USE OF DECISION SUPPORT SYSTEM FOR AGRO TECHNOLOGY TRANSFER (DSSAT) MODEL IN AGRICULTURE

Javed Iqbal Khan*, M. Jamil Khan and M. Niamatullah****
*Pakistan Meteorological Department, Islamabad,
**Faculty of Agriculture, Gomal University, Dera Ismail Khan,

ABSTRACT

Experimental Maize crop data was used in Decision Support System for Agro Technology Transfer (DSSAT) Model. These experiments were conducted during three consecutive years i.e. 2005, 2006 & 2007 at experimental farm of Regional Agromet Centre, Rawalpindi. DSSAT Model provides a user-friendly working environment in which various stand-alone tools and applications are seamlessly integrated. Within the shell, the user can launch applications for creating and modifying data files, running the crop models, and analyzing the results. DSSAT Model requires only four weather parameters as input viz. air temperature (Min. & Max.), solar radiation & precipitation. These parameters are to be given on daily basis. As an output, the model simulated different weather parameters viz. air temperature (Min. & Max.), average temperature, solar radiation, precipitation, soil temperature and day length hours. Some of results obtained from the model were compared with results recorded in the field. These results are annexed in Tables & Graphs form. Yield parameters were recorded on daily basis with the help of DSSAT Model (Frequency of output days).The role of soil temperature is significant from germination to ripeness and soil temperature were simulated at different depths which were compared with mean soil temperatures recorded at 0300, 0900 and 1200 (GMT) on daily basis during the entire growth period. The role of precipitation is also significant from germination to ripeness of a crop and was simulated during entire three years of crop growth period.

Key words: Agro-tech model, maize, soil temperature, precipitation.

INTRODUCTION

Pakistan is an agricultural country where about 22 million hectares (MHA) cultivated land under crop production depends directly or indirectly on rainfall. In these areas Maize is commonly planted in early July. Areas that are always moist or warm are not suited for maize crop. Maize is commonly sown around the start of July under rainfed conditions. Climate of upper Indus basin & Potohar plateau of Pakistan is transitional between the Central Asia and the monsoon climate of South Asia (Rao, 1981). Categorically the climate of Potohar plateau is semi-arid mainly nourished by summer monsoon (July-September) getting some share from winter precipitation (Chaudhry e*t al*. 2003). Early onset of monsoon precipitation results in timely sowing of Kharif crops in Potohar region. DSSAT is principally a research tool for crop production analysis which incorporates:

- Crop-Soil–Weather Models
- Analysis Tools (Uncertainty, Economics)
- Support Software (Graphics, Weather Data Generator)
- GIS Linkages, Spatial Variability Analysis

- Utilities to Help Users Integrate Data with Models

Yield parameters data such as grain yield, stem weight, root weight, water stress and nitrogen stress can also be simulated on daily basis with the help of DSSAT Model (Frequency of output days). In 1986, Jones, C.A. used cereal crops maize growth and development in Texas A&M University through DSSAT (V4) crop simulation model. During 1998, Carlos Pampulim University of Florida, worked on Soybean crop growth and yield model by IBSNAT version through DSSAT V3 to find a relational database between AGROSYS—DSSAT Model. Similar studies were also conducted by Carlos Pampulim Caldeira by Linking DSSAT V3 to a Relational Database. Sarkar and Kar (2006) studied evaluation of management strategies for sustainable maize-wheat cropping system using DSSAT seasonal analysis. Reshmi Sarkar (2006) conducted a simulation study using the Seasonal Analysis program on DSSAT model by taking into account years 2001 to 2003 data. This study was conducted by Reshmi Sarkar under a subhumid subtropical climate in Kharagpur, West Bengal, India. The study revealed that the generated future weather data were reliable and DSSAT could successfully use it to predict the future crop yields under different management practices.
This study related to the Maize Variety Agaiti-2002, sown in three consecutive years. The results obtained from three years provided a base to estimate the optimum ranges of various meteorological parameters for getting highest yield of the maize crop, grown under different Agro-climatic conditions.

Objectives

- To study the impact of different meteorological parameters on crop growth and its development.
- To develop the yield parameters of maize crop in the Rainfed areas of Potohar Region.
- To investigate the water satisfaction sensitivity of crop in Potohar region of Pakistan.
- To cover a step forward for formulation of yield estimation & forecasting at different phonological stages.

MATERIAL AND METHODS

For this purpose, