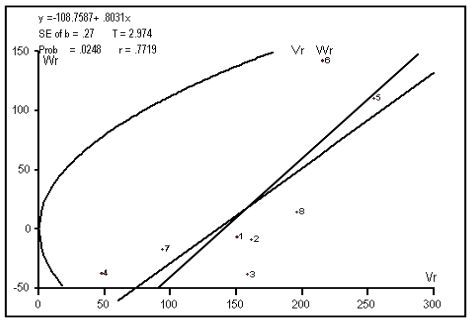

Fig 3. Wr, Vr graph for number of pods per plant

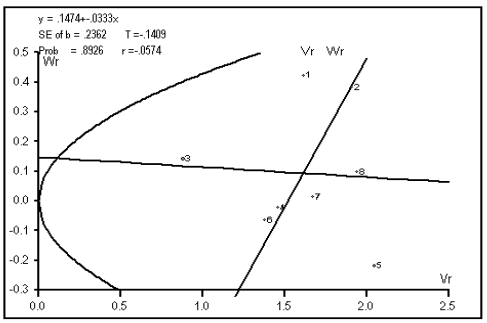

Fig 4. Wr, Vr graph for number of seeds per pod

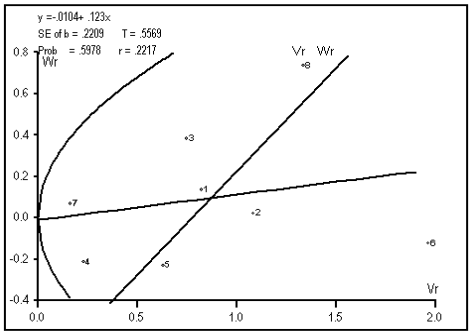

Fig 5. Wr, Vr graph for protein content (%)

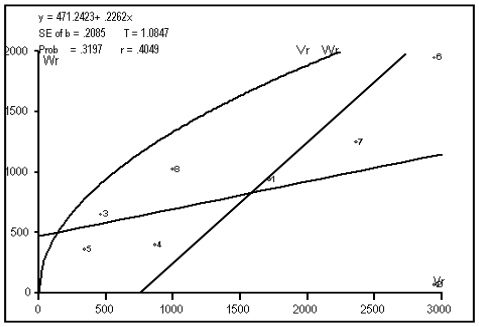

Fig 6. Wr, Vr graph for plant height (cm)

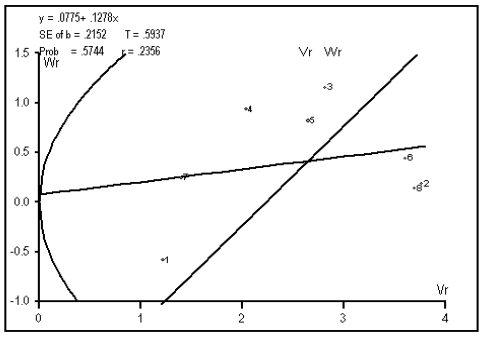

Fig 7. Wr, Vr graph for test weight (g)

Where,

1= DF-1
2 = KPMR 400
3 = VIKAS
4 = PRAKASH
5 = ADARSH
6 = IPFD 10-13
7 = NDP-1
8 = APARNA

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MANAGEMENT STUDIES ON TOMATO DAMPING-OFF WITH NATIVE ANTAGONISTS

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Received-12.06.2015, Revised-20.06.2015

Abstract: Plant disease management with bio agents is a non chemical and environmental safe method in agriculture**.** Tomato damping-off caused by *Pythium aphanidermatum* (Edson) Fitz. is one of the most dreadful diseases. Six isolates of *P. aphanidermatum* were collected from tomato nurseries of different geographical areas in Andhra Pradesh and designated as CTR_1, CTR_2, KDP_1, KDP_2, KNL_1 and KNL_2. Native *Trichoderma harzianum* and *Pseudomonas fluorescens* were isolated from tomato rhizosphere using selective media. These two native bioagents were identified upto species level based on morphological characters. Among the two native antagonists, *T. harzianum* recorded maximum per cent inhibition on all isolates of *P. aphanidermatum*. Maximum inhibition was observed in CTR_2 when *T. harzianum* was used while *P. fluorescens* recorded maximum inhibition on KDP_2 *in vitro*. *In vivo* studies revealed that seed treatment with combination of *T. harzianum* and *P. fluorescens* was found to be effective in controlling pre and post-emergence damping-off.

Keywords: *T. harzianum; P. fluorescens;* Tomato Damping – off; *P. aphanidermatum*

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is the most versatile vegetable crop grown in almost all the countries. There are over 20 diseases of tomato reported either in nursery, on the standing crop or during post harvest activities. Among these, damping-off caused by *Pythium aphanidermatum* (Edson) Fitz. is one of the most dreadful diseases and is particularly severe in densely crowded nurseries. The disease was quite severe killing 10-15% of the tomato seedlings in nurseries (Govindappa and Grewal, 1965). The ubiquitous fungus, *P. aphanidermatum* was more common in both summer and winter grown tomato nurseries, causing losses to an extent of 50 per cent (Bisht *et al.*, 1997). Since this disease mostly affects nursery, proper management at nursery stage is very critical to ensure a healthy crop in the main field. Any negligence in the management of this disease at juncture, may jeopardise the cultivation of tomato crop totally as it literally wipes out the entire nursery. Crop losses inflicted by soil-borne pathogens continue to increase and become a limiting factor in stabilising or maximising crop yields on a world-wide basis.

The control measures available today including fungicides are not enough to the realistic elimination of soil-borne plant pathogens. The ill effects of escalated use of potentially hazardous pesticides like environmental pollution, increased cost of application and pathogen resistance lead to a drastic shift in the management strategies towards biological control of plant pathogens as an alternative to or as a part of IPM system for disease control (Baker and Snyder, 1965). These biocontrol methods can be successfully used in modern agriculture, especially with the native antagonists. Chemical seed treatment can protect the crop only at the early stage of its growth. Antagonists applied to seeds were found to colonize the rhizosphere and offer protection against soil borne pathogens (Muthamilan, 1989; Selvarajan, 1990; Turner and Backman, 1991).

Hence there is a need to screen *Trichoderma* and *Pseudomonas* populations of rhizosphere soil of tomato to identify effective ones against the test pathogen.

MATERIAL AND METHOD

Isolation of soil microflora: The soil microflora was isolated by serial dilution pour plate technique (Johnson and Curl, 1972) using selective media. *Trichoderma* spp. were isolated on *Trichoderma* selective medium (Elad and Chet, 1983) while *P. fluorescens* was isolated on King's B selective medium. The dilution used for isolation of *Trichoderma* spp was 10^{-4} and for *P. fluorescens* was 10^{-6}.

Trichoderma spp. were identified based on mycological keys described by Barnett and Hunter (1972), whereas *P. fluorescens* was identified based on Bergey's manual of determinative bacteriology (Holt *et al.*, 2000). *Trichoderma* spp. were maintained on PDA and *P. fluorescens* was maintained on nutrient agar medium by periodical transfer.

***In vitro* screening:** Dual culture technique was used to screen *Trichoderma* spp. and *P. fluorescens* against all the six isolates of *P. aphanidermatum*, *Trichoderma* and *P. fluorescens* were screened

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following the procedures of Khara and Hadwan, 1990; Vidhyasekaran *et al.,* (1997).

Three replications were maintained per treatment. The plates were incubated at 28 ± 2°C for 4 days and the zone of inhibition was measured. The per cent inhibition was calculated by using the following formula.

$$\% \text{ inhibition of } P. \text{ } aphanidermatum = \frac{\text{Growth of } P. \text{ } aphanidermatum \text{ in control plate} - \text{Growth of } P. \text{ } aphanidermatum \text{ in the presence of bio-agent}}{\text{Growth of } P. \text{ } aphanidermatum \text{ in control plate}} \times 100$$

Pot culture studies: The potential native antagonists were screened alone and in combination under glasshouse conditions against damping-off disease. 15 cm diameter pots were filled with 2 kg of sterilized soil. The virulent strain of *P. aphanidermatum* obtained was mass multiplied on the sorghum grains for 15 days. The multiplied inoculum was mixed with sterilized potting medium @ 100 g/ kg of soil. Then the pots were watered to activate the growth of the pathogen. After 2 days, tomato seeds treated with *Trichoderma* and *P. fluorescens* were sown @ 25 seeds per pot. Metalaxyl as seed treatment @ 6 g/kg of seed was included as a standard treatment for comparision. Pre-emergence and post-emergence damping-off disease incidence were recorded at 7 days and 25 days respectively after sowing.

The following treatments were imposed

T_1 - Seed treatment with *T. harzianum*-1 (T_1)
T_2 - Seed treatment with *P. fluorescens*
T_3 - Combination of ($T_1 + T_2$)
T_4 - Seed treatment with metalaxyl @ 6 g/kg
T_5 - Pathogen inoculated (control)
T_6 - Pathogen un-inoculated (control)

The *T. harzianum* were applied by the seed treatment method described by Syamasundar Reddy (1999). *P. fluorescens* was applied following the procedure given by Ramamoorthy *et al.* (2002). Seed treated with metalaxyl (ridomil MZ 72% WP) @ 6 g/kg of seeds included as a standard treatment for comparison.

Per cent disease incidence (PDI) was calculated using the following formula.

$$PDI = \frac{\text{Total no. of seeds sown - Healthy seedlings}}{\text{Total no. of seeds sown}} \times 100$$

RESULT AND DISCUSSION

Six isolates of *P. aphanidermatum* isolated from the infected tomato plants were identified and maintained on PDA medium. These isolates were proved to cause damping-off of tomato as it could be reisolated from infected seedlings in the pathogenicity test.

In the present study, *T. harzianum* and *P. fluorescens* were isolated from tomato rhizosphere using selective media. These antagonists were identified upto species level based on morphological characters (Subramanian, 1971).

T. harzianum and *P. fluorescens* were screened against all isolates of *P. aphanidermatum*. Among the two antagonists, *T. harzianum* recorded maximum per cent inhibition compared to *P. fluorescens* on all isolates of the pathogen. Among the six isolates of *P. aphanidermatum*, CTR_2 was more sensitive to *T. harzianum* and CTR_1 was less sensitive. In case of *P. fluorescens*, KDP_2 was more sensitive, while the isolate CTR_1 was found to be the least sensitive. The results indicate that *T. harzianum* is a destructive mycoparasite on *P. aphanidermatum* isolates (Table 1). This could be due to coiling of *Trichoderma* around the hyphae of *Pythium* isolate, CTR_2 while less penetration in other isolates. Similar observations were made by Vijaya Krishna Kumar (1997) who isolated different rhizosphere mycoflora from tomato plants and tested them against *P. aphanidermatum*. Among them *T. harzianum* was found to be more effective. *In vitro* screening of *T. harzianum* and *P. fluorescens* also reported by Swant and Mukhopadhyay (1990); Pratibha Sharma *et al.* (2003); Ongena *et al.,* 1999 and Ramamoorthy *et al.* (2002).

In vivo studies revealed that pre and post-emergence damping-off was less in the treatments having seed treatment with *T. harzianum* and *P. fluorescens* individually and in combination. Seed treatment with Ridomil MZ also controlled pre and post-emergence damping off. Among all the treatments, seed treatment with combination of *T. harzianum* and *P. fluorescens* was effective and recorded the least incidence in pre and post - emergence damping-off disease (Table 2).

The effectiveness of *T. harzianum* as seed treatment for the control of pre & post emergence damping-off caused by *Pythium* was reported by several workers (Krishna Moorthy and Bhaskaran (1990); Rama moorthy, *et al.,* (2002); Rahman *et al.,* 2003). The use of antagonistic microflora identified in this study offer a cheaper and environmentally safer alternative to the use of fungicides for seed treatment.

Table 1. Efficacy of antagonists against *P. aphanidermatum* isolates by dual culture technique

Soil microflora	Isolates of *P. aphanidermatum*											
	CTR_1		CTR_2		KDP_1		KDP_2		KNL_1		KNL_2	
	*Fungal growth (mm)	*% inhibition	Fungal growth (mm)	% inhibition	Fungal growth (mm)	% inhibition	Fungal growth (mm)	% inhibition	Fungal growth (mm)	% inhibition	Fungal growth (mm)	% inhibition
Trichoderma harzianum isolate-1	27.0	69.2 (56.3)	10.3	88.5 (70.2)	18.1	79.8 (63.3)	12.6	86.0	15.5	82.7 (65.4)	24.2	73.1 (58.7)
P. fluorescens	28.8	67.9 (55.1)	13.5	85.0 (67.2)	19.8	77.9 (61.9)	11.6	87.1 (68.9)	16.8	81.3 (64.4)	25.2	72.0 (58.0)
Control	90.0	0.00 (0.00)	90.0	0.00 (0.00)	90.0	0.00 (0.00)	90.0	0.00 (0.00)	90.0	0.00 (0.00)	90.0	0.00 (0.00)
SEm (±)		1.92		0.48		0.77		0.61		0.79		0.57
CD (5%)		6.63		1.66		2.66		2.13		2.74		1.96

* Mean of three replications
Figures in parentheses are angular transformed values

Table 2. Effect of different treatments on pre and post - emergence damping - off at 7 and 25 days after sowing (DAS)

Treatments		*Pre-emergence (7 DAS) damping-off		*Post-emergence (25 DAS) damping-off	
		(Per cent disease incidence)	Per cent inhibition over control	(Per cent disease incidence)	Per cent inhibition over control
T_1	Seed treatment with *T. harzianum*	9.2 (17.6)	62.2 (52.0)	30.5 (33.5)	54.3 (47.4)
T_2	Seed treatment with *P. fluorescens*	10.0 (18.4)	59.1 (50.24)	36.2 (36.9)	45.8 (42.5)
T_3	Seed treatment with combination of *T. harzianum* and *P. fluorescens*	5.7 (13.8)	76.5 (61.0)	19.3 (26.0)	71.1 (57.4)
T_4	Seed treatment with Metalaxyl (6 gm/kg)	9.0 (17.4)	63.2 (52.6)	26.0 (30.6)	61.0 (51.3)
T_5	Pathogen inoculated control	24.5 (29.6)	0.0 (0.0)	66.8 (54.8)	0.00 (0.0)
T_6	Pathogen un-inoculated control	0.0 (0.0)	100.0 (90.0)	0.00 (0.00	100.0 (90.0)
	SEm (±)	0.16	-	0.20	-
	CD at 5%	0.48	-	0.62	-

* Mean of three replications
Figures in parentheses are angular transformed values

ACKNOWLEDGEMENT

The authors are grateful to Acharya N.G. Ranga Agricultural University, Hyderabad for the financial assistance.

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HONEYBEE – A NATRUAL POLLINATOR IN INCREASING THE SEED YIELD AND INCOME IN THE NIGER (*GUIZOTIA ABYSSINICA* CASS) A TRADITIONAL TRIBAL CROP OF SOUTH GUJARAT REGION

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Received-11.05.2015, Revised-18.05.2015

Abstract: Niger (*Guizotia abyssinica* Cass) is one of the important minor oilseed crop of hilly regions and it is used for oil purpose only by the tribal people. Therefore a study was planned to document about the role of honeybees as a pollinator in increasing the seed yield in Niger crop with paired plot technique at the Niger Research Station (NRS) at Navsari Agricultural University (NAU) and at farmer's field, Vanarasi, Navsari, Gujarat and also studied its cost benefit ratio (CB) of Niger cultivar. The trial was conducted at Niger Research Station (NRS), Vanarasi in 2014-15 and at farmer's field to ascertain the involvement of honey bees (*Aphis mellifera*) in escalating the seed yield of Niger crop (Due to pollination) and its effect on income due to increase in the Niger seed yield. Significant differences were observed for number of capitula/plant, number of seeds/capitula, 1000 seed weight and seed yield in both the location. However, the seed yield and gross returns were considerably higher in first location of T1 Natural plot/ open pollinated with Bee hive (*Aphis mellifera)*. The maximum seed yield of 275 Kg/ha with the gross return of Rs. 16,500/- was obtained in this treatment.

Keywords: Niger, Honeybee, *Aphis mellifera*, Pollination

INTRODUCTION

Niger (*Guizotia abyssinica* Cass) is a tribal crop and is one of the most important minor oilseed crops of India. Niger having many names but the most commonly as *ramtil*, *jagni* or *jatangi* (Hindi), *ramtal* (Gujarati), *karale* or *khurasani* (Marathi), *uhechellu* (Kannada), *payellu* (Tamil), *verrinuvvulu* (Telgu), *alashi* (Oriya), *sarguza* (Bengali), *ramtil* (Punjab) and *sorguja* (Assamese) in various parts of the country (Rao and Ranganatha, 1989). The natural habitat is disturbed for many reasons and the vegetation cover is declining now a day's worldwide (Kearns *et al* .,1998). Agriculture plays a role in declining native pollinators through the modification and elimination of pollinator habitats and the use of agricultural chemicals including (pesticides, herbicides and fertilizers) (Donaldson, 2002). Free, 1993 stated that clean and intensive cultivation of land may affect wild insect pollinators. He mentioned practices such as destruction of hedgerows and rough verges, which destroyed many natural food sources and nesting sites of wild pollinating insects. Generally, it has been concluded that habitat degradation, pesticide misuse, diseases and intensive cultivation of lands may be the causes of decline in managed honeybees and wild pollinators (Gallai *et al.*, 2009). At present, it is grown in the area of about 1.8 lakh ha. (Duhoon, 2001). In addition, it is cultivated to limited extend in Ethiopia, South Africa, West Indies, Zimbabve and India. In India, it is mainly cultivated in tribal pocket of M.P., Orissa, Maharashtra, Bihar, Karnataka and Andhra Pradesh. It is also grown sizeable area in certain region of Arunachal Pradesh, Gujarat, U.P., Tamil Nadu and Rajasthan. Niger although considered as a minor oilseed, is very important in terms of quality and taste of its oil and export potential (Rajpurohit, 2011). Honeybee pollinators are estimated to be involved in producing up to 30 % of the human food supply directly or indirectly; farmers rely on managed honeybees throughout the world to provide these services (Greenleaf and Kremen, 2006). Honeybees are responsible for 70-80% of insect pollination (Johannsmeier and Mostert, 2001). The contribution of managed honeybee pollination to crop production and quality has been estimated to be more than the value of honey and wax production (Shrestha, 2004). Looking on significance in terms of oil extraction, which having high medicinal values but knowledge of the diseases of this Niger crop merits attention, Niger is a crop of dry areas grown mostly by tribal in interior places due to which desired attention has not been given on the biotic and abiotic stresses. Now the crop is gaining importance and studies are being made on to ascertain there is tremendous contribution of honey bees (*Aphis mellifera*) and many other insects, flies and butterflies in increasing the seed yield of Niger crop at the time of flowering (due to pollination) and its ultimately maximizes the income of farmers due to seed yield increase. Therefore a study was planned to document about the role of honeybees as a pollinator in increasing the seed yield in Niger crop with paired plot technique at the Niger Research Station (NRS) at Navsari Agricultural University (NAU) and at farmer's field, Vanarasi, Navsari, Gujarat and also studied its cost benefit ratio (CB) of the Niger cultivar.

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MATERIAL AND METHOD

Objective	**:**	To ascertain the contribution of Italian bee (*Apis mellifera*) in increasing the seed yield of crop
Location	**:**	Niger Research Station (NRS) and at farmer's field
Year of commencement	**:**	*Kharif*, 2014
Experimental details		
Treatment	**:**	01
Design	**:**	Pair Plot Technique
Replication	**:**	Non replicated
Plot size (Net) in meter	**:**	20 x 10 m
Spacing	**:**	-
Fertilizer NPK kg/ha	**:**	20:20:00
Date of sowing	**:**	08.08.2014
Date of Irrigation	**:**	30.09.2014
Date of harvesting	**:**	01.12.2014
No. of Weedings with dates	**:**	Two weedings 03.09.2014 & 12.10.2014
Previous crop	**:**	Fallow
Plant Protection measures adopted	**:**	-
Result	**:**	Table: 1

In addition, the research described in this AICRP project aimed to improve the understandings of the use of honeybee colonies in Niger cultivated crop pollination. The findings of this will therefore contribute to the definition of general guidelines to maintain or improve Niger crop pollination.

RESULT AND DISCUSSION

It is now apparent that most of the pulses and oilseeds, fruits and orchard crops including vegetables heavily depend on bees for their pollination. This is also true for seed production of vegetables like onion, cabbage, cauliflower, tabacco, sunnhemp, alfa alfa and clovers (http://agritech.tnau.ac.in/farm_enterprises/fe_api_beefloraapollin.html). The number of colonies of honeybees required per hectare very much depends on the strength of foraging bees in the colony, the crops and prevailing weather conditions.

Significant differences were observed for number of capitula/plant, number of seeds/capitula, 1000 seed weight and seed yield in both the location. However, the seed yield and gross returns were considerably higher in first location of T1 Natural plot/ open pollinated with Bee hive (*Aphis mellifera)*. The maximum seed yield of 275 Kg/ha with the gross return of Rs. 16,500/- was obtained in this treatment. (Table: 1).

Qualities of honeybees, which make them good pollinators

- Body covered with hairs and has structural adaptation for carrying nectar and pollen.
- Bees do not injure the plants
- Adult and larva feed on nectar and pollen which is available in plenty
- Considered as superior pollinators, since store pollen and nectar for future use
- No diapauses is observed and needs pollen throughout the year
- Pollinate wide variety of crops
- Forage in extreme weather conditions

Management of bees for pollination

- Place hives very near the field source to save bee's energy
- Migrate colonies near field at 10 per cent flowering
- Place colonies at 3/ha for Italian bee and 5/ha for Indian honey bee
- The colonies should have 5 to 6 frame strength of bees, with sealed brood and young mated queen
- Allow sufficient space for pollen and honey storage

Table 1. Cost Benefit Ratio (CBR)

	Treatment	No. of Capitula/ Pl.	No. of Seeds/ Capitula	1000 Seed Weight (gm)	Seed Yield (Kg/ha)	Gross Returns (Rs.)	Cost of Cultivation	Net Income (Rs.)	BC Ratio
1st Location (NRS)	**T1 Natural plot/ open pollinated with Bee hive (Uncovered)**	**22**	**21**	**4.10**	**275**	**16500**	**9538**	**6962**	**1.72**
	T2 Covered plot with bee hive (Covered)	18	16	4.00	238	14280	10538	3742	1.35
2nd Location (Farmers Field)	**T1 Open pollinated without bee hive**	15	13	3.85	175	10500	7038	3462	1.49
	T2 Covered plot with bee hive (Covered)	17	14	3.95	225	13500	10538	2962	1.28

- Cost of Niger seed calculated Rs. 6000 per Quintal
- Cost of honey not included

Steffan-Dewenter and Tscharntke (1999) found that isolation from natural habitats diminishes abundance and species richness of bees, which are the most important flower-visiting insects. Honeybees were by far the most frequently recorded insects on onion flowers. The high proportion of honeybees compared to other insects visiting the flowers indicated that honeybees were the major pollinators of the onion crop at our field site, with both honeybee abundance and seed yield and quality increasing proportionally. Simiraly, Yucel and Duman (2005) reported that the germination rate was greater on average by 12% in onion with honeybee activity.

Activity of Honeybee & other pollinators in Niger crop





CONCLUSION

Insect pollinators such as honeybees increased the Niger seed yield and quality and also cost benefit ratio.

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EFFECT OF AUXIN AND SIMULATED ACID RAIN ON THE SULPHUR CONTENT IN THE LEAVES OF *CAPSICUM FRUTESCENS* VAR. *SWEET MAGIC*

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Received-16.06.2015, Revised-23.06.2015

Abstract: Sulphur compounds of plant as well as of animal origin are of immense medicinal interest as they cure a number of ailments. For instance , thiazoles are antibiotic (e.g. Penicillin) , anti-microbial (e.g. Sulphathiazoles). They are vitality factors (for instance, Vitamin – B_1) & act on central nervous system besides other functions. Compounds of plant origin are safer in comparison to synthetic compounds. Therefore, we planned to enhance sulphur contents in the plants of Capsicum. For this purpose *Capsicum frutescens* var. *sweet magic* was treated with simulated acid rain of the pH 3.0 , 4.0 & 5.0 ; auxin (indole acetic acid) solutions of 1.0 x 10^{-5} , 1.0 x 10^{-6} & 1.0 x 10^{-7} M concentrations as well as interactive effects of pH – auxin binary solutions of different combinations (3.0 + 1.0 x 10^{-5} M , 3.0 + 1.0 x 10^{-6} M , 3.0 + 1.0 $^{-7}$ M ; 4.0 + 1.0 x 10^{-5} M , 4.0 + 1.0 x 10^{-6} M , 4.0 + 1.0 x 10^{-7} M & 5.0 + 1.0 x 10^{-5} M , 5.0 + 1.0 x 10^{-6} M , 5.0 + 1.0 x 10^{-7} M) & their effect on the sulphur contents of leaves of *Capsicum frutescens* var. sweet magic were studied . Best pH for sulphur content is 3.0 [sulphur content at 60th day = 155.86 % of control] & best auxin concentration is 1.0 x 10^{-5} M[sulphur content = 141.77 % of control at 45th day] . Best combination of pH & auxin is 3.0 + 1.0 x 10^{-6} M [sulphur content = 198.85 % of control at 60th day] . Moreover , acid rain & auxin assist each other towards enhancement of sulphur content in leaves.

Keywords: *Capsicum Frutescens* var. *sweet magic*, Simulated acid rain (SAR), Auxin (indole acetic acid)

INTRODUCTION

Capsicum frutescens L. is a small shrub of family Solanaceae. It is an annual or short lived pungent perennial plant (Chopra *et al.* 1956). *Capsicum frutescens* is native of South or Central America and is believed to have been introduced in India in the middle of seventeenth century in Shimla hills . This plant is a much branched shrub, 3-4 ft. in height. *Capsicum frutescens* is of therapeutic value also. Its fruit causes burning sensation and increase in appetite. It is useful in indigestion, diarrhoea, chronic ulcers, loss of consciousness and delirium & it's juice is antimicrobial, useful in backache, stomach ache, chest trouble and cough etc. Capsicum is of great nutritive value as it contains protein, carbohydrates and ascorbic acid. Besides vitamin-A (thiamin chloride hydrochloride) some minerals are also present . Sulphur contents in plants are due to the presence of sulphur containing compounds like vitamin-A, amino acids like cysteine , cystine , methonine , biotin etc. which may be responsible for curative effect of *Capsicum frutescens* . Acid rain has multiferous effects. It has direct as well as indirect effects on organisms as it comes in contact with. When deposited in gaseous form, it causes direct damage to plants in the form of visual injury along with yellowing and tissue depigmentation known as chlorosis (Sharma, B.K., 2001). Acid precipitation affects terrestrial vegetation due to reduced rate of photosynthesis and growth (Cohen et.al.,1981), as well as increased vunerability to drought and disease. Present work is done on the *Capsicum frutescens* L.var. *sweet magic* . Effects of simulated acid rain (pH3.0, 4.0 and 5.0) and (1x10^{-5} M, 1x10^{-6} M and 1x10^{-7} M) Auxin solution and interactive effect of acid rain and Auxin (pH3.0+1x10^{-5} M, 3.0+1x10^{-6} M, 3.0+1x10^{-7} M), (pH4.0+1x10^{-5} M, 4.0+1x10^{-6} M, 4.0+1x10^{-7} M) and (pH5.0+1x10^{-5} M, 5.0+1x10^{-6} M, 5.0+1x10^{-7} M) have been studied on sulphur contents in leaves .

MATERIAL AND METHOD

Simulated acid rain of different grades of pH (3.0, 4.0, 5.0) were prepared with the help of electronic pH meter by adding mixture of H_2SO_4 and HNO_3 in ratio of 7:3 (v/v) in distilled water (Lee, J.J.,1981).
The molar solution of Auxin (IAA) (10 $^{-4}$ Molar) were prepared by dissolving 17.5 mg Auxin in 1000 ml of distilled water. Thereafter, dilution was done as required for preparing the solutions of 1x 10^{-5}, 1x10^{-6}, 1x10^{-7} M concentration of Auxin.
For the study of sulphur content in the leaves of *Capsicum frutescens* var. *sweet magic* certified seeds were sown in the soil. Besides the regular watering to plants the setwise treatment which was given to plant is detailed below in Table-A.

Table A.

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Sr. No	Set No	Treatment	Periodicity
1	1st set	Control- Water (pH6.0)	10 ml spayed twice a week
2	2nd set	Acid rain - pH 3.0	10 ml sprayed twice a week
3	3rd set	Acid rain - pH 4.0	10 ml sprayed twice a week
4	4th set	Acid rain - pH 5.0	10 ml sprayed twice a week
5	5th set	$1x10^{-5}$ M Auxin	10 ml sprayed twice a week
6	6th set	$1x10^{-6}$ M Auxin	10 ml sprayed twice a week
7	7th set	$1x10^{-7}$ M Auxin	10 ml sprayed twice a week
8	8th set	Acid rain + Auxin (pH 3.0 + $1x10^{-5}$M)	10-10 ml each sprayed twice a week
9	9th set	Acid rain + Auxin (pH 3.0 + $1x10^{-6}$M)	10-10 ml each sprayed twice a week
s10	10th set	Acid rain + Auxin (pH 3.0 + $1x10^{-7}$M)	10-10 ml each sprayed twice a week
11	11th set	Acid rain + Auxin (pH 4.0 + $1x10^{-5}$M)	10-10 ml each sprayed twice a week
12	12th set	Acid rain + Auxin (pH 4.0 + $1x10^{-6}$M)	10-10 ml each sprayed twice a week
13	13th set	Acid rain + Auxin (pH 4.0 + $1x10^{-7}$M)	10-10 ml each sprayed twice a week
14	14th set	Acid rain + Auxin (pH 5.0 + $1x10^{-5}$M)	10-10 ml each sprayed twice a week
15	15th set	Acid rain + Auxin (pH 5.0 + $1x10^{-6}$M)	10-10 ml each sprayed twice a week
16	16th set	Acid rain + Auxin (pH 5.0 + $1x10^{-7}$M)	10-10 ml each sprayed twice a week

Estimation of Sulphur

Quantification of sulphur was done by turbiditory method as according to C.C.Mitchell (1992). 100 mg dried and finely powdered leaves were taken in 100 ml borosil beaker. 2 ml concentrated HNO_3 was added in it and each of the beaker covered with watch glass and allowed to stand over- night or till frothing subsides. Covered beakers were placed on hot plate at 125^0c for one hour. After one hour removed the beaker from hot plate and cooled. Added 1 ml of 30% H_2SO_4 and digested at the same temperature. Heated and added H_2O_2 till digest is clear. After the digestion of sample, removed watch glass and evaporated to dryness at 80^0C (residue should be colourless or white). Now added dilute HNO_3 or HCl or a combination of two and also added deionised water to dissolve the residue and make up the volume depending upon requirement of analytical procedure .Now, kept the solution in eppendorf tubes and centrifuged at 3000 rpm for 15 minutes. 1ml of each standard and digested sample is taken in test tubes. Added 22 ml AcOH – H_3PO_4 solution and mixed on stirrer. Added 0.5ml of $BaSO_4$ seed suspension, 1ml of $BaCl_2$ solution and mixed each tube exactly for same length of time on a vertex. Added 1 ml of gum acacia solution and mixed again.

Allowed to stand for 30 minutes. Mixed each sample uniformly just prior to reading absorbance or transmittance on a spectrophotometer set at 440 nm wave length. The amount of sulphur is calculated with the help of calibration curve.

RESULT AND DISCUSSION

Effect of simulated acid rain of different concentrations (pH 3.0, 4.0 and 5.0) on sulphur content in the leaves of *Capsicum frutescens* var. '*Sweet magic* is shown in Table-1. When the treatment of pH 3.0 is given, sulphur content is 117.80%, 155.86%, 132.18%, 121.43% and 97.48% of control at the age of 45, 60, 75, 90 and 105 days respectively. At pH 4.0, the sulphur is 76.59%, 57.47%, 73.68%, 66.58%, 57.47% of control, and sulphur content is 91.77%, 101.38%, 116.63%, 100.35% and 88.10% of control at pH 5.0 concentration at plant age of 45, 60,75,90 and 105 days respectively.

Table-2 shows the effect of treatment of $1x10^{-5}$, $1x10^{-6}$, $1x10^{-7}$ M auxin on sulphur content in the leaves of *Capsicum frutescens* var. *Sweet magic*. When the treatment of $1x10^{-5}$ M auxin is given to the plants, the sulphur content is 141.77%, 74.71%, 91.40%, 89.02% and 93.33% of the control; On treatment with $1x10^{-6}$ M auxin, the sulphur content is 108.29%, 74.71%, 72.38%, 102.67% and 99.56% of control and at $1x10^{-7}$ M , the sulphur content is 110.49%, 115.79%, 92.12%, 104.02% and 94.21% of the control at the plant age of 45, 60, 75, 90 and 105 days respectively.

The Interactive effect of treatment of simulated acid rain of pH 3.0 , 4.0 & 5.0 and auxin ($1x10^{-5}$, $1x10^{-6}$, $1x10^{-7}$) on sulphur content in the leaves of *Capsicum frutescens* var. *Sweet magic* is shown in table-3. On treating the plants with acid rain and auxin (pH $3.0+1x10^{-5}$ M), the sulphur is 101.40%, 110.19%, 81.71%, 83.38% and 62.10% , at the treatment of acid rain and auxin (pH $3.0+1x10^{-6}$ M), the sulphur are 146.34%, 198.85%, 98.81%, 105.51% and 100.92% and when the plants undergo a treatment of acid rain and auxin (pH $3.0+1x10^{-7}$ M) , the sulphur is 133.35%, 154.10%, 90.47%, 103.24% and 100.80% of the control at the plant age of 45, 60, 75, 90 and 105 days respectively.

At the treatment of acid rain and auxin (pH $4.0+1x10^{-5}$ M), the sulphur content is 132.99%, 121.01%, 73.37%, 102.23% and 111.94% , when the treatment of acid rain and auxin (pH $4.0+1x10^{-6}$ M) is given , sulphur content is 99.94%, 139.08%, 107.98%, 105.25% and 107.27% and the sulphur content are 161.34%, 183.30%, 106.79%, 116.32% and 118.29% at the plant age of 45, 60, 75, 90 and 105 days respectively at the treatment of acid rain and auxin (pH $4.0+1x10^{-7}$ M).

When made to undergo treatment with acid rain and auxin (pH $5.0+1x10^{-5}$ M), the sulphur content in the leaf of the plant are 111.22%, 89.50%, 103.52%, 89.24% and 94.69% , at the treatment of acid rain and auxin (pH $5.0+1x10^{-6}$ M), the sulphur content are 140.49%, 136.17%, 91.76%, 93% and 75.68% and at the treatment of acid rain and auxin (pH $5.0+1x10^{-7}$ M), the sulphur content is 109.88%, 103.07%, 117.15%, 112.29% and 110.98% of the control at the plant age of 45, 60, 75, 90 and 105 days respectively.

For var. *sweet magic*, maximum sulphur content is found on 45^{th} day at pH 3.0 [155.86 % of the control] . Minimum sulphur content at 45^{th} day was found at pH 4.0 [57.47% of control]. At pH 5.0 , significant increase at 45^{th} day . The reason for higher concentrations of sulphur in treated plant may be the sulphuric acid component of acid rain (Sharma, 1990) which may interact with sulphur metabolism. . Higher sulphur content at earlier age might have been due to the greater accumulation in smaller plants.

In leaves of var. *sweet magic*, maximum sulphur content is found at $1x10^{-5}$ M auxin at the 45^{th} day to significant level [141.77% of control]. At all the concentrations after that, there is an initial decline at the 75^{th} day, followed by variable increase. Variable pattern of change in sulphur content at different concentrations of auxin treatment with the number of days can be reasoned on account of interaction of auxin with plant metabolism and dependence of yield of biosynthesis on variable condition like temperature, wind, water contents sunlight and sun heat.

For var. *sweet magic*, maximum sulphur content is found on 60^{th} day at pH $3.0+1x10^{-6}$ M [198.85% of control] . Thus it is the optimum combination for sulphur content. Pattern of change is irregular. Minimum significant combination is pH $3.0+1x10^{-5}$ M at 105^{th} day. The reason for higher concentrations of sulphur in treated plant may be the sulphuric acid component of acid rain (Sharma, 1990) in combination which may interact with sulphur metabolism. Effect of auxin to increase sulphur metabolism might have assisted effect of acid rain to increase sulphur content. High sulphur content at earlier plant age is due to greater accumulation at juvenile stage.

CONCLUSION

Sulphur contents increase with increase in H^+ ion concentration in acid rain due to the presence of H_2SO_4 in acid rain. Auxin also interacts with metabolism of plants which may enhance synthesis of sulphur compounds. Combination of acid rain & auxin show increase in sulphur contents due to sulphur content in acid rain & interaction of auxin with sulphur metabolism.

ACKNOWLEDGEMENT

Authors are thankful to the Principal, DAV College – Muzaffarnagar for providing Lab. facilities. Thanks are also due to FRI- Dehradun [Dr. Meena Bakshi & Ankur Vichitra} for the experiments carried out in Plant Physiology Division. Help provided by Dr. Vimla Murti, Dept. of Botany- CCS University, Meerut is also thankfully acknowledged.

Table 1. Effect of simulated acid rain (pH 3.0, 4.0, 5.0) on sulphur content(µg/100mg dry wt ± SD .) in the leaves of *Capsicum frutescens* var. *sweet magic*

Treatment	PLANT AGE (in Days)				
	45	60	75	90	105
Control	5.47 ± 0.50	4.35 ± 0.32	6.43 ± 0.42	7.62 ± 0.30	8.35 ± 0.30
3.0	6.44* ± 0.20	6.78** ± 0.15	8.50** ± 0.45	9.25* ± 0.73	8.14 ± 0.39
4.0	4.19* ± 0.39	2.50** ± 0.33	4.74* ± 0.54	5.07** ± 0.44	4.80** ± 0.48
5.0	5.02 ± 0.30	4.41 ± 0.39	7.50 ± 1.33	7.65 ± 1.18	7.35 ± 1.03

NB **=.01 level of significance *=.05 level of significance

Table 2. Effect of Auxin ($1x10^{-5}$,$1x10^{-6}$,$1x10^{-7}$ M) on Sulphur content (µg/100mg dry wt., ± SD) in the leaves of *Capsicum frutescens* var. *sweet magic*

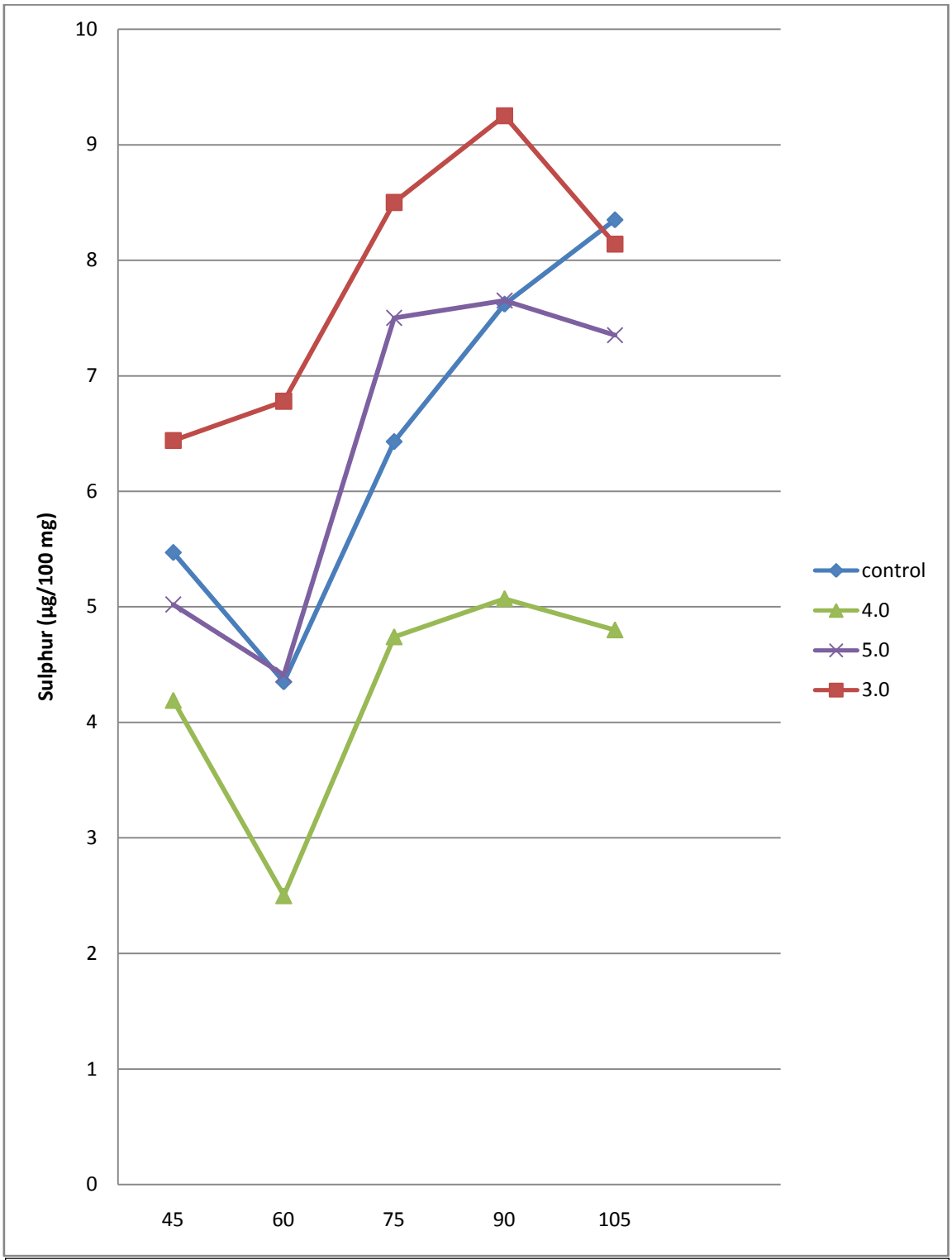
Treatment	PLANT AGE (in Days)				
	45	60	75	90	105
Control	5.47 ± 0.50	4.35 ± 0.32	6.43 ± 0.42	7.62 ± 0.30	8.35 ± 0.30
$1x10^{-5}$ M	7.75** ± 0.61	3.25** ± 0.25	5.88 ± 0.21	6.78 ± 0.28	7.79 ± 0.12
$1x10^{-6}$ M	5.92 ± 0.31	3.45** ± 0.25	4.66* ± 0.81	7.82 ± 0.17	8.31 ± 0.48
$1x10^{-7}$ M	6.04 ± 0.79	5.04 ± 0.29	5.93 ± 0.34	7.93 ± 0.79	7.86 ± 0.28

N.B. **=.01 level of significance *=.05 level of significance

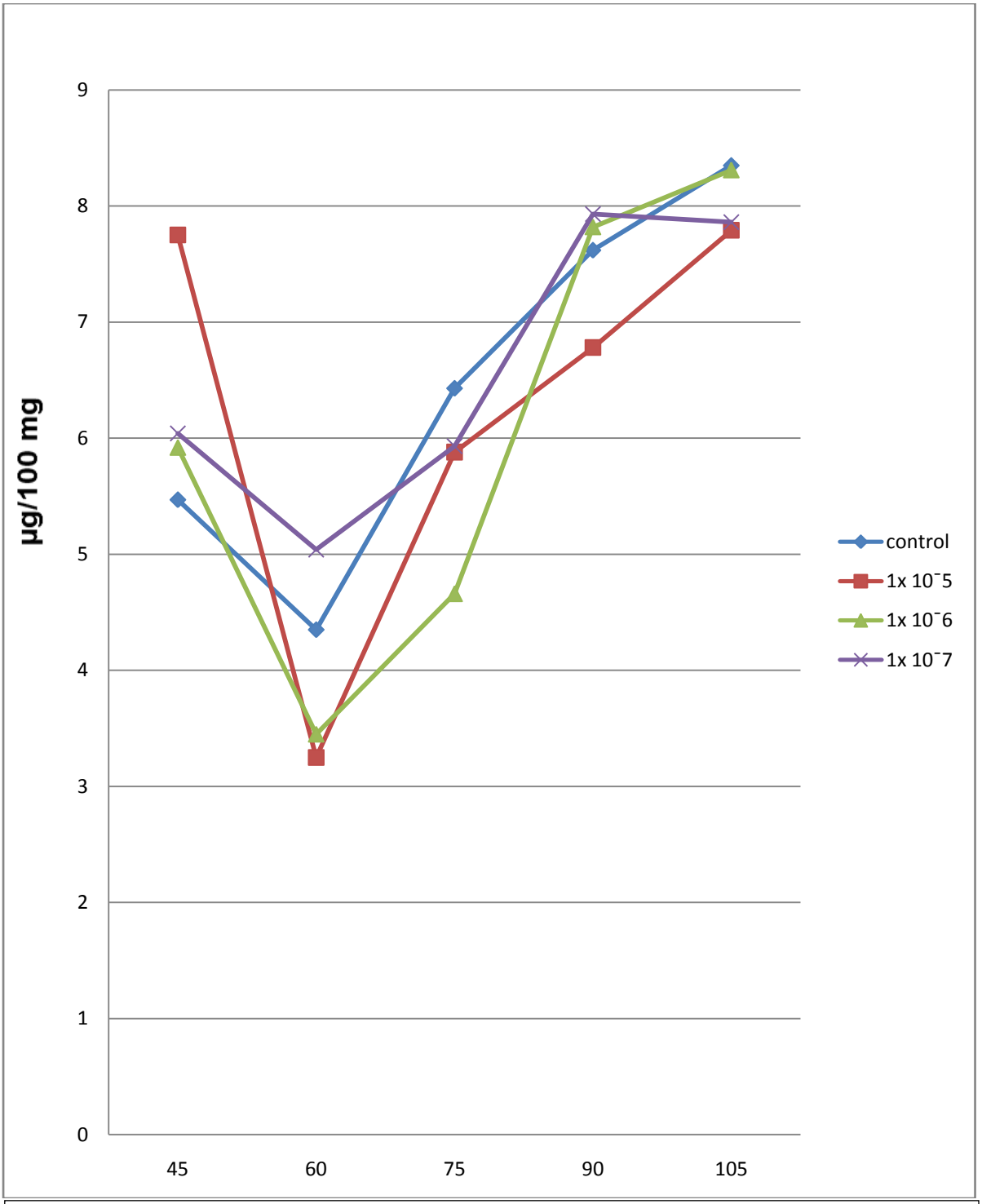
Table 3. Interactive Effect of simulated acid rain (pH3.0,4.0,5.0) and Auxin (10^{-5},10^{-6},10^{-7}M) on sulphur content(µg/100mg dry wt ± SD.) in the leaves of *Capsicum frutescens* var. *sweet magic*.

Treatment	PLANT AGE (in Days)				
	45	60	75	90	105
Control	5.47	4.35	6.43	7.62	8.35
	± 0.50	± 0.32	± 0.42	± 0.30	± 0.30
3.0 +1X10^{-5} M	5.54	4.79	5.26*	6.35*	5.18**
	± 0.39	± 0.38	± 0.18	± 0.47	± 0.29
3.0 + 1x10^{-6} M	8.00*	8.65**	6.36	8.04	8.42
	± 0.81	± 0.67	± 0.36	± 0.61	± 0.51
3.0 +1x10^{-7} M	7.29*	6.70*	5.82	7.87	8.41
	± 0.52	± 1.01	± 0.42	± 0.45	± 0.51
4.0 +1X10^{-5} M	7.27**	5.27	4.72**	7.79	9.34
	± 0.43	± 0.87	± 0.43	± 0.75	± 0.65
4.0 + 1x10^{-6} M	5.46	6.05**	6.95	8.02	8.95
	± 0.54	± 0.45	± 0.84	± 1.48	± 0.83
4.0 +1x10^{-7} M	8.82**	7.97**	6.87	8.86*	9.87*
	± 1.04	± 0.78	± 0.66	± 0.47	± 0.54
5.0 +1X10^{-5} M	6.08	3.89	6.66	6.80	7.90
	± 0.56	± 0.57	± 0.74	± 0.47	± 0.86
5.0 + 1x10^{-6} M	7.68**	5.92	5.90	7.09	6.32*

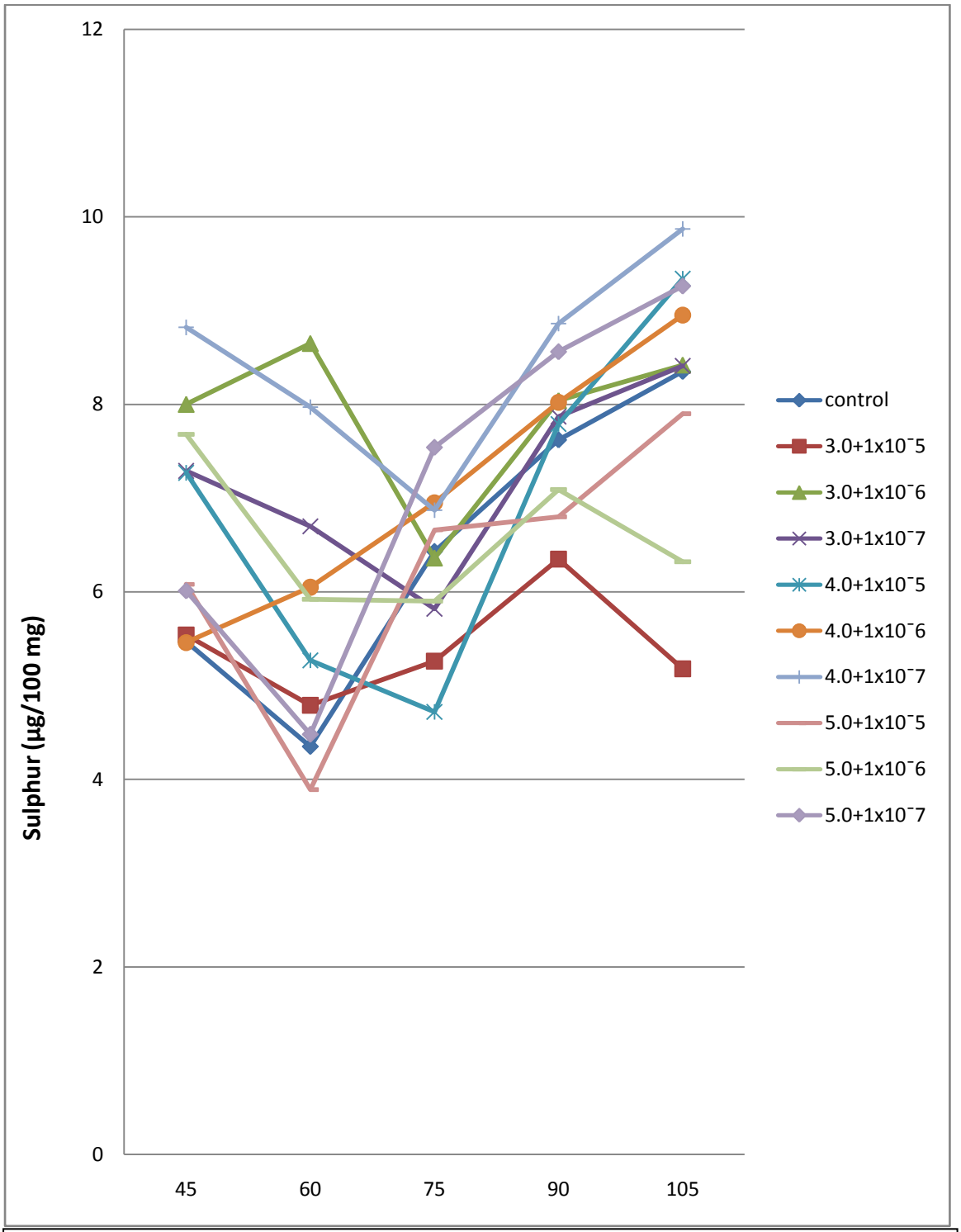
	± 0.43	± 0.98	± 0.53	± 0.36	± 0.96
5.0 +1x10^{-7} M	6.01	4.48	7.54	8.56	9.26
	± 0.85	± 0.95	± 0.64	± 1.27	± 0.62
N.B.	**=.01 level of significance *=.05 level of significance				



Graph No 1: Effect of simulated Acid rain (pH3.0, 4.0 & 5.0) on Sulphur content (µg/100mg dry wt.) in the leaves of *Capsicum frutescens* var. *Sweet magic* at different plant age



Graph No 2:Effect of Auxin (1x10 $^{-5}$, 1x 10^{-6}, 1x 10^{-7} M) on Sulphur content (µg/100 mg dry wt.) in leaf of *Capsicum frutescens* var. *Sweet Magic* at different plant age



Graph No:3: Interactive Effect of acid rain (pH 3.0, 4.0 & 5.0) and Auxin ($1x10^{-5}$, $1x10^{-6}$, $1x10^{-7}$ M) on Sulphur content (µg/100mg dry wt.) in leaf of *Capsicum frutescens* var. *Sweet Magic* at different plant age

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VARIATIONS IN BOD AND COD AT VARIOUS STAGES OF BIOGAS PRODUCTION USING DIFFERENT AGRICULTURAL WASTES

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Received-12.06.2015, Revised-20.06.2015

Abstract: Cow dung along with other agricultural wastes (press mud, poultry litter, kitchen wastes, maize stalks and fruit wastes) were used for the biogas production in lab scale. For each treatment 750 g of substrate and 1500 ml of water was used as inoculum mixture in 3 liters glass bottles. Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) was estimated at various stages of gas production. BOD and COD of the slurry samples was more in the substrates initially before anaerobic digestion but later reduced gradually by the end of gas production which implies the effect of anaerobic digestion on the reduction of BOD and COD and this indirectly leads to the reduction in the environmental pollution.

Keywords: Agricultural wastes, Anaerobic digestion, Biological Oxygen Demand, Chemical Oxygen Demand

INTRODUCTION

Currently, as the fossil-based fuels become scarce and more expensive, the economics of biogas production is turning out to be more favourable. Biogas originates from bacteria in the process of biodegradation of organic material under anaerobic conditions. Anaerobic digestion, a biological conversion process that occurs in the absence of oxygen, has a number of advantages for waste conversion and ultimately producing methane and carbon dioxide (Garba and Sambo, 1995). It consists of a varying proportion of CH_4 (methane) and CO_2 (carbon dioxide) and traces of H_2S, N, CO and water vapour. Methane is the most valuable component under the aspect of using biogas as a fuel. Biochemical oxygen demand (BOD) and Chemical oxygen demand (COD) of the agricultural wastes is very high. Through this anaerobic digestion BOD and COD levels monitored.

MATERIAL AND METHOD

Collection of substrates

Different substrates were collected from different places and biogas digesters were set in lab scale. Press mud was collected from Nandyal sugar factory located at Nandyal, Kurnool district and cow dung was collected from the cattle farm of Veterinary University, Rajendranagar, Hyderabad. Poultry litter was collected from poultry farm of Veterinary University, Rajendranagar, Hyderabad. Kitchen wastes were collected from the mess of hostel-C. Maize stalks were collected from the college farm of ANGRAU, Hyderabad. Fruit wastes were collected from the fruit market at Rajendranagar, Hyderabad. Cow dung was collected from the cattle farm of Veterinary University, Rajendranagar, Hyderabad.

Treatment	Substrate
T_1	Press mud + Cow dung
T_2	Poultry litter + Cow dung
T_3	Kitchen wastes + Cow dung
T_4	Maize stalks + Cow dung
T_5	Fruit waste + Cow dung
T_6	Cow dung alone

Equipment and apparatus used

BOD incubators were used for incubating the samples in BOD bottles to estimate the BOD in the slurry samples. COD apparatus was used for estimating COD in the slurry samples.

Laboratory analysis

BOD in the slurry samples

Biological Oxygen Demand is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain

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temperature over a specific time period. It was determined by measuring oxygen concentration in slurry sample, idometrically before and after incubation in the dark at 20^0 C for 5 days by the colorimetric method (APHA, 1992).

COD in the slurry samples

Chemical oxygen demand is the total measurement of all chemicals in the water that can be oxidized. It was determined by the closed reflux colorimetric method (APHA, 1992).

Measurement of Gas production from different treatments

The biogas production readings were taken on an alternate day by water displacement method in the measuring jar.

RESULT AND DISCUSSION

Biogas production

All the biogas production units with six treatments and three replications were set on the same day with 750 grams substrate and 1500 ml water (1:2 ratio).

The highest gas production was observed in T_1 (Cow dung + Press mud) 9903.31 ml, as compared to T_6 (Cow dung alone) 8103.31 ml, T_2 (Cow dung + Poultry litter) 6079.98 ml, T_3 (Cow dung + Kitchen waste) 4066.63 ml, T_5 (Cow dung + Fruit waste) 3373.32 ml and less in T_4 (Cow dung + Maize stalks) 3099.97 ml. (Table 1).

Ofoefule *et al.* (2010) stated cow dung produced highest amount of biogas while goat dung produced less volume of biogas. Anaerobic digestion of some animal dung like cow, swine, rabbit, poultry and goat was carried out. The average volume of biogas produced was 44, 40, 37, 33 and 31 dm^3 per total mass of slurry respectively

Biological Oxygen Demand (BOD)

At the end of the process (on 56^{th} day) the reduction in BOD was observed and significantly more reduction was in T_5 (Cow dung + Fruit waste) 58.74 per cent compared to T_2 (Cow dung + Poultry litter) 52.20 per cent T_6 (Cow dung alone) 51.03 per cent, T_3 (Cow dung + Kitchen waste) 50.30 per cent, T_1 (Cow dung + Press mud) 45.57 per cent and less reduction in T_4 (Cow dung + Maize stalks) 27.68 per cent (Table 2).

The above results were similar to that of Bhumesh Singh and sai (2011) who studied on biogas generation from dairy effluent and explained that BOD and COD reduced to the extent of 50 per cent by the end of the process.

Chemical Oxygen Demand (COD)

At the end of the process (on 56^{th} day) decrease in COD was observed and more decrease was in T_6 (Cow dung alone) 52.15 per cent compared to T_2 (Cow dung + Poultry litter) 49.88 per cent, T_1 (Cow dung + Press mud) 41.55 per cent, T_3 (Cow dung + Kitchen waste) 40.26 per cent, T_5 (Cow dung + Fruit waste) 30.04 per cent and less reduction in T_4 (Cow dung + Maize stalks) 18.77 per cent (Table 3).

Li and jha (2014) studied the characteristics of semi-dry anaerobic digestion of cow dung and pig manure mixture under psychrophilic condition. The Chemical Oxygen Demand (COD) in the substrates was estimated. In cow dung the COD was 150.54 g l^{-1} and in pig manure 163.63 g l^{-1}.

SUMMARY AND CONCLUSION

The combination of Cow dung + Press mud (T_1) was found to be the best in biogas production. However, all the combinations were also proved to be better for the biogas production. Hence the agricultural wastes can be utilized for biogas production. Reduction in BOD and COD was observed gradually from the initial stage of anaerobic digestion till the end of gas production in all the treatments. This implies that anaerobic digestion of agricultural wastes can be used to reduce the environmental pollution.

Table 1. Biogas production from combination of different substrates

	At the end of first week (ml)	At the end of second week (ml)	At the end of third week (ml)	At the end of fourth week (ml)	At the end of fifth week (ml)	At the end of sixth week (ml)	At the end of seventh week (ml)	At the end of eighth week (ml)	At the end of ninth week (ml)	At the end of tenth week (ml)
T_1	1110.00	1236.67	1313.33	1353.33	1483.33	1380.00	1076.67	586.66	266.66	96.66
T_2	353.33	383.33	460.00	1276.67	1380.00	886.66	616.66	563.33	120.00	40.00
T_3	313.33	623.33	1123.33	723.33	540.00	416.66	203.33	76.66	26.66	20.00
T_4	213.33	920.00	683.33	503.33	203.33	183.33	150.00	123.33	106.66	13.33
T_5	520.00	680.00	840.00	563.33	240.00	150.00	123.33	106.66	90.00	60.00
T_6	370.00	523.33	1240.00	1380.00	1523.33	1280.00	966.66	563.33	176.66	80.00
S.E(m)	4.082	3.600	5.270	3.043	3.333	3.333	3.043	4.082	4.303	1.925
CD (P=0.05)	12.719	11.217	16.420	9.480	10.385	10.385	9.480	12.719	13.407	5.996

T_1 = Cow dung (250 g) + Press mud (500 g) + water (1500 ml) – 1:2:6
T_2 = Cow dung (250 g) + Poultry litter (500 g) + water (1500 ml) – 1:2:6
T_3 = Cow dung (250 g) + Kitchen waste (500 g) + water (1500 ml) – 1:2:6
T_4 = Cow dung (250 g) + Maize stalks (500 g) + water (1500 ml) – 1:2:6

T_5 = Cow dung (250 g) + Fruit wastes (500 g) + water (1500 ml) – 1:2:6
T_6 = Cow dung (750 g) + water (1500 ml) – 3:6
*The values within the brackets in the table indicate the difference between the values of adjacent weeks

Table 2. BOD at different stages of biogas production

	Zero day (Inoculum mixture) ($mg\ l^{-1}$)	At the end of first week (7^{th} day) ($mg\ l^{-1}$)	At the end of second week (14^{th} day) ($mg\ l^{-1}$)	At the end of third week (21^{st} day) ($mg\ l^{-1}$)	At the end of fourth week (28^{th} day) ($mg\ l^{-1}$)	At the end of sixth week (42^{nd} day) ($mg\ l^{-1}$)	At the endof the process (56^{th} day) ($mg\ l^{-1}$)
T_1	101.00	94.33(6.67)	90.67(3.66)	80.14(10.53)	76.83(3.31)	71.90(4.93)	67.34(4.56)
T_2	118.00	104.00(14.00)	103.15(0.85)	91.28(11.87)	76.26(15.02)	74.74(1.52)	62.00(12.74)
T_3	134.85	124.05(10.80)	121.47(2.58)	107.64(13.83)	95.01(12.63)	83.55(11.46)	71.89(11.66)
T_4	106.88	95.02(11.86)	96.76(1.74)	90.71(6.05)	84.78(5.93)	82.98(1.80)	81.21(1.77)
T_5	67.25	60.64(6.61)	51.32(9.32)	44.00(7.32)	39.87(4.13)	35.70(4.17)	32.84(2.86)
T_6	151.75	139.51(12.24)	132.43(7.08)	117.40(15.03)	103.63(13.77)	92.83(10.80)	81.88(10.95)
S.E(m)	2.207	1.378	0.897	0.612	1.074	1.085	0.909
CD(P=0.05)	6.876	4.294	2.795	1.906	3.346	3.380	2.832

Table 3. COD at different stages of biogas production

	Zero day (Inoculum mixture) ($g\ l^{-1}$)	At the end of first week (7^{th} day) ($g\ l^{-1}$)	At the end of second week (14^{th} day) ($g\ l^{-1}$)	At the end of third week (21^{st} day) ($g\ l^{-1}$)	At the end of fourth week (28^{th} day) ($g\ l^{-1}$)	At the end of sixth week (42^{nd} day) ($g\ l^{-1}$)	At the endof the process (56^{th} day) ($g\ l^{-1}$)
T_1	111.85	110.24(1.61)	107.82(2.42)	101.59(6.23)	92.59(9.00)	85.14(7.44)	71.91(13.23)
T_2	101.35	94.81(6.54)	87.27(7.54)	72.01(15.26)	62.52(9.49)	58.57(3.95)	54.91(3.66)
T_3	133.81	130.53(3.28)	128.28(2.25)	113.12(15.16)	104.71(8.41)	90.99(13.72)	82.62(8.37)
T_4	127.49	125.78(1.71)	123.58(2.20)	118.78(4.80)	113.59(5.19)	109.53(14.06)	106.19(3.34)
T_5	109.54	105.44(4.10)	103.93(1.51)	97.84(6.09)	95.47(2.37)	90.24(4.23)	80.54(9.70)
T_6	138.24	131.41(6.83)	124.74(6.67)	102.38(22.36)	84.57(17.81)	78.74(5.83)	71.10(7.64)
S.E(m)	0.655	0.431	0.282	0.498	0.255	0.267	0.321
CD (P=0.05)	2.041	1.343	0.877	1.551	0.794	0.833	1.000

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CALCIUM INTERACTION WITH $CdCl_2$ INDUCED EFFECTS ON SEEDLING GROWTH AND METABOLISM OF *VIGNA MUNGO* L. AND *SOLANUM MELONGENA* L.

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Received-31.05.2015, Revised-08.06.2015

Abstract: In the present research work surface sterilized seeds of *Vigna mungo.* L. and *Solanum. melongena* L. were raised to analyzed changes in germination, seedling growth, chlorophyll contents, nitrate and nitrite reductase activity under $CdCl_2$, $CaCO_3$ stress singly and in combination 10^{-2} M+200 ppm, 10^{-4} M +100 ppm 10^{-5} M+50 ppm, 10^{-8} M+25 ppm and control were investigated. Observations were recorded at 3, 5, 7, 10, 30, 45 and 60th day of sowing displayed significant decrease in all the attributes of both crop plants on $CdCl_2$ application However, activity of nitrate and nitrite reductase, seedling growth, and chlorophyll contents were enhanced in lower Cd stress 10^{-8} M. Application of $CaCO_3$ shows the more elevations than $CdCl_2$ singly while combined effect of Cd+Ca is more pronounced in comparison to their individual effects.

Keywords: $CaCO_3$, NR activity, Chlorophyll contents**,** *Vigna mungo.* L. and *Solanum. melongena* L.

INTRODUCTION

Among the heavy metals cadmium (Cd) is a highly toxic and persistent environmental contaminant introduced into the soil, through anthropogenic activity phosphate fertilizers, sewage sludge and atmospheric fallout from industrial and municipal activity (Wagner *et al*., 1993). Although Cd is not essential for plants but because of its mobility in soil and solubility in water it is readily absorbed by plants, where it adversely affects the growth and metabolism and in high concentration it can lead to cell death and destruction of whole plant (Benavides *et al*., 2005). Cadmium enters into the cells due to its similar chemical and physical characteristics to plant nutrients, using Ca channels or Fe, Mn or Zn transporters and reduces the uptake of iron (Fe), nitrogen(N), phosphorus (P), potassium (K), Zinc (Zn), copper (Cu) and sodium (Na) (Wojcik *et al*., 2006). Cadmium is one of the most toxic metals in plants because it is active at concentrations much lower than other heavy metals and it also irreversibly replaces other metal ions in essential metalloenzymes (Jackson *et al.,* 1990). Cadmiun accumulation in plants causes disturbance in membrane function (Hernandez and Cooke, 1997), Enzyme activity (Tamas *et al*., 2006).

Excessive level of HMs in the soil environment adversely affect the germination of seeds, plant height, interfere with the activities of many key enzymes (Ashan *et al.,* 2007 and kuriakosa and Prassad 2008), Nitrate reductase activity (Hernandez *et al.,* 1996), Chlorophyll contents and phytomass (Siddhu *et al.,* 2012). Seed is a stage in life cycle of plant that is well protected against various stresses. However, after imbibition and subsequent vegetative developmental processes, they become stress sensitive (Li *et al.,* 2005). Heavy metals have high affinity to sulfydryl groups and disulfide bond which causes damage to secondary structure of proteins (Siediecka and Kurpa, 2002). The mechanism of action lies in their ability to form strong bonds with base and phosphate of nucleic acids (Tabaldi *et al.,* 2007). Cadmium accumulation in plants causes disturbance in membrane function (Hernandez and Cooke, 1997). Tyler and McBride (1981) and Brown *et al.,* (1983) investigated cadmium to be more mobile in soil than other common trace metals. McBride (1980) found that Cd was sorbed form dilute solution by $CaCO_3$ by chemisorption. Mechanism of Cd immobilization was discussed by Zahan (1986). The effect of combined metal Cd and Ca on *Vigna mungo* L. and *Solanum melongena* L. may be quite different from those of individual metals due to their mitigation to encounter the toxic effect of Cd through cation exchange chemisorpiton. Therefore, in the present study, an attempt has been made to investigate combined effect of Cadmium and calcium on seed germination, seedling growth, Chlorophyll contents & NR activity of *Vigna mungo* L. and *Solanum melongena* L. to encounter toxic effects of cadmium.

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MATERIAL AND METHOD

Uniform healthy seeds of *Phaseolus mungo* L. cv.T-9 and *Solanum melongena* L. cv.Pusa uttam were obtained from Indian Agricultural Research Institute, New Delhi-12 and were made surface sterilized with 0.1 % $HgCl_2$ solution. Cadmium solution was prepared by dissolving the molecular weight of cadmium chloride (228.35) in one liter of Hoagland's nutrient solution. This solution was known as 1M solution of cadmium and served as a stock solution (S.S.), other molar conc. were prepared from this 1M (one molar) solution.

In the present investigation, there were two methods of cadmium treatment employed i.e. presoaking and irrigation. For presoaking treatment sterilized seeds of *Phaseolus mungo* L. and *Solanum melongena* L. were imbibed upto 12 hrs in the different molar conc. of cadmium viz. (10^{-2}M, 10^{-4}M, 10^{-5}M, 10^{-8}M, $CaCO_3$ as 25,50,100,200 ppm and in combination as 10^{-2}M+200 ppm, 10^{-4}M+100 ppm, 10^{-5}M+50 ppm, 10^{-8}M+25 ppm, & control) and for irrigation process metal was also given to soil in the form of above molar conc. before sowing. The surface sterilized seeds were sown in polythene bags in triplicate containing 10 kgs. of sandy loam soil (pH 7.45). The experiment was conducted at Environmental Science Laboratory during the year 2004, 2005 and 2006. Observations on seedling growth, morphological and biochemical attributes were recorded. Data were analysed statistically and significant value critical difference at 5 % level were calculated. Seedling vigour index was calculated according to (Abdulbaki and Anderson, 1973) and phytotoxicity percentage of root and shoot was measured by the formula derived by Chou and Muller (1972). Chlorophyll contents were estimated by adopting the method of Smith and Benetiez (1955). Nitrate and nitrite reductase activity, soluble sugar and protein contents of seeds were estimated the method given by Sadasivum and Manickam (1992).

RESULT AND DISCUSSION

Seeds of *Phaseolus mungo* L. and *Solanum melongena* L. were germinated in different. conc. of cadmium singly(10^{-2}M, 10^{-4}M, 10^{-5}M, 10^{-8}M, $CaCO_3$ as 25,50,100,200 ppm and is combination as 10^{-2}M+200 ppm, 10^{-4}M+100 ppm, 10^{-5}M+50 ppm, 10^{-8}M+25 ppm, & control) in petriplates polythene bags in triplicate. Results on Germination percentage, seedling vigour index (S.V.I) and number of lateral roots shows -10.52%, -54.97% and -31.97% reduction in 10^{-2} M $CdCl_2$ singly while interaction of both metal shows a decrease in percent of reduction (-7.36%, -47.33%, and -16.57%). However $CaCO_3$ and 10^{-8}+25 ppm show significant stimulations in these parameters. These observations are in the conformation with that of Siddhu *et al.* (2008). (Table -1 & 2.)

It is obvious from the results of present investigation that seed germination under the different treatments were reduced significantly in 10^{-2} M of $CdCl_2$ while application $CaCO_3$ along with $CdCl_2$ shows a remarkable increase. Peusal of data on seedling growth the *Vigna mungo* L. and *Solanum melongena* L. in $CdCl_2$ shows (-44.22%, -53.11%, -44.438%, -64.805%, -36.64% and -14.93%, -43.87%, -46.11%, -30.65% & -28.7%) reduction oven control in radical & plumule length & dry wt. and shoot root ratio respectively in 10-^{2}M at 10^{th} day however percentage of reduction decrease (-37.39%, -47.27%, -3535%, -6093%, -39.61% and -8.14%, .36-57%, -45.57%, -22.96%, -41.51%) due to interaction of $CdCl_2$ and $CaCO_3$ in (10^{-2} M + 200 ppm) (Table-1 & 2). The inhibition was none in root than shoot because plant roots are finest point of contact with heavy metals in nutrient media (Zhang *et al.*, 2009). The reason for reduced seedling growth under metal treatment could be the reduction in meristematic cells present in the region and some enzymes present in cotyledons and in endosperm.

When Cd-Ca on Cd-Zn interactions are considered, the absorption of Cd decreased in vegetative parts of the plants. Such interactions can be accounted by antagonism process. It is presumed that Ca^{+2} compete with Cd ions or exchange sites on the roots because the radius of Calcium is similar to that of cadmium. Increase significance has been observed in radical & plumule length & dry wt. and shoot root ratio in 10^{-8}M + 25 ppm. The observed significance is (7.22%, 3.15%, 10.14%, 10.75%, -1.23% & 1.58%, 2.80%, 5.93%, 11.17% & 5.01%) respectively. However, Ca Singly increased the length and dry wt. of radical and plumule. Similar trend of observation have been reported with $CaCO_3$ by Salim and Nair (1982). Cadmium reduced the root growth by decreasing Ca in root, calcium being a requirement for root growth development is affected (Greger and Bertell, 1992) (Table-1 & 2).

In our experiment on *Vigna mungo* L. it has been observed that Cadmium alone decreased the germination and seedling growth but along with Ca. the toxic effect of cadmium are reduced to some extent. The combine application of both the elements increases the germination and seedling growth while Ca alone increased the germination and growth of seedlings. Similar observations have been reported by Mohan and Saran (1999). He reported that soaking of $CaCl_2$ and KNO_3 alleviated the effects of Cd toxicity to some extent.

The synergistic effects of cadmium and calcium on the chlorophyll contents at the age of 30^{th}, 60^{th} days of *Vigna mungo* L. and *Solanum melongena* L. in 10^{-2}M +200 ppm of Ca + Cd and in 25 ppm of $CaCO_3$ have been observed. Cadmium treatment caused a significant reduction in the leaf chlorophyll contents of both the crop plants compared with their controls. The maximum decline -34.88%, -44.54%, -51.48% & -46.24% in proto. Chlorophyll. Chl a. chl b. and total chlorophyll contents of *Solanum melongena* L. over control were observed (Table). Destruction of chlorophyll pigments reported due to the instability of pigment-protein complex which may be correlated to the indirect effects of Na and Cl^- ions and also due to impaired uptake of Mg, Fe and Ca by plants (Jaleel *et al.,* 2008). On the contrary, combined treatments of 10^{-2} M + 200 ppm could reduces proto. Chlorophyll. Chl a. chl b. and total chlorophyll contents only by -64.05%, -58.49%, -45.74%, -62.52% & -45.74%, -33.36%, 38-49% and -45.74% in *Solanum melongena* L. *and Vigna mungo* L. respectively. The extend of percent of reduction was less in 10^{-8} M +25ppm of Cd + Ca treatment, thus showing a remedial effects CdCl2 treatment. Observation on CaCO3 singly shows the same trend. Calcium might prevent the damage from cellular dehydration by balancing osmotic strength of cytoplasm (Arshi, *et. al.,* 2006 ab). CSI result shows the stimulation in 10^{-2}M + 200 ppm and 200 ppm of $CaCO_3$ however, 10^{-8}M +25 ppm, 25ppm & 50ppm revealed significant reduction (Table-3).

Nitrate and nitrite reductase activity of *Vigna mungo* L. and *Solanum melongena* L. revealed its inversely proportional to the conc. of cadmium (10^{-2}M, 10^{-4}M, 10^{-5}M, 10^{-8}M). These observations are in the conummeration with that of Mehindirata *et al.* (1999) and Ali khan and Siddhu (2006). Combined result on effect of $CaCO_3$ and $CdCl_2$ levels in nitrate and nitrite reductase activities showed increase in 10^{-8}M +25 ppm at 45^{th} and 60^{th} day. Observed promotion is 3.81%, -15.60% & -33.75%, -9.23% in nitrate reductase enzyme activity and -8.57%, -8.35% & -89.56%, -65.45% in nitrite reductase enzyme activity however, significant reduction -42.85%, -43.13%, -51.74%, & -39.46% in 10^{-2}M+200ppm of Cd + Ca at 45^{th} & 60^{th} day. Activity of nitrate reductase enzyme is increased with increasing $CaCO_3$ concentration. Nishi *et al.* (1996) reported that $CdCl_2$ could recover the loss of in vivo NRA in roots caused by either of the metal combination whereas the salt could recover the loss in leaf NRA caused only by Pb^{2+}, Cd^{2+} (1.0 mM each) and organic N contents of root and leaf however, increased significantly with $CaCl_2$ alone and with the metals supplied in various combinations (Table-4).

Concluding thoughts

In present is study combined effect of Cd+Ca on *Vigna mungo* L. *and Solanum melongena* L. have been observed quite different from those of individual metal pollutant due to their mitigation to encounter the toxic effects of cadmium through cation exchange chemisorptions. Results due to application of both metals revealed more pronounced than $CdCl_2$ singly, however $CaCO_3$ results shows the slight alleviations in all plants attributes in comparison to cadmium.

ACKNOWLEDGEMENT

Authors extend sincere thanks to Professor Y. Vimla, Department of Botany, C.C.S. University, Meerut, Dr. Attar Singh and Dr. N.K. Parsad (Plant Physiology Division , I.A.R.I., New Delhi) and providing laboratory facilities and valuable suggestions during this work.

Table 1. Effect of cadmium chloride on seedling growth of *Vigna mungo L.*

CdCl2treatment	DAS	Germination percentage	Germination relative index (G.R.I.)	Seedling vigour index (S.V.I.)	Shoot: Root ratio	Dry weight of root	Dry Weitht of shoot	Number of lateral roots	Root length	Root length	Phytotoxicity percentage of root length	Phytotoxicity percentage of root length
Control	3	75.00	855.00	505.950	3.240	4.500	14.583	12.050	4.930	1.816	0.000	0.000
	5	91.66	1008.15	1048.040	3.803	7.361	28.000	17.000	5.480	5.954	0.000	0.000
	7	95.00	1007.00	1866.180	3.699	8.130	30.077	17.855	7.420	12.224	0.000	0.000
	10	95.00	950.00	2051.810	3.569	8.756	31.255	18.000	8.344	13.254	0.000	0.000
$CdCl_2$+$CaCO_3$												
10^{-2} M + 200ppm	3	70.00*	798.00*	213.360*	4.126*	2.100*	8.666*	8.655*	1.847*	1.201*	62.535*	33.865*
	5	83.00*	916.30*	599.059*	2.272*	4.201*	9.545*	12.055*	3.244*	3.945*	40.802*	33.742*
	7	88.00*	935.98*	902.202*	2.208*	4.980*	11.000*	12.428*	4.345*	5.869*	41.442*	51.987*
	10	88.00*	883.00*	1080.540*	2.155*	5.666*	12.211*	12.631*	5.245*	6.988*	37.140*	47.276*
10^{-4} M+ 100ppm	3	73.00*	835.62*	322.514*	3.381*	3.121*	10.555*	9.000*	2.954*	1.464*	40.811*	19.383*
	5	88.33*	971.30*	827.387*	3.464*	5.323*	18.442*	15.625*	4.222*	5.145*	22.956*	13.587*
	7	91.66*	971.49*	1075.721*	3.802	6.124*	20.242*	15.798*	5.212*	6.524*	29.757*	46.629*
	10	91.66*	916.50*	1325.036*	3.000*	7.000*	21.000*	15.912*	6.232*	8.224*	25.311*	37.950*
10^{-5} M+ 50ppm	3	74.00	850.62*	427.760*	3.263	4.245	13.852*	12.445	3.885*	1.576	21.196*	13.215*
	5	90.00	990.00*	951.120*	3.848	6.898*	26.545*	16.675	5.022*	5.546*	8.357*	6.852*
	7	93.33*	998.98*	1293.180*	3.679	7.844	28.864*	16.875	5.644*	8.212*	23.935*	32.820*
	10	93.33*	933.00*	1529.678*	3.527	8.345*	29.440*	17.033*	6.545*	9.845*	21.560*	25.720*
10^{-8} M+ 25ppm	3	81.66*	930.81*	661.364*	3.023	5.622*	17.000*	14.000*	5.245	2.854*	-6.389*	-57.158*
	5	95.00*	1026.30*	1230.630*	4.062	7.876*	32.000*	18.122*	6.000	6.954*	-9.489*	-16.795*
	7	98.33*	1041.98*	2112.128*	3.844	8.643*	33.224*	18.724*	8.245	13.235*	-11.118*	-8.270*
	10	98.33*	983.00*	2307.500*	3.525*	9.644*	34.000*	19.011*	9.255	14.212*	-10.918*	-7.228*
$CaCO_3$												
25 ppm	3	61.66*	702.81*	213.096*	4.357*	2.300*	10.022*	9.000*	2.000*	1.456*	59.432*	19.823*
	5	68.33*	751.30*	464.029*	3.263*	4.545*	14.834*	12.345*	2.559*	4.232*	53.302*	28.921*
	7	81.66*	865.49*	884.622*	3.143*	5.700*	17.916*	12.745*	4.500*	6.333*	39.353*	48.192*
	10	81.66*	816.50*	1058.598*	3.023*	6.200*	18.745*	13.142*	5.684*	7.255*	31.879*	45.261*
50ppm	3	66.66*	759.81*	317.634*	3.921*	3.400*	13.333*	9.445*	3.221*	1.544	34.665*	14.977*
	5	75.00*	825.00*	735.750*	4.027*	5.555*	22.375*	15.755*	4.566*	5.244*	16.678*	11.924*
	7	83.33*	882.98*	1063.624*	4.270	6.666*	28.466*	15.862*	5.765*	6.999*	22.304*	42.743*
	10	83.33*	833.00*	1286.615*	3.906*	7.455*	29.122*	16.054*	6.666*	8.774*	20.109*	33.801*
100ppm	3	68.33*	778.62*	391.804*	3.140	4.342*	13.636*	12.454*	4.122*	1.612	16.389*	11.233*

	5	78.33*	861.30*	854.580*	3.757	6.984	26.245*	16.855*	5.244	5.666	4.306*	4.833*
	7	88.33*	935.98*	1295.447*	3.641	7.844	28.567*	16.925*	5.955*	8.711*	19.740*	28.738*
	10	88.33*	883.00*	1538.885*	3.448	8.656*	29.854*	17.062*	7.000*	10.422*	16.107*	21.367*
200ppm	3	70.00*	798.00*	589.190*	3.014	5.712*	17.220*	14.455*	5.433*	2.984*	-10.202*	-64.317*
	5	81.00*	898.15*	1110.410*	4.097	7.942*	32.545*	18.322*	6.500*	7.000*	-18.613*	-17.568*
	7	90.00*	954.00*	1997.280*	3.885	8.754*	34.011*	19.000*	8.550*	13.642*	-15.229*	-11.600*
	10	90.00*	900.00*	2158.920*	3.416	10.211 *	34.885*	--	9.422*	14.566*	-12.919*	-9.898*

* Significant at 5% level.
DAS = Days after sowing

Table 2. Effect of cadmium chloride on seedling growth of Solanum melongena L.

CdCl2treatment	**DAS**	**Germination percentage**	**Germination relative index (G.R.I.)**	**Seedling vigour index (S.V.I.)**	**Number of lateral roots**	**Radicle length**	**Plumule length**	**Phytotox-icity percentage of radicle length**	**Phytotoxi-city percentage of plumule length**	**Shoot root ratio (SRR)**	**Dry weight of radicle**	**Dry weight of plumule**
Control	3	23.33	265.62	-	-	-	-	-	-	-	-	-
	5	85.00	935.00	444.805	-	5.233	-	-	-	-	0.538	-
	7	96.66	1024.49	1123.189	5.482	7.676	3.945	-	-	3.378	0.740	2.500
	10	96.66	966.50	1320.955	7.524	7.886	5.780	-	-	3.129	0.926	2.900
$CdCl_2$+$CaCO_3$												
10^{-2} M + 200ppm	3	6.66*	37.62*	0.0*	-	-	-	-	-	-	-	-
	5	70.0*	421.3*	267.68*	-	3.824*	-	36.955*	-	-	0.363*	-
	7	88.33*	901.0*	746.39*	2.445*	5.453*	3.00*	28.951*	23.954*	3.985*	0.426*	1.7*
	10	88.33*	850.0*	963.68*	2.622*	7.244*	3.66*	8.141*	36.564*	4.428*	0.504*	2.234*
10^{-4} M+ 100ppm	3	11.66*	57.0*	0.0*	-	-	-	-	-	-	-	-
	5	73.33*	476.3*	281.88*	-	3.844*	-	26.543*	-	-	0.454*	-
	7	91.66*	935.98*	905.32*	3.256*	6.666*	3.211*	13.138*	18.60*	3.910*	0.514*	2.012*
	10	91.66*	883.0*	1066.55*	3.578*	7.324*	4.312*	7.126*	25.397*	3.467*	0.676*	2.346*
10^{-5} M+ 50ppm	3	13.33*	75.81*	0.0*	-	-	-	-	-	-	-	-
	5	83.3	495.0*	404.33*	-	4.854*	-	7.242*	-	-	0.489*	-
	7	93.33*	954.0*	988.36*	3.624*	6.945*	3.645*	9.394*	7.604*	3.875*	0.598*	2.320
	10	93.33*	900.0*	1152.90*	4.625*	7.585*	4.768*	3.816*	17.508*	2.958	0.892*	2.640*

10^{-8} M+ 25ppm	3	26.66*	301.81*	0.0*	-	-	-	-	-	-	-	-
	5	86.66	981.75*	518.66*	-	5.985*	-	-14.37*	-	-	0.567*	-
	7	98.33	1052.58*	1220.17*	6.885*	7.989*	4.42*	-4.091*	-12.040*	3.795*	0.761	2.888*
	10	98.33	993.0*	1371.99*	8.678*	8.011	5.942	-1.833*	-2.802*	3.286	0.981*	3.224*
$CaCO_3$												
25 ppm	3	0.0	0.0*	0.0*	-	-	-	-	-	-	-	-
	5	30.0*	330.0*	120.75*	-	4.025*	-	23.084*	-	-	0.384*	-
	7	85.0*	901.0*	740.94*	2.566*	5.68*	3.037*	25.993*	23.016*	4.789*	0.454*	2.176*
	10	85.0*	850.0*	924.8*	2.8*	6.898*	3.982*	11.488*	31.107*	4.571*	0.538*	2.461*
50ppm	3	0.0*	0.0*	0.0*	-	-	-	-	-	-	-	-
	5	50.0*	550.0*	241.4*	-	4.828*	-	7.739*	-	-	0.477*	-
	7	86.66*	918.49*	892.16*	3.455*	6.875*	342*	10.423*	13.307*	4.00*	0.555*	2.222*
	10	86.66*	866.5*	1094.42*	3.756*	7.754	4.765*	1.673*	17.560	3.538*	0.769*	2.722*
100ppm	3	1.66*	18.81*	0.0*	-	-	-	-	-	-	-	-
	5	58.33*	641.3*	298.70*	-	5.121	-	2.140*	-	-	0.512	-
	7	88.33*	935.98*	1070.11*	3.757*	7.35*	3.588*	4.234*	9.049*	3.678*	0.666*	2.452
	10	88.33*	883.0*	1115.51*	4.8*	7.765	4.875*	1.534*	15.657*	3.16	0.900	2.844
200ppm	3	3.33*	37.62*	0.0*	-	-	-	-	-	-	-	-
	5	65.00*	715.0*	392.88*	-	6.044*	-	-15.505*	-	-	0.600*	-
	7	96.66	1024.49*	1266.43*	7.00*	8.137*	4.965*	-6.026*	-25.855*	3.471	0.777*	2.7*
	10	96.66	966.5*	1392.19*	8.898*	8.414*	5.898*	-6.695*	-3.615*	3.260*	1.012*	3.4*

* Significant at 5% level.
DAS = Days after sowing

Table 3. Effect of $CdCl_2$ + $CaCO_3$ on chlorophyll contents (mg/g. f. wt.)of *Solanum melongena* L. and *Vigna mungo L*.

		Solanum melongena				***Vigna mungo***			
Treatment	**DAS**	**P. chl.**	**Chl. a**	**Chl. b**	**Total chl.**	**P. chl.**	**Chl. a**	**Chl. b**	**Total chl.**
$CdCl_2$									
Control	30^{th}	1.735	0.5788	0.168	0.7468	1.827	0.453	0.1770	0.630
10^{-2} M		1.258*	0.242*	0.0145*	0.256*	0.930*	0.209*	0.092*	0.302*
10^{-4} M		1.380	0.325	0.056*	0.409	1.691	0.293	0.108	0.401*
10^{-5} M		1.627*	0.381*	0.068*	0.448*	1.708*	0.308*	0.112	0.421
10^{-8} M		1.702*	0.422*	0.072*	0.494*	1.718*	0.356*	0.115*	0.471*
Control	60^{th}	1.1797	0.36038	0.0986	0.459	1.388	0.292	0.099	0.391
10^{-2} M		0.638*	0.0701*	0.0281*	0.099*	0.741*	0.098*	0.036*	0.135*
10^{-4} M		0.733*	0.213*	0.0290	0.242	0.887	0.106	0.040	0.147

10^{-5} M		0.784	0.218	0.0364*	0.254	0.928*	0.117	0.046	0.163*
10^{-8} M		0.928*	0.226*	0.0423*	0.268*	1.081*	0.134*	0.056*	0.190*
$CdCl_2$+$CaCO_3$									
10^{-2} M + 200ppm		1.2582*	0.2424*	0.1450*	0.2569*	0.956*	0.216*	0.096*	0.312*
10^{-4} M+ 100ppm	30^{th}	1.3805	0.3254	0.0564	0.4096	1.709	0.303	0.102	0.406
10^{-5} M+ 50ppm		1.627*	0.3801*	0.0682	0.4483	1.765	0.318	0.108	0.427*
10^{-8} M+ 25ppm		1.702*	0.4223	0.0723*	0.4946*	1.780*	0.386*	0.117*	0.504*
$CdCl_2$+$CaCO_3$									
10^{-2} M + 200ppm		0.6386*	0.07018*	0.0290*	0.0992*	0.753*	0.105*	0.041*	0.146*
10^{-4} M+ 100ppm	60^{th}	0.7335	0.2133	0.2956	0.2428	0.895	0.112	0.045	0.160*
10^{-5} M+ 50ppm		0.7842*	0.2185*	0.0364	0.2549*	1.078*	0.128	0.048	0.176
10^{-8} M+ 25ppm		0.9285*	0.2265*	0.0423*	0.2688*	1.182*	0.141*	0.067*	0.209*
$CaCO_3$									
25 ppm		1.338*	0.392*	0.033*	0.426*	0.967*	0.231*	0.099*	0.330*
50 ppm	30^{th}	1.459*	0.421	0.086	0.507	1.721	0.312	0.112	0.425
100 ppm		1.752	0.484*	0.088	0.573*	1.769	0.325*	0.114	0.440*
200 ppm		1.775*	0.512*	0.090*	0.602*	1.789*	0.406*	0.119*	0.525*
$CaCO_3$									
25 ppm		0.659*	0.188	0.0335*	0.221*	0.762*	0.112*	0.044*	0.156*
50 ppm	60^{th}	0.749	0.223*	0.0338	0.257	0.905*	0.120	0.049	0.169
100 ppm		0.807*	0.235	0.0428*	0.278*	0.930	0.135*	0.053*	0.187*
200 ppm		0.946*	0.253*	0.0495*	0.302*	1.087*	0.149*	0.069*	0.218*

DAS=Days after sowing
*Significant at 5% level

Table 4. Effect of cadmium chloride on Nitrate (µg. NO_2^-prod/min/gm f.w.t) and nitrite (µg. NO_2^-red/min/gm f.w.t) reducatase activity of leave at 45th and 60th day (in parentheses), of *Vigna mungo L.* and *Solanum melongena L.*

Treatment	Nitrate reductase activity		Nitrite reductase activity	
$CdCl_2$	**Vigna mungo**	**Solanum melongena**	**Vigna mungo**	**Solanum melongena**
Control	4.642 (7.920)	2.45 (5.35)	3.50 (5.627)	1.677 (2.446)
10^{-2} M	2.00* (4.747)*	0.324* (1.343)*	1.33* (2.895)	0.125* (0.326)*
10^{-4} M	3.332* (4.933)*	1.122 (2.23)	1.882 (3.983)	0.135 (0.456)
10^{-5} M	3.885 (5.287)	1.253 (2.501)	2.00 (5.164)	0.148 (0.624)
10^{-8} M	4.544* (5.600)*	1.376* (4.770)*	2.892* (5.373)*	0.165* (0.695)*
$CdCl_2$+$CaCO_3$				
10^{-2} M + 200ppm	2.245* (4.794)*	0.565* (1.435)*	1.55* (3.22)*	0.133* (0.563)*
10^{-4} M+ 100ppm	3.55 (5.122)	1.340 (2.356)	2.00 (4.176)	0.140 (0.622)
10^{-5} M+ 50ppm	4.00 (5.395)	1.476 (2.621)	2.35 (5.265)	0.160 (0.752)
10^{-8} M+ 25ppm	4.465* (6.684)*	1.623* (4.856)*	3.200* (5.558)*	0.175* (0.845)*
$CaCO_3$				
25 ppm	2.125* (4.765)*	0.600* (1.564)*	1.25* (3.00)*	1.019* (1.465)*
50 ppm	3.245 (4.954)	1.455 (2.466)	1.88 (3.55)	1.342 (1.636)
100 ppm	3.955 (5.255)	1.562 (2.855)	1.22 (5.18)	1.421 (1.784)
200 ppm	4.352* (6.255)*	1.755* (5.245)*	3.00* (5.412*)	1.485* (1.944)*

* Significant at 5% level

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CORRELATION OF THE ENVIRONMENTAL FACTORS WITH THE BACTERIAL BLIGHT DISEASE OF COTTON CAUSED BY *XANTHOMONAS CAMPESTRIS* PV. *MALVACEARUM* UNDER SOUTH GUJARAT CONDITION

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Received-22.05.2015, Revised-31.05.2015

Abstract: Bacterial blight (BL), caused by *Xanthomonas campestris* pv. *malvacearum* (Smith) Dye, is a common disease affecting the growth, development and yield of cotton crop. Field trial was conducted for a season to determine the influence of environmental conditions representing rainfall periods, temperature and humidity on development of disease incidence. Bacterial blight disease infestation was recorded with its first appearance and subsequently at weekly interval till it prevailed on cotton G.Cot.Hy. 12 variety. The result indicated that the disease was first appeared in 32nd standard week (First week of August) with 2.66 % intensity and prevailed up to 47th Met. Week *i.e* third week of November (1.37 %) with its peak during 38th week *i.e.* September 3rd week (24.75 %) and then it gradually decreased.

Keywords: Bacterial blight, Epidemiology, *Xanthomonas campestris* pv. *malvacearum*

INTRODUCTION

Cotton (*Gossypium hirsutum*) is one of the most important commercial crop and it is the back bone of national economy of our country. Cotton remains the most miraculous fiber under the sun, even after 8,000 years. No other fiber comes close to duplicating all of the desirable characteristics combined in cotton. The fiber of a thousand faces and almost as many uses, cotton is noted for its versatility, appearance, performance and above all, its natural comfort. From all types of apparel, including astronauts' in-flight space suits, to sheets and towels, and tarpaulins and tents, cotton in today's fast-moving world is still nature's wonder fiber. It provides thousands of useful products and supports millions of jobs as it moves from field to fabric (www.cotton.org). Cotton is a white fibrous agricultural product that has a wide variety of uses, from textile production, to creating paper, to producing oil and food products. Cotton is grown all around the globe, and is traded internationally as well. The production is influenced by the repeated out breaks of pest and diseases and these are the major factors responsible for lower yield of cotton in India. Out of 25 diseases known to occur in cotton crop from time to time, the bacterial blight is the most wide spread and destructive disease reported to cause yield losses of about 10 to 30 per cent (Kalpana *et al*., 2004) and also affect the quality of lint (Sharma and Chauhan, 1985). Bacterial leaf blight, boll rots, wilts and leaf spots are the most destructive cotton diseases (Chopra, 1977). Leaf spots rank third among the diseases on cotton in India. Among the leaf spots, bacterial blight (*Xanthomonas campestris* pv. *malvacearum* (Smith), Alternaria leaf spot (*Alternaria macrospora* Zimn) and grey mildew (*Ramularia aereola*) have been reported to be damaging. Bacterial blight (BL) of cotton caused by *Xanthomonas campestris* pv. *malvacearum* (Smith) Dye affects the entire aerial parts of cotton plant *i.e*. necrosis of parenchymatous tissue in the local phase and blockage of xylem vessels in its systemic phase (Casson *et al*., 1977). Resistant varieties are the valid option in any disease management strategies. Control of the disease through chemicals, seed treatment or acid delinting is recommended but bactericide alone or in combination with fungicides dose not eradicate the pathogen completely (Khan and Ilyas, 1999; Hussain and Tahir, 1993). Characterization of environment factors conductive for bacterial blight disease may provide a basis to forecast the disease and issue advance warning to cotton growers for its timely management. Keeping in view the seriousness of this disease, a study was conducted at Main Cotton Research Station (MCRS), Surat (Gujarat) during *kharif*, 2013 to know the affect of environment factors on the disease development.

MATERIAL AND METHOD

The susceptible cultivar LRA – 5166 were sown around the G.Cot.Hy. 12 in this experiment by dibbling method with the following experimental details. All the recommended agronomic practices were followed for raising the good crop. The observations on disease development were recorded at weekly interval from 20 randomly selected tagged plants and 5 leaves from lower part and 5 leaves from middle/ plant were selected by using 0-4 scale as given by (Sheoraj, 1989).

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$$\text{Disease incidence (\%)} = \frac{\text{No. of infected plants}}{\text{No. of leaves observed x Max. Grade}} \times 100$$

Score	Description
0	Immune, completely free from bacterial blight
1	Highly resistant, infection 0-10 %
2	Moderately resistant, infection 11-20 %
3	Moderately susceptible, infection 21-40 %
4	Highly susceptible, infection more than 40 %

The weather data of the corresponding disease interval was obtained from the meteorological observatory of MCRS, Surat. The data were compiled to standard weeks and subjected to correlation equations (Gomez and Gomez, 1984).

RESULT AND DISCUSSION

Bacterial blight disease infestation was recorded with its first appearance and subsequently at weekly interval till it prevailed on cotton G.Cot.Hy. 12 variety. The result presented in Table: 1 and Fig: 1 indicated that the disease was first appeared in 32nd standard week (First week of August) with 2.66 % intensity and prevailed up to 47th Met. Week *i.e* third week of November (1.37 %) with its peak during 38th week *i.e*. September 3rd week (24.75 %) and then it gradually decreased.

The correlation of bacterial blight disease (BLB) incidence with the weather parameters revealed positive and significant correlation with the mimimum temperature. All other parameters (morning & evening humidity, maximum temperature, rainy days and rainfall) had positive but non-significant correlations.

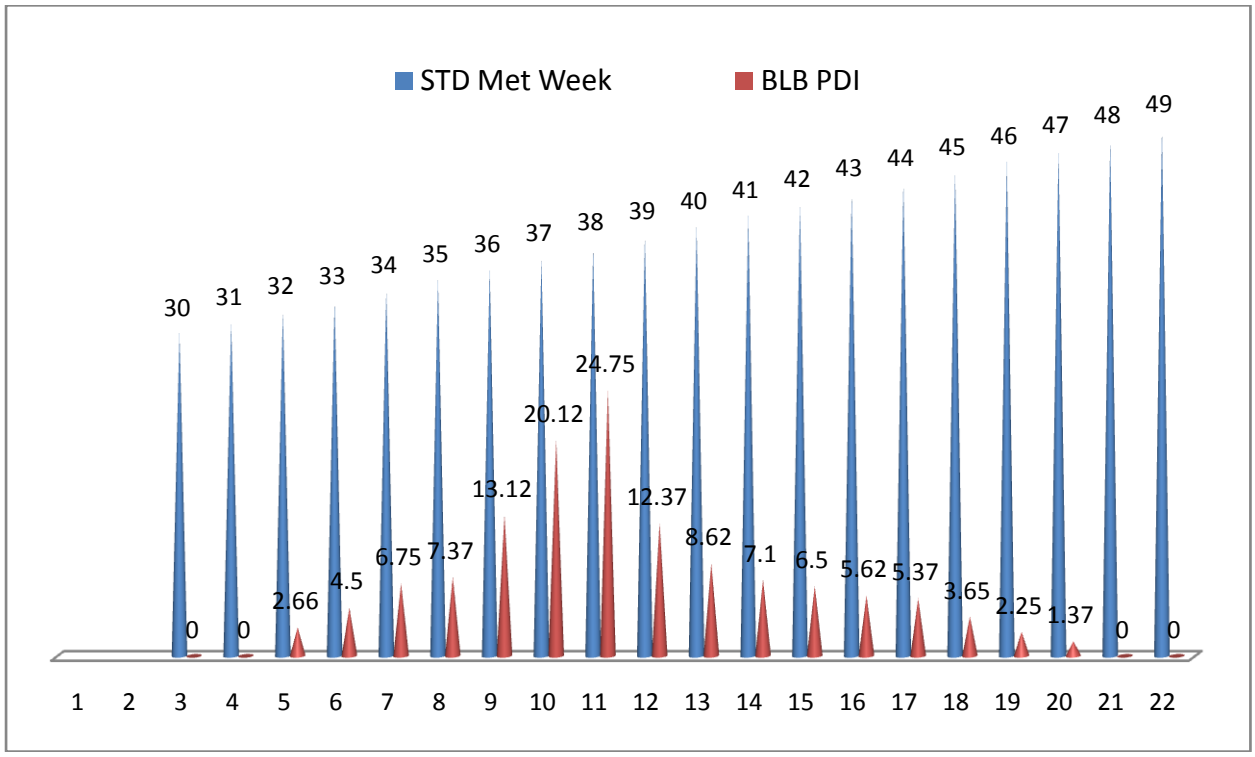

Fig: 1. Seasonal incidence of bacterial blight disease in cotton during 2013-14.

Table 1. Occurrence of Bacterial blight on G. Cot. Hy. 12 in relation to weather parameters at MCRS, NAU, Surat (2013-14)

Sr. No	STD Met Week	Period	BLB PDI	Weather parameter					
				Temp		Humidity		Rainy days	Rain fall
				Max	Min	Morning	Evening		
1	30	23/07/13-29/07/13	0.00	**29.2**	**27.3**	**88.5**	**81.7**	**7**	**86.9**
2	31	30/07/13-05/08/13	0.00	28.0	26.6	90.3	82.9	7	196.4

3	32	06/08/13-12/08/13	2.66	30.2	27.7	89.6	79.9	4	31
4	33	13/08/13-19/08/13	4.50	30.7	27.1	88.9	80	7	57
5	34	20/08/13-26/08/13	6.75	30.2	27.2	86.7	77.3	3	25.6
6	35	27/08/13-02/09/13	7.37	31.6	27.2	83.3	69.1	2	2.2
7	36	03/09/13-09/09/13	13.12	32.3	27.1	85.7	77.7	3	12.6
8	37	10/09/13-16/09/13	20.12	34.2	26.7	88.6	63.3	3	27
9	38	17/09/13-23/09/13	24.75	33.1	26.9	85.7	73.9	3	62.1
10	39	24/09/13-30/09/13	12.37	29.2	26.7	91.8	90.6	5	385.4
11	40	01/10/13-07/10/13	8.62	32.1	27.4	89.6	82.4	3	2.8
12	41	08/10/13-14/10/13	7.10	32.1	26.3	91.0	83.1	2	21.4
13	42	15/10/13-21/10/13	6.50	36.2	25.6	86.3	51.3	0	0
14	43	22/10/13-28/10/13	5.62	35.3	24.9	69.8	35.0	0	0
15	44	29/10/13-04/11/13	5.37	34.9	22.1	76.4	37.4	0	0
16	45	05/11/13-11/11/13	3.65	32.2	22.7	83.7	36.7	0	0
17	46	12/11/13-18/11/13	2.25	32.2	22.1	74.8	38.0	0	0
18	47	19/11/13-25/11/13	1.37	33.6	19.8	67.7	37.1	0	0
19	48	26/11/13-02/12/13	0.00	34.5	24.2	66.7	52.0	0	0
20	49	03/12/13-09/12/13	0.00	33.2	20.2	76.8	52.0	0	0
21	50	10/12/13-16/12/13	0.00	31.8	17	71.0	28.8	0	0
22	51	17/12/13-23/12/13	0.00	30.8	17.3	80.0	35.2	0	0
Correlation efficient				0.203	0.491*	0.409	0.368	0.168	0.181

*significant at 5 % and ** 1% level of significance

S.N.	Experiments	Location /Zone	Treat.	Variety	Design	Rep.	Plot size		Spacing (cm)	Sowing Date	Fertilizer NPK kg/ha	Irrigation
							Gross	Net				
1	Proj.Patho.1(b)	SG II Surat (Gujarat)	1	G.Cot.Hy. 12	Single block	1	36.0 x 13.5	33.6 x 11.7	120 x 45	18/06/13	240.40.0	2

ACKNOWLEDGEMENT

Author thanks to Main Cotton Research Station (MCRS), Surat (Gujarat) for providing the required facility and other arrangements for the conducting the experiment.

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VARIABILITY AND DECOMPOSITION ANALYSIS OF CEREALS PRODUCTION ACROSS DIFFERENT AGRO-CLIMATIC ZONES OF UTTAR PRADESH

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Received-16.06.2015, Revised-24.06.2015

Abstract: Present study in based on the secondary information collected on area, production and productivity of cereal crops grown among different agro climatic zones of Uttar Pradesh. The variability and decomposition analysis were analysed to measure the variation and decomposition analysis in area, production and productivity of cereals during three phases i.e 1981-82 to 2011-12. The decomposition analysis indicates increase in production of cereals was due to positive area and yield effect. The contribution of yield effect was greater than area effect in increasing the production of cereals in the state. Variability in area, production and productivity was also observed lowest i.e 1.34 per cent, 3.35 per cent and 3.43 per cent respectively during 2001-02 to 2011-12 and highest i.e 1.91 per cent, 6.17 per cent and 5.21 per cent respectively.

Keywords: Area, Cereals, Decomposition Analysis, Production, Productivity, Variability

INTRODUCTION

Agriculture is the backbone of Indian economy, contributing about 14 per cent to national GDP and providing employment to 54.8 per cent of the total work force. India occupies an important place in production of cereals, is predominant by smallholders that are characterized by low level output. Cereal crop contributes largely to achievement of food security level of a given country. Therefore, factors that affect the cereals production also have direct impacts on food security as majority of poor population depend on cereals as it is comparatively cheaper than any other form of diet. The increase in cereals production witnessed in India over the period 1950-51 to 1976-77 cannot be considered insignificant. The figure nearly 125 million tonnes for 1977-78 presents a sharp contrast to the 1950-51 production estimate of a little over 55 million tonnes. The total cereal production has increased from 2.33 per cent in the 1970`s to 2.84 per cent in the 1990`s and declined to 2.02 per cent in following decades and the same trend was experienced in the yield growth of total cereals. The share of rice and wheat to total cereals production has shown increasing trend from about 20 per cent during the 1970`s to about 57 per cent per year in total grain production during 21st century.

The negative growth rates of area under coarse grains were experienced from the period of 1970 to 2010. A higher positive growth rate registered in yield (2.54) per cent and production (1.92 per cent) during 1970`s. The decline in coarse cereals production, which is largely grown for self consumption, has occurred along with changes in consumption pattern in rural India. Such decline trend in the growth rate of food grain production during 1990`s had serious implications for national food security in recent times. Prior to green revolution, increase in food production has been achieved through the expansion of area, but during post green revolution, technological impact witnessed the shift towards rise in productivity, becomes a major factor contributing to the increase in output. However, during the 2000`s there was stagnation on both the accounts.

The stagnation in expansion of area and increase in productivity has forced us to give emphasis on variability and decomposition analysis. Instability associated growth not only hampers the agricultural development, but also reduces the economic health of the country, where agriculture still constitutes a sizeable proportion of the gross domestic product. So, it is always desirable to maintain higher rise in farm production with minimum variability in order to achieve sustained economic growth. Sometime, it is argued that high growth rate is associated with higher degree of instability. Again, variability in production affects both producers and consumers along with intermediaries involved in the movement of products through price fluctuations. Instability in agriculture and food production is also important for food management and macroeconomic stability. Although natural factors are mainly responsible for fluctuations in agriculture production but influence of technological factors cannot be also ignored. However, the impact of new technology on instability in agriculture and food production has not been quite clear and has remained a matter of concern. Whereas the decomposition analysis will allow us to understand the reason for the decrease or increase of production on the basis of three parameters i.e area, yield and their interaction. Keeping in view the present study is an attempt to examine variability in area, production and productivity and decomposition analysis of cereals.

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DATA BASE AND METHODOLOGY

Uttar Pradesh was selected purposively for the present study and divided into nine agro-climatic zones (NARP classification). The secondary data was collected and utilized for arriving at various conclusions of the study which was collected from different publications of Directorate of Agriculture Statistics, Uttar Pradesh and other related sources. The collected data was categorized, classified and then tabulated as per need and then suitable statistical tools and techniques were employed to analyse them. The statistical tools employed were:

Variability: Instability in area, production and productivity of cereal crops is measured in relative terms by the Cuddy-Della Valle index which is used in recent years by a number of researchers as a measure of variability in time series data. The simple coefficient of variation over estimates, the level of variability in time-series data characterized by long-term trends and the Cuddy-Della Valle index corrects the coefficient of variation. The variability index is given as:

Variability = $C.V.\times \sqrt{1} - R^2$

Where, $C.V.= \frac{\text{standard deviation}}{\text{Mean}} \times 100$

R^2 is coefficient of multiple determinations.

Decomposition Analysis: To determine the extent of relative contribution of area, yield and their interaction on the change in production of cereals, decomposition analysis is employed as suggested by Bastine et al. (1994)

The following additive scheme of decomposition was used:

$\Delta P = A_0\Delta Y + Y_0\Delta A + \Delta A\Delta Y$

Where,

A_0 = Total area under crops in base period

Y_0 = Total yield under crops in base period

$\Delta P/ \Delta Y/ \Delta A$ = Average difference in total production/ yield/ area during two periods.

RESULT AND DISCUSSION

The perusal of table 1 shows variability in area, production and productivity of cereal crops in the state and across different agro-climatic regions. It is the state as a whole overall variability, was estimated to be 2.23 per cent in comparison to 1.91 per cent, 1.34 per cent, and 1.77 per cent during the I, II and III phase respectively. Across the region variability as specified was found highest 4.48 per cent in Bhabhar and Tarai Zone and lowest 1.07 per cent in the Eastern Plain Zone during the first phase (1981-90). In the second phase (1991-2000) the same was varying from 0.91 per cent (Central Zone) to 4.92 per cent (Vindhayan Zone). Similarly in the III phase (2001-2011) it was found to be highest 6.58 per cent (Vindhyan Zone) and minimum 0.67 per cent in North Eastern Plain Zone. Overall growth across the region was observed to be highest 12.17 per cent in Vindhayan Zone and lowest 1.52 per cent in North Eastern Plain Zone.

Table also indicates the variability in production and shows during the first phase (1981-90) was highest 9.19 per cent in Bhabhar and Tarai Zone and lowest 5.54 per cent was reported in Eastern Plain Zone. 8.96 per cent variability was in Vindhayan Zone and 2.92 per cent production variability was estimated during the second phase. In the third phase more variation in production was to be observed than I and II. Overall variability in production was highest 32.08 per cent in Vindhayan Zone and 7.10 per cent in Western Plain Zone. State as a whole it was 17.23 per cent.

The overall variability in productivity of cereal crops in the state was 15.85 per cent, which was 4.30 per cent, 3.43 per cent and 5.21 per cent during I, II and III phases respectively. The overall variability across different zones, Vindhayan Zone shows highest 22.96 per cent variability and minimum in Bundelkhand Zone. During I and II phase, no more variation was observed while in the third phase yield variability was found from 3.75 per cent to 17.09 per cent.

Decomposition analysis of cereals production is showed in the table 2. The result from the table shows that there was increase in production in the state during the Phase I, Phase II, Phase III and overall situation due to positive area and yield effect. The yield effect has the major contribution in increasing the production than area effect.

In phase I, the production of cereals increased throughout all the regions of the state i.e. Western Plain Zone, South Western Semi-Arid Zone, Bhabha and Tarai Zone, Bundelkhand Zone and North Eastern Plain Zone due to low negative area and high positive yield effect and Mid-Western Plain Zone, Central Zone, Eastern Plain Zone and Vindhayan Zone indicates positive area and yield effect.

In phase II, increase in production throughout all the regions. In South Western Semi-Arid Zone, Mid-Western Plain Zone, Bhabhar and Tarai Zone, Central Zone, Eastern Plain Zone, Vindhayan Zone and North Eastern Plain Zone is due to positive area and yield effect while in case of Western Plain Zone and Bundelkhand Zone due to low negative area and positive yield effect. In phase III, production has increased in all the regions of the state with positive area and yield effect except the Vindhayan Zone.

The overall situation show an increase in overall production during all three phases in all the regions of the state was due to positive area and yield affect except, in North Eastern Plain Zone, it was observed negative area and positive yield effect. Mainly increase in production was more due to yield effect than area effect. Therefore, more emphasis is to be given on yield aspects of such crops.

Table 1. Variability of area, production and productivity of total cereals in different zones of Uttar Pradesh. (in percentage)

Character	Phases	Regions									State
		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	
Area	**I**	4.22	3.59	4.21	4.48	3.50	2.74	1.07	2.12	1.61	1.77
	II	2.02	1.82	3.96	3.94	0.91	2.72	4.16	4.92	0.92	1.34
	III	3.51	2.43	3.88	3.24	2.94	6.07	1.52	6.58	0.67	1.91
	Overall	11.29	4.93	6.46	5.95	3.03	9.47	3.10	12.17	1.52	2.23
Production	**I**	8.69	7.25	8.40	9.19	7.40	7.17	5.94	8.90	6.22	5.63
	II	3.56	4.19	2.92	3.52	4.05	6.44	5.49	8.96	5.89	3.35
	III	6.32	4.64	5.55	3.19	5.78	19.88	8.56	22.64	6.92	6.17
	Overall	7.10	19.88	21.33	17.87	18.09	18.33	18.07	32.08	19.17	17.23
Productivity	**I**	5.76	5.01	5.06	6.91	4.50	5.77	5.52	8.89	5.54	4.30
	II	3.47	3.63	3.41	4.18	3.86	5.58	5.30	9.31	5.51	3.43
	III	4.08	4.07	4.38	3.75	4.55	14.42	7.91	17.09	7.15	5.21
	Overall	13.61	16.49	16.17	14.58	16.91	13.04	16.31	22.96	19.80	15.85

Note : Zone I- Western Plain Zone, Zone II- South Western Semi Arid Zone, Zone III- Mid Western Plain Zone, Zone IV- Bhabhar and Tarai Zone, Zone V- Cental Zone, Zone VI- Bundelkhand Zone, Zone VII- Eastern Plain Zone, Zone VIII- Vindhyan Zone, Zone IX- North Eastern Plain Zone

Table 2. Decomposition Analysis of total cereal production into area, yield and interaction effect in different zones of Uttar Pradesh. (in percentage)

Regions	Effects	Phase I	Phase II	Phase III	Over all
Zone 1	**Area**	-3.99	-0.05	+2.82	-2.74
	Yield	+8.63	+4.20	+4.39	+5.49
	Interaction	-0.11	-0.06	+0.33	-0.41
	Increase(+) /Decrease(-)	+	+	+	+
Zone 2	**Area**	-0.11	+11.58	+5.97	+4.24
	Yield	+11.75	+9.30	+10.52	+10.89
	Interaction	-0.38	+2.04	+1.01	+0.74
	Increase(+) /Decrease(-)	+	+	+	+
Zone 3	**Area**	+2.39	+7.87	+7.13	+3.92
	Yield	+11.46	+8.17	+9.09	+9.23
	Interaction	+0.82	+1.32	+1.18	+0.66
	Increase(+) /Decrease(-)	+	+	+	+
Zone 4	**Area**	-0.09	+2.88	+1.18	+0.82
	Yield	+5.39	+2.28	+2.28	+3.55
	Interaction	-0.31	+0.30	+0.11	+0.12
	Increase(+) /Decrease(-)	+	+	+	+
Zone 5	**Area**	+2.14	+9.32	+4.25	+2.69
	Yield	+20.53	+9.48	+25.22	+18.42
	Interaction	+0.66	+1.06	+1.01	+0.47
	Increase(+) /Decrease(-)	+	+	+	+
Zone 6	**Area**	-1.21	-0.01	+4.75	+0.06
	Yield	+3.02	+3.79	+7.55	+5.09
	Interaction	-0.28	-0.04	+1.33	+0.11
	Increase(+) /Decrease(-)	+	+	+	+

Zone 7	**Area**	+4.11	+1.76	+9.22	+4.59
	Yield	+17.95	+4.84	+20.84	+15.17
	Interaction	+1.32	+0.13	+2.17	+0.78
	Increase(+) /Decrease(-)	+	+	+	+
Zone 8	**Area**	+2.52	+2.23	-1.66	+0.23
	Yield	+9.81	+3.29	+2.03	+1.76
	Interaction	+0.55	+0.82	-0.37	+0.45
	Increase(+) /Decrease(-)	+	+	+	+
Zone 9	**Area**	-1.07	+0.71	+0.79	-0.41
	Yield	+22.03	+16.48	+26.22	+17.33
	Interaction	-0.40	+1.55	+2.30	-0.79
	Increase(+) /Decrease(-)	+	+	+	+
State	**Area**	+2.94	+35.39	+33.77	+13.65
	Yield	+10.12	+62.39	+109.28	+86.84
	Interaction	+0.95	+5.44	+7.43	+2.38
	Increase(+) /Decrease(-)	+	+	+	+

Note : Zone I- Western Plain Zone, Zone II- South Western Semii Arid Zone, Zone III- Mid Western Plain Zone, Zone IV- Bhabhar and Tarai Zone, Zone V- Cental Zone, Zone IV- Bundelkhand Zone, Zone VII- Eastern Plain Zone, Zone VIII- Vindhyan Zone, Zone IX- North Eastern Plain Zone

CONCLUSION

The state registers the high instability during 1991-92 to 2000-01 i.e II phase in area, production and productivity with minimum instability during 2001-02 to 2011-12 (III phase) Decomposition analysis reveals that yield is the main contributor in increasing the production of cereals. Due to positive effect of area and yield the cereal production increased drastically. The present analysis clearly indicates limited scope for the horizontal expansion of area, thus more emphasis should be given to increase in productivity through technological impact.

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ROLE OF *ALOE VERA* GEL COATINGS IN PROLONGING SHELF LIFE OF BANANA

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Received-31.05.2015, Revised-08.06.2015

Abstract: The present study was carried out to evaluate the ability of *Aloe vera* gel based herbal coatings to reduce the loss of post harvest fruit quality in banana. Unripe green banana fruits were coated with different formulations of Aloevera gel. The coated and uncoated fruits were stored at 25^0C in polypackaging and in open as well for 12 days. Visual, Firmness and sensory characteristics and marketability were analysed at regular intervals during the storage period. The coated fruits survived the storage period for 12 days in polybags and 10 days in open condition whereas all the uncoated controls decayed within 4-5 days in open and polybags respectively. The coatings controlled the PLW, ripening process and decay to a great extent and there by extended the shelf life and quality of the fruits. The effectiveness of AG coating was found to improve on incorporation of citric acid. This is probably the first study on utilizing an herbal alternative to extend the shelf life of banana.

Keywords: *Aloe vera*, Banana, Coating, Shelf life, Polypackaging

INTRODUCTION

Banana (Musa sp.) is a large perennial herb with leaf sheaths that form trunk like pseudostem**.** Banana has its origin in tropical region of south east Asia. Banana is a nutritious gold mine. They are high Vitamin B6 which helps to fight infections and is essential for this synthesis of heme the iron containing of hemoglobin; they are also rich in potassium and great source of fiber. Bananas are the fifth largest agricultural commodity in the world trade after cereals, sugar, coffee and cocoa. India, Ecuador, Brazil and China alone produce half of total banana of the world. The availability of this fruit is its availability round the year. FAO estimates that the present status of India is the largest producer of Bananas in the World with annual production of 29.7 million tonnes, which is the 23% of World's over all banana production. The major Banana producing states of India are Tamilnadu, Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Assam, Madhya Pradesh. India has the potentials to emerge as a major exporter of banana by minimizing the post harvest losses which is nearly up to 30-40 % .This high loss is due to lack of packaging, storage facilities and poor means of transportation (Workneh *et al*., 2010). For the fresh Bananas to reach the consumer in the right condition, it must be marketed properly, bearing in mind the application of most suitable temperature and humidity as well as appropriate packaging and handling method. Good handling during harvesting can minimize mechanical damage and reduce subsequent wastage due to microbial attack (Wills *et al.*, 1998). Recently, the use of Aloe vera (*Aloe barbadensis*) gel as an edible coating has been reported to prolong the shelf life and delay senescence in sweet cherry and table grapes (Martinez Romero et al., 2006; Serrano et al., 2006). *Aloe vera* gel based edible coatings have been shown to prevent moisture loss and softening decrease, control respiration and senescence rate, delay oxidative browning and reduce microorganism proliferation in fruits such as sweet cherries, table grapes, nectarines and papaya (Ahmad *et al*., 2009; Valverde *et al*., 2005; Martinez- Romero *et al*., 2006; Marpudi *et al*., 2011).

The traditional packaging method for banana is nested packaging in which dried banana leaf are used but the effectiveness of these packaging materials even has not yet been well investigated. Plastic films have been found to increase the shelf life of banana fruit but so far very little work has been done on post harvest management of banana. Use of edible coatings over fruits is used to improve their quality and shelf life. These can be also safely eaten as part of the product and do not add unfavorable properties to the food stuff. Recently, there has been increased interest in using Aloe Vera gel as an edible coating material for fruits and vegetables driven by its antimicrobial activity. Aloe Vera gel based edible coating have been shown to prevent loss of moisture and firmness, control respiratory rate and maturation development, delay oxidative browning and reduce microorganism proliferation in fruits such as Oranges, Grapes, sweet cherries and Papaya.

There are no reports presently on the post harvest application of Aloe Vera coating with polypackaging in minimizing the post harvest losses and enhancement of shelf life and quality of banana fruits. Therefore, this study was conducted with the objective of evaluating the effects of different formulation of Aloe Vera gel on post harvest life of banana fruits.

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MATERIAL AND METHOD

Freshly harvested banana (variety Robusta) fruits were procured from the local market of Noida. They were selected on the basis of absence of injuries and colour, fresh leaves of aloevera were obtained from the Noida International University, Greater Noida, U.P.

Preparation of coating solution

Aloe Vera gel matrix was separated from the outer cortex of leaves and this colourless hydroparenchyma was ground in a blender. The resulting mixture was filtered to remove the fibers. The liquid obtained constituted fresh Aloeveragel. The gel matrix was pasteurized at 70^0C for 45 minutes. Four different formulations of pure Aloevera gel were made i.e. 20%, 40%, 60% and 80%.Among them 40% pure AloeVera gel at pH4 is giving efficient result.40% Pure Aloe Vera gel is divided into four formulations

1-40% pure *Aloe vera* Gel (Pure AG)

2-40% Aloe Gel with citric acid (4.5-4.6gL-1)(AG+CA)

3-40% Aloe Gel with Ascorbic acid (1.9-2gL-1) plus citric acid (4.5-4.6gL-1)(AG+AS+CA)

4-40% Aloe Gel with Ascorbic acid ($2gL^{-1}$) only.(*AG*+AS)

Application of Herbal Coating

Before Coating, banana fruits were washed thoroughly and dried. The coating solution used for banana fruits were 40% Aloevera gel, AloeGel+ Citric acid, AloeGel plus Ascorbic acid, Aloevera Gel plus citric acid plus ascorbic acid. The fresh fruits were dipped in coating solution with gelling agent to increase the efficiency of coating at room temperature for 15 min. They were allowed to drain and then dried at room temperature to allow a thin film layer to be formed on the fruits. A bunch of six fruits were used for each coating solution. Fruits were then weighed and stored at 25^0C.Fruit without coating were stored under same conditions as those for coated fruits. Various parameters were analysed at fixed intervals. The parameters analysed included physiological loss in fresh weight, Change in peel colour, Appearance of sugar spot, Texture analysis and sensory analysis of fruit quality.

Visual Analysis

Visual Analysis of the fruit was done for the change in fruit weight and peel color rating.

Peel color rating is done on the basis of 7 point score scale.

1=All Green, 2=Light Green 3=50% Green, 50% yellow,4=More Yellow than green,5=Yellow with green tips,6=Full Yellow,7=Yellow flecked with Brown)

Sugar Spot Rating

Differently Aloevera coated fruits were visually observed for sugar spot Rating

Sugar spot rating is done on the basis of 0 to 3 score scale.

[0=no spots,1=1-20 spots per hand,2=21 to 50 spots per hand,3=more than 50 spots per hand]

Texture Analysis: For texture analysis penetrometer of 5/16" (8mm) tip was used after peeling the fruit.

Sensory Analysis: Sensory Analysis was carried out by 6 selected panelists. The fruits were randomly selected from each batch was evaluated visually in terms of peel color, texture, Flavor, Marketability. They rated each of the variant on the basis of 9-point Hedonoic Score Scale.

(1=Dislike extremely,2=Dislike very much,3=Dislike moderately,4=Dislike slightly,5=neither like nor dislike,6=like slightly,7=like moderately,8=like very much,9=like extremely.)

RESULT

Pure Aloevera gel and aloe vera gel with citric acid coated banana in polybags maintained at pH-4, kept at 25^0C showed delayed ripening, less sugar spot, fresh extended the shelf life upto 10-12 days whereas control got deteriorated within 4-5 days.

Visual Characteristics

The effect of different formulations of Aloe Vera coating in PLW was observed in table 1 and the shelf life is showed in fig.1. Physiological loss in weight during storage was found to be significantly different among the banana fruits treated with the different coatings and from control at the end of 10-12 days storage.

Table 1. Change in Fresh Weight of poly packed banana stored at 25^0C

Days	Control	G+CA	AG+CA+AS	AG+AS	Pure AG
0	327.15	373.18	369.58	385.50	310.58
4	308.14	368.50	358.55	371.65	306.74
8	-	356.65	-	-	295.55
12	-	340.95	-	-	280.05

Change in peel color rating is observed(Table2) in banana during 12 days storage. Pure AG and AG+CA coated banana showed approximately similar result till 10 days storage in open condition. AG+CA+AS and AG+AS coated bananas showed 6 (full yellow) and 7 (yellow flecked with brown)respectively stages of peel color rating scale during 10 days storage in open.

Sugar Spot Rating is also observed (Table2) in banana during 12 days of storage. On 10th day of storage AG+CA and Pure AG coated banana showed stage 3 (> 50 spots per hand),AG+CA+AS and AG+AS stage 3 (more than 50 spots per hand)on 6th day, during 10th day of storage. Control got deteriorated within 4th day of storage.

Table 2. Peel Color(PC) & Sugar Spot(SS) Rating of Polypacked banana stored at 25^0C

Days	Control		AG+CA		AG+CA+AS		AG+AS		Pure AG	
	PC	SS	PC	SS	PC	SS	PC	SS	PC	SS
0	2	0	2	0	2	0	2	0	2	0
4	7	3	4	1	5	2	5	2	4	1
8	-	-	5	2	-	-	-	-	6	2
12	-	-	6	2	-	-	-	-	7	3

Firmness Characteristics

During 12 day storage of banana in open and in polypackaging as well, on the 10th day there is approximately similarity between the texture of AG+CA coated and pure AG Coated i.e. 1.2 and 1.5 kg/cm^2.On the other hand banana showed improved texture comparative to control in polypackaging in terms of extended shelf life i.e. 12th day AG+CA and Pure AG coated banana showed 0.7 and 0.6 kg/cm^2 firmness (Table3).

Table 3. Texture Analysis (Kg/cm^2) of polypacked banana stored at 25^0C

Days	Control	AG+CA	AG+CA+AS	AG+AS	Pure AG
0	2.5	2.6	2.4	2.9	2.6
4	0.5	2.0	1.3	0.9	2.0
8	-	1.4	-	-	1.6
12	-	0.7	-	-	0.3

Sensory Characteristics

Colour, firmness, taste and marketability the major sensory attributes were scored by selected panel members. During 4th day, over all liking score 8.0,6.8,8.4,8.8,6.2 for Control AG+CA,AG+CA+AS,AG+AS, Pure AG respectively. Control showed complete ripening yellow in colour, sweeter in taste with adequate sugar spot, AG+CA coated showed towards ripening, 50% yellow,50% green stage with less sugar spot, AG+CA+AS showed full yellow peel colour with adequate sugar spot AG+AS yellow flecked with brown with adequate sugar spot, Pure AG coated showed more yellow than green peel colour.

On 12th day of storage AG+CA showed full yellow peel colour ,less sugar spot and better in taste comparative to pure AG coated banana showed yellow flecked with brown peel colour with more sugar spot. Polypacked bananas showed improved quality and shelf life compared to different formulations of Aloe Vera coated bananas in open. (Table4).

Table 4. Sensory Evaluation of polypacked banana stored at 25^0C

Days	*Control	*AG+CA	*AG+CA+AS	*AG+AS	*Pure AG
0	2	3.2	3.8	2.3	2.1
4	8	6.8	8.4	8.8	6.2
8	-	8.4	-	-	8.8
12	-	8.8	-	-	7.8

*Mean of Color, texture, Flavour & overall acceptability for each treatments.

DISCUSSION

Postharvest losses of fruits are a serious problem because of rapid deterioration during handling, transport and storage. Use of edible coatings over fruits is used to improve their quality and self life. These can be also safely eaten as part of the product and do not add unfavourable properties to the foodstuff. Recently there has been increased interest in using Aloe Vera gel as an edible coating material for fruits and vegetables driven by its antifungal activity. Edible coatings provide a barrier against external elements and therefore increase shelf life (Guilbert et al., 1996) by reducing gas exchange, loss of water, flavors and aroma and solute migration towards the cuticle (Saltveit,2001and Marpudi *et al.* 2012). Aloe Vera gel based edible coating have been shown to prevent loss of moisture and firmness, control respiratory rate and maturation development, delay oxidative browning and reduce microorganism proliferation in fruits such as Oranges, grapes, sweet cherries and Papaya. In case of Papaya, the Aloe Vera coated fruits survived the storage period of 15 days at low temperature whereas all the uncoated

controls decayed within 10 days. (Marpudi *et al*; 2011) Marketability was also found to be better for coated fruits. When studies were done of Grapes, it was found that the storability could be extended up to 35 days at 1 °C. (Asghari *et al*., 2013). Oranges have also been used for study and it was found that Aloe Vera coating in oranges resulted in decrease in weight loss, increase in titrability of acids and higher TSS. (Arowara *et al*;2013). Thus, Aloe Vera gel is being increasingly studied as edible coating in fruits, which would be an innovative and interesting means for commercial application and an alternative to the use of postharvest chemical treatments leading to the enhancement of shelf life of fruits.

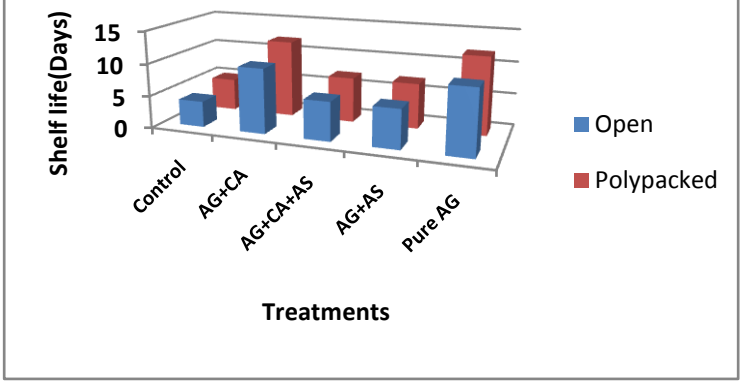

Fig. 1. Shelf life of Open and polypacked bananas stored at 25^0C

The results have proved the ability of different formulations of Aloe Vera in extending the shelf life of banana. Different formulations of *Aloe vera* has been tried on banana. Banana in polybags showed better shelf life comparative to open at 25^0C .Pure Aloevera gel has extended the shelf life up to 10-12 days without and with bagging in terms of quality also. Different concentrations of pure Aloe vera has shown appreciating results.40% Aloe Vera gel with citric acid giving efficient results in comparison to 20% ,40%,60%,80% Aloe Vera gel coated banana.

40% Aloe Vera gel with citric acid coated banana in poly bags maintaining pH-4 keeping at temperature 25^0C showed encouraging results.60% and 80% pure aloevera gel coated banana showed not much effective results as they got deteriorated within 7 days.20% Aloe vera gel maintaining pH-5,7 showed less sugar spot but there is no proper ripening as banana showed shrinkage.40% Aloe Vera gel maintaining pH-5,7 showed fast ripening, more sugar spot, shelf life is not much extended in comparison to control.

Aloe Vera with citric acid played significant role in extension of shelf life of banana as there is less microbial infection is observed comparative to other formulation of Aloevera. Aloe Vera with citric acid improved the quality, firmness, less sugar spot &sensory characteristics of banana.

CONCLUSION

On the basis of finding, it can be concluded that the shelf life of banana enhanced with Aloe Vera gel based coating and its effectiveness can be increased with polypackaging.40% Aloe Vera gel with citric acid maintaining pH-4 keeping at temperature 25^0C showed significant role in retarding microbial infection. Polybags showed effective results as they have enhanced the shelf life upto 12 days.

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A REVIEW ON THE USE OF NICOTINE BASED INSECTICIDES IN INSECT PEST MANAGEMENT

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Received-12.06.2015, Revised-05.07.2015

Abstract: The green revolution in our country paved the pathway for intensive and indiscriminate use of chemical pesticide which caused serious hazardous to human being and their environment a part for increasing trends to resistance in insects. The ill effects of chemical pesticides have once again focused our attention to use the pest control. It is well known that natural pesticides are ecofriendly and are safe to the non target organisms. The tobacco plants have been recognized for its insecticidal properties. A number of nicotine based insecticides with unique mode of action were registered during the late 1990s and early 2000s for insect control in agriculture. These new insecticides have several advantages over older groups of insecticides.

Keywords: Nicotine, Insecticides, Insect

INTRODUCTION

Now a days pesticide are being used extensively in the control of insect pests because agriculture has been facing the destructive activities of numerous insect pests leading to decrease in yields. So the production and consumption of pesticides has greatly increase agriculture production can be denied, but synthetic pesticides have also cause unprecedented ecological damage. Use of these naturally occurring plant to check pest population is one of the safest method of insect pest management and botanically pesticide has raised some hope for better management of dreaded pests worldwide in an eco-friendly manner. Use of chemical pesticide has resulted in immediate high returns to farmers. However their heavy and extensive use has created various health and environmental problems. To avoid this problem use of environmental safer bio-pesticides is gong momentum these days. Nicotine is an alkaloid obtained from tobacco plant and tobacco *Nicotiana* spp. family Solanaceae whose insecticidal properties have been known for several years. Nicotine active against insect orders viz: coloeptera (Beetles), hemiptera (Aphids, whitefly) and thysonoptera (Thrips) etc.

Nicotine is one of the oldest known plant origin insecticidal activities. It acts as contact poison, which kills the insects rapidly within hour causing activities mimics acetylcholine in the nerve synapse causing tremors loss of co-ordination and eventually death. Nicotine represents the class of nicotinoids with a unique mode of action.

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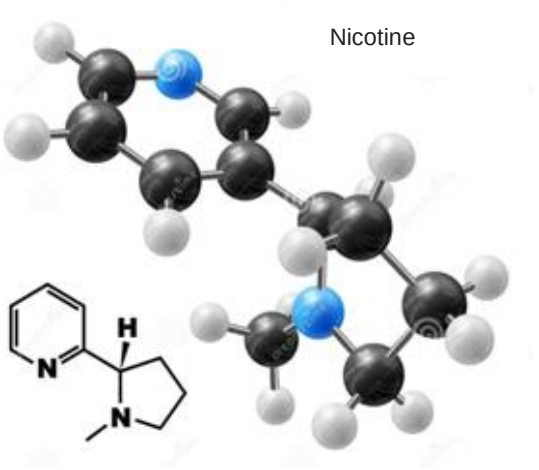
History

The plant has been cultivated by the American, Indians for at least 1000 years and it remained a part of their religious ceremonies. Long before knew of nicotine alkaloid in tobacco, *Nicotiana tabacum* L., the latter was being used as a dust or water extract to control phytophagous insects, some three hundred year ago, Nicotine has by now been isolated from at least 18 species of plants. *Nicotiana rustic a* containing 18 per cent nicotine is a better source than the more familiar *N. tabacum* containing 6 per cent nicotine. Many of these plants also contain the related alkaloid nornicotine and anabasine. *N. glauca* grown in Argentina and Uruguay contains a higher amount of anabasine. Systematic use of nicotine sulphate started with the Introduction standardized pesticide formulation containing 40 per cent actual nicotine around l910. Before Second World War, nicotine sulphate was a very popular insecticide around the globe. With the advent of synthetic insecticides, it lost its ground due to less persistence and high cost. Now that interest in botanicals is being revived, nicotine sulphate has also resurged as a preferred pesticide.

Chemical properties

Neo-nicotinoids are a class of neuro-active insecticides chemically similar to nicotine. Most neo-nicotinoids are water soluble and break down slowly in the environment, so they can be taken up by the plant and provide protection from insects as the plant grows.



Independent studies show that the photo degradation half life time of most neo-nicotinoids is around 34 days when exposed to sunlight. However, it might take up to 1,386 days (3.8 years) for these compounds to degrade in the absence of sunlight and microorganism activity. Some researchers are concerned that neo-nicotinoids applied agriculturally might accumulate in aquifers.

Reason of using bio-pesticides synthesized from Nicotine

Until the mid 20th century, pest insect control in agriculture relied on largely inorganic and botanical insecticides, which were inadequate. Then, the remarkable insecticidal properties of several organochlorines, organophosphates, methylcarbamates, and pyrethroids were discovered, leading to an arsenal of synthetic organics. The effectiveness of these insecticides, however, diminished over time due to the emergence of resistant insect strains with less sensitive molecular targets in their nervous systems. This created a critical need for a new type of neuroactive insecticide with a different yet highly sensitive target. Nicotine in tobacco extract was for centuries the best available agent to prevent sucking insects from damaging crops, although this alkaloid was hazardous to people and not very effective. The search for unusual structures and optimization revealed a new class of potent insecticides, known as neonicotinoids, which are similar to nicotine in their structure and action.

The neonicotinoids had three other distinct advantages:

1. They are far more toxic to insects than to mammals, making them much safer for humans.
2. They are absorbed by plants and translocated via the vascular system, giving effective control of sap sucking and boring insects which other sprayed insecticides might not contact.
3. They can be applied as seed treatments thus being a solution to the longstanding problem that roughly 99% of sprayed treatments never actually hit a target pest, and thus are unnecessarily dumped into the environment.

Nicotiana tabacum L.

The neonicotinoid insecticides have become widely popular with farmers, and when used as seed treatments, drenches, or attentively applied foliar sprays, appear to indeed be more environmentally friendly than the alternatives. However, the problem lies in the delicate balance between applying them in a manner that targets the pests, without harming "off target" species, such as bees and native pollinators. So let's look at some of the questioned adverse effects.

Mode of action of nicotine

Neonicotinoids, like nicotine, bind to nicotinic acetylcholine receptors of a cell and trigger a response by that cell. In mammals, nicotinic acetylcholine receptors are located in cells of both the central nervous system and peripheral nervous systems. In insects these receptors are limited to the central nervous system. Nicotinic acetylcholine receptors are activated by the neurotransmitter acetylcholine. While low to moderate activation of these receptors causes nervous stimulation, high levels over stimulate and block the receptors, causing paralysis and death. Acetyl cholinesterase breaks down acetylcholine to terminate signals from these receptors. However, acetyl cholinesterase cannot break down neonicotinoids and their binding is irreversible.

Role of neo-nicotinoids for insect pest management in different crops

Cotton: It is well known that there is a major problem of sucking insects in the Bt. Cotton. There are so many sucking insects found associated to Bt cotton viz. Aphid *Aphis gossypii*, White fly *Bemasia tabaci* (Genn.) , Jassids *Amrasca biguttula biguttula* (Ishida) and Thrips *Thrips tabaci.* Spray against Jassid should be controlled by the Imidacloprid 17.8% SL @ 20-25 a.i. (gm)/Ha and this insecticide also control the white fly, aphid and thrips. Thiacloprid, is a highly active novel insect control agent with broad spectrum efficacy against sucking

and biting insects at 48-180 g a. i./ha depending on crops, pest and application type. Five years of field studies have revealed excellent control of important pests in cotton. (Elbert, A. *et al.,* 2009)

Rice: Insect-pests pose serious threats to the rice crop by attacking every part of the plant at all the growth stages. Some of the major insect pests of rice are Stem Borer *Scirpaphaga incertulas* (Walker), BPH *Nilaparvata lugens* (Stal.), WBPH (*Sagetalla furcifera*) and GLH *Nephotettix virescens* (Dist.). The nio-necotine based biopesticides are using mostly for the control of these insects in various agricultural fields of their effective insecticidal properties. Registered neo-nicotine based insecticides are using against BPH, WBPH and GLH Imidacloprid 17.8% SL @ 20-25 a.i. (gm)/Ha. Use granular Imidacloprid 0.3% effective to reduce the population of Stem borer. several experiments were conducted under greenhouse conditions to assess the toxicity of neonicotinoid and phenylpyrazole compounds against brown plant hopper (BPH, *Nilaparvata lugens*), white-backed plant hopper (WBPH, *Sogatella furcifera*) and green leafhopper (GLH, *Nephotettix virescens*) infesting rice. Data were recorded for knock-down kill and persistent toxicity against the mobile stage of hopper pests; downward- and upward translocation efficacy of newer insecticides (thiamethoxam, Imidacloprid, thiacloprid, fipronil and ethiprole) (Krishnaiah, N. V *et al.,* 2004)

Oilseed crops: Mustard Saw fly *Athalia Lugens proxima*, Jassids *Empoasca kerri* Aphids *Lipaphis ersyimi*, Thrips *Thrips tabaci* and Painted bug these are the main pest of oil seed crops. Against mustard saw fly recommended neonicotinoid Imidacloprid 70% WS/100 kg seed were found to be effective in reducing the population of this pest in mustard. Jassid, aphid and white fly successfully controlled by the using of Imidacloprid 17.8% SL. thiamethoxam applied as Cruiser OSR at 15 L/1000 kg seed (=17 g a.i. ha^{-1}) gave significant control of *Myzus persicae* for up to 10 weeks after sowing, equivalent to that given by clothianidin plus beta-cyfluthrin applied as Modesto at 12.5 L/1000 kg seed (=24+4 g a.i. ha^{-1}). Control given by Imidacloprid plus beta-cyfluthrin applied as Chinook at 20 L/1000 kg seed (=8+8 g a.i. ha^{-1}) was significantly poorer and less persistent on some occasions. Infection of plants by turnip yellows virus (TuYV) in the following spring was also significantly reduced by thiamethoxam and clothianidin plus betacyfluthrin in all trials**.** (Dewar, A. M. *et al.,* 2011)

Fruit crops: Mango, citrus and grapes are important fruit crops in the plains of India. These crops together herbivore by different species of insect pests. Some of them are Mango hopper *Idioscopus clypealis* (Lethiery), Leaf minor *Phyllocnistis citrella* (Stai.) and psylla *Diaphorina citri* (kuwayana). In case of mango trees there are a number of insect pests of this fruit and over 175 species of insects have been reported damaging mango tree but the most abundant and destructive at the flowering stage are the mango hoppers. Three species of mango hoppers recorded as pests are *Idioscopus clypealis* (Lethiery), *Amritodus atikinsoni* (Lethiery) and *I. niveosparus* (Lethiery). They are widely distributed in India. The citrus psylla is also the most destructive and consequently, the most important of all the insect pest of citrus. Another problem of citrus psylla is also responsible for spreading the greening virus. The nicotine based insecticide (nio-necotine) Imidacloprid 17.8% SL was found effective and recommended for the control of hoppers. Field experiments were conducted to evaluate Imidacloprid, *Verticillium lecanii* and a neem product against mango hopper during 2007 and 2008 in low hills of Himachal Pradesh. Two sprays were given, first before opening of flowers and second 21 days after first. The insecticides were also evaluated at high pest density during May, 2008. Imidacloprid was found highly effective against mango hopper maintaining hopper count (<1/panicle) even at a lower test dose (0.0036%). This also resulted in higher fruit set in 'Dashehari' mango. (Singh Mohinder *et al.,* 2010)

Fodder crops: In case of sorghum, crop insect shoot fly *Atherigona soccata* attack the young crop. The total loss in yield is some time as high as 60 per cent. And in pearl millet shoot fly and termite cause loss the crop. The nicotine based insecticide Imidacloprid 70% WS/100 kg seed recommended for the management. the bioefficacy of chemicals as seed treatment of sorghum *bicolor* cv. M 35-1 against shoot fly and shoot bug showed that treatment with thiamethoxam 70 WS at 2 g/kg recorded lower infestation of dead heart (7.9%) with less shoot bug population (5.83/5 plant), and higher grain yield (31.93 q/ha) besides, higher fodder yield (56.92 q/ha). Imidacloprid 70 WS at 5 g/ha, endosulfan 35 EC seed soaking (8 h) at 2 ml/litre/kg and carbosulfan 25 DS at 40 g/kg were the next best treatments and were on par with each other. (Kumar, L. V.; Prabhuraj, A. 2007)

Vegetables: There are many vegetable crops which is damaging by the sucking insects. Mustard aphid (*Aphis erysemi*) is found to be regular and major pest of vegetables in addition to act as a vector for Yellow Mosaic Virus. Cabbage aphid (*Brevicornye brassicae)* is also reported as important pest of cabbage. Jassid, aphid and thrips reducing the yield of chilly and they are also vector of disease transmission. In tomato field white fly damage found some time and these insect are controlled by the Imidacloprid 17.8% SL @ 20-25 a.i. (gm)/Ha. Thiamethoxam at normal and double the recommended use rate effectively controlled aphids, whiteflies and *Helicoverpa*, as the insect population decreased to a minimum within 10 days of spraying in comparison with the control. There was no significant difference between1 the two rates of

application, and both thiamethoxam treatments significantly increased tomato fruit yield compared with the untreated control. (Rajib *et al.*, 2009)

CONCLUSION

Botanicals help in preventing the dumping of thousands of tons of pesticides on the earth; they are safer to the user and the environment because they are biodegradable and break down into harmless compounds within hours or days in the presence of sunlight.

There is a wide scope for the use of plant-based pesticides in the insect pest management. Production of botanical insecticides would remove the high cost of importation in developing countries.

The appropriate use of eco-friendly botanical insecticides can play a significant role in sustainable crop production by providing a stable insect management programme. Thus the search of new botanical insecticides with greater efficacy, persistance and desirable host specificity should continue using molecular tools and recent novel technique.

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SHORT COMMUNICATION

FLORAL PHENOLOGY OF *TRICHOSANTHES CUCUMERINA* L. – A MEDICINALLY IMPORTANT CUCURBIT

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Received-19.06.2015, Revised-24.06.2015

Abstracts: *Trichosanthes cucumerina* L. is an annual cucurbit popularly known as "Jangali Chachinda" in hindi. It is widely distributed in tropical regions of Bangladesh, India, Nepal, Pakistan, Srilanka, Myanmar, Vietnam, Indonesia, Malaysia and Philippine (Sandhya *et al*., 2012). The fruits of the species are relished as a vegetable and are known to have good nutritional value. The plant is also rich in flavonoids, carotenoids and phenolic compounds. It holds promising place in the Ayurvedic and Siddha system of medicine due to its various medicinal values like antidiabetic, hepatoprotective and cytotoxic effects (Sandhya *et al*., 2010).

Keywords: *Trichosanthes cucumerina*, Monoecious, Nocturnal, Reproductive efficiency

INTRODUCTION

In Jammu district of J&K state (India) vines of the species can be seen growing at several places (Samba, Birpur, Purmandal, Kathua, Hiranagar). In our attempt to enlist wild cucurbits of Jammu province some of these plants were located and tagged at Birpur and Purmandal area of Samba district of Jammu province (Alt - 345masl, Loc – N33º08.648, E075º45.939). To promote this species as a cash crop under cultivation due to its high nutritional and medicinal value, phenological data was gathered on these plants. Plants were seen to propagate by seeds only. Seeds germinate in the month of June and the plant pass a brief vegetative phase of one and a half month. Commencement of flowering occurs in mid July and extends till the ending September.

The temperature during the flowering season fluctuates between 25.9 - 36.6 ºC in the month of July to 22.4 - 31.9 ºC in September. The species is monoecious bearing separate male and female flowers. Lower nodes of the vine bear staminate flowers, while on the middle and upper nodes both staminate and pistillate flowers coexist. Male flowers are first to open on a vine at lower staminate nodes followed by the opening of female flowers after a time gap of 10 – 12 days at middle nodes, on the nodes of their coexistence female flowers are first to open followed by the opening of male flower after a gap of 9-10 days. Successful fruit set thus requires pollen transfer between different nodes.

Male flowers are borne on pedunculate raceme with each raceme bearing about 27 – 31 male flowers. Female flowers are solitary with short peduncle. Both male and female are white coloured with tubular calyx and corolla lobes fringed with hair like outgrowths (Fig.1). Both male and female flowers of the species are fragrant and nectariferous.

T. cucumerina is nocturnal with flower opening initiating between 2030 to 2100 hrs. Male flowers are first to open followed by the opening of female flowers after an interval of 10 – 15 mins, at the time of their existence, at different nodes on a vine. Another dehiscence in male flower begins as soon as the flower open but it gets completed only by 6000 to 7000hrs of the next day, at a time when female flower show maximum receptivity. Stigma receptivity in female flower also initiates with flower opening, though the peak is achieved only during morning hrs. Flowers of both the sexes remain open for the whole day and finally close by 1800hrs. Fruit set is initiated simultaneously with the closure of female flowers. Opening thus expands for about 20 – 22 hrs. During this period of flower opening, flowers are visited by both nocturnal (moths) and diurnal (bees, butterflies, ants) insect visitors. Species thus enjoys dual benefit of nocturnal and diurnal pollination. The same results in high reproductive efficiency which is depicted in both high fruit set (75%) and seed set (80%).

ACKNOWLEDGEMENT

The authors are grateful to the Head of Botany, University of Jammu and BSR (Basic Scientific Research) Fellowship for providing the financial support and all other necessary facilities to carry out the research work.

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Fig-1. ***Trichosanthes cucumerina*** **a) A climbing vine b) A Male flower (X 1.5) c) A Female flower (X 1.2) d) A fruit (X 0.5)**

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SHORT COMMUNICATION

EVALUATION OF AVAILABLE MICRONUTRIENTS (Fe & Cu) STATUS IN BLACK SOILS OF BAMBHANIDIH BLOCK IN DISTRICT JANJGIR-CHAMPA OF CHHATTISGARH

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Received-15.06.2015, Revised-21.06.2015

Abstract: A Study was undertaken to evaluate the micronutrients status of Bambhanidih block in Janjgir- Champa district, Chhattisgarh covering 32 villages during 2011-2012. The systematic collection of samples was carried out in geo–referenced surface (0-0.15m) soils samples from 575 sites representing *Alfisols* and *Vertisols* using Global Positioning System. The samples were analyzed for DTPA-extractable iron and copper content. The statistical description of soil characteristics indicated the available Cu and Fe content ranged from 0.2 to 12 and 4.1 to 57.1 mg kg^{-1} with mean 1.7 and 23.1 respectively. The available copper and iron content showed high level in soils of Bambhanidih block

Keywords: Micronutrients, Iron, Copper, *Alfisols*, *Vertisols*

INTRODUCTION

Soil fertility management will ultimately consider all aspects of soil – plant relationship and pollution of the environment as well. Soil fertility may be defined as the soil system's nutrient supplying capacity. It helps in adopting appropriate measures for overcoming various limitations and at the same time ensures optimum crop production. All plant needs certain mineral elements for proper growth, development, and maintenance. Micronutrients are important soil elements that control its fertility. Soil fertility is one of the important factors in relation to evaluation of productivity status of the soils of an area and region. It is an important aspect in context of sustainable agriculture production. Soil fertility is an important factor, which determines the growth of plants. Soil fertility is related to the amount of available nutrients which is measured by yield capacity. There are some other factors like organic matter or even soil texture which influence the availability of nutrients and the productivity. Soil micro nutrients are an essential as primary and secondary nutrients for the development of crop growth. The addition of micro nutrients to fertilizers in the optimum amounts and in degraded soils ensures the sustainability of cropping through balanced nutrition and ultimately sustainable development of the fertilizer industry. Soil test-based fertility management is an effective tool for increasing productivity of agricultural soils that have high degree of spatial variability resulting from the combined effects of physical, chemical or biological processes (Goovaerts, 1998). However, major constraints impede wide scale adoption of soil testing in most developing countries. In India, these include the prevalence of small holding systems of farming as well as lack of infrastructural facilities for extensive soil testing (Sen. *et al.*, 2008). The advent of information technology have provided tools like Global Positioning System (GPS), Remote sensing, Simulation modeling and Geographical Information System (GIS), which help in collecting a systematic set of georeferenced samples and generating the spatial data about the distribution of nutrients (Sharma, 2008). This will also helps to monitor the changes in micronutrients status over a period of time as sampling sites can be revisited with the help of GPS which is otherwise difficult in the random sampling (Sood *et al.*, 2003).

Study area

Bambhanidih is located at Janjgir district lying between $21^0$51'956"N latitude to $82^0$44'989"E longitude. It has average elevation of 792 feet.The District Janjgir- Champa is situated in the center of the Indian state of Chhattisgarh and so it is considered as the "Heart of Chhattisgarh". The Janjgir-Champa district is a major producer of food grains in the state of Chhattisgarh. The Hasdeobango project has been considered as life supporting canal for the District Janjgir-Champa. Under this project 75% area of the District will be covered for irrigation. The District head quarter of Janjgir-Champa is in Janjgir-Champa, which is situated on national highway no.- 200. Janjgir-Champa is 65 Km away from Bilaspur and 175 Km from state capital Raipur through road route.

MATERIAL AND METHOD

The micronutrients Fe were extracted by using 0.005M DTPA (Diethyl triamine penta acetic acid), 0.01M calcium chloride dehydrate and 0.1M triethanol amine buffered at 7.3 pH Lindsay and Novell (1978) and concentrations were analyzed by atomic absorption spectrophotometer 4129.

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RESULT AND DISCUSSION

Available Cu status

Table 1. Range and Mean values of different nutrients in study area according to soil type

SOIL PARAMETERS	ALFISOLS		VERTISOLS	
	RANGES	MEAN	RANGES	MEAN
Available Cu mg kg^{-1}	0.2-12.0	1.7	0.2-5.3	1.9
Available Fe mg kg^{-1}	4.1-57.1	23.0	5.9-48.3	25.3

Table 2. Distribution of available copper status in surface soils of Bambhanidih block

Available Cu (mg kg^{-1})		Alfisols		Vertisols		Total (%)
		No. of Samples	% Samples	No .of Samples	% Samples	
Deficient	<0.2	5	0.9	1	2.9	1.0
Sufficient	0.2-0.4	20	3.7	6	17.6	4.5
High level	>0.4	516	95.4	27	79.4	94.4

The DTPA-extractable Cu content of soils under study varied from 0.2 to 12.0 mg kg^{-1} in *Alfisols* and *Vertisols* with an average content of available Cu recorded as 1.7 mg kg^{-1} (Table 1). The results were in conformity with the findings of Singh and Raj, (1996) in soils of Himachal Pradesh and similar results were also reported by Singh and Jain, (1971), Meena *et al.*, (2006), Yadav and Meena, (2009) and Singh *et al.*, (2009).

The available Cu ranged from 0.2 to 12.0 and 0.2 to 5.3 mg kg^{-1}with an average value of 1.7 and 1.9 mg kg^{-1} in *Alfisols and Vertisols*, respectively of study area (Table 2). Considering deficient (<0.2), sufficient (0.2-0.4) and high (>0.4 mg kg^{-1}) level of DTPA-extractable Cu as critical limit (Follett and Lindsay, 1970) in table 4.2, 94.4% soil samples were found to be in higher level, 4.5% soil samples were found to be in sufficient level and only 1.0% in deficient available content of Cu, in soils of Bambhanidih block (Table 2). A major group of soils fell under higher level of available copper (>0.4 mg kg^{-1}) having 95.4% and 79.4%, in *Alfisols and Vertisols*, respectively of Bambhanidih block.

Most of the soil samples were found under high level in available Cu content with a model class of >0.4 mg kg^{-1} DTPA-extractable Cu (Table 2). Kumar *et al.*, (2009), Rajeshwar *et al*., (2009), Meena *et al.*, (2006), Jatav (2010), Shukla (2011) and several other workers reported available copper in similar range.

Available Fe status

Table 3. Distribution of available iron status in surface soils of Bambhanidih block

Available Fe (mg kg^{-1})		Alfisols		Vertisols		Total (%)
		No. of Samples	% Samples	No. of Samples	% Samples	
Deficient	<4.5	4	0.7	0	0	0.7
Sufficient	4.5-9	58	10.7	5	14.7	10.95
High level	>9	479	88.5	29	85.3	88.3

The available Fe content ranged from 4.1 to 57.1 and 5.9 to 48.3 mg kg^{-1} with an average of 23.1 and 25.3 mg kg^{-1} in *Alfisols and Vertisols*, respectively of study area (Table 1). These findings corroborate with results as reported by Rajeshwar *et al.* (2009) in soils of Krishna district of Andhra Pradesh and also confirm the findings of Singh *et al.* (2009) in the DTPA-extractable Fe in the soils of district Gajipur, Uttar Pradesh.

Similar results were also reported by Jatav (2010) in the soils of *Inceptisols* group of Baloda block of Janjgir-Champa district of Chhattisgarh and Shukla (2011) in the *Inceptisols, Alfisols* and *Vertisols* orders of Pamgarh block in Janjgir-Champa district (C.G.).

Considering 4.5 mg kg^{-1} DTPA-extractable Fe as critical limit (Table 3) (Lindsay and Norvell, 1978), 0.7% soil samples were found deficient, and 10.95% found sufficient however, 88.3% samples recorded higher level of available Fe content (Table 3). High available Fe content in soils of Bambhanidih block might be due to its topography and cultivation of rice, which induced prolonged submergence coupled with reducing conditions. Majority of the soils were not deficient in Fe as the amount of iron required by crops is being released by iron bearing minerals in these soils. The soil pH had reverse effect on the availability of Fe content in soil. It was concluded from the table 3 that 88.5% and 85.3% samples recorded higher level of Fe and 0.7% and 0% samples observed deficient level of Fe, where as 10.7 and 14.7% samples recorded sufficient Fe in *Alfisols and Vertisols*, respectively.

CONCLUSION

It can be concluded from the above results that most of the *Alfisols* and *Vertisols* of Bambhanidih block in Janjgir-Champa district of Chhattisgarh showed most of soil samples tested observed high level of DTPA-extractable Fe and Cu observed in study area (Table 2-3). Hence, the soils require attention regarding nutrient management practices and regular monitoring of soil health for better crop production, in future.

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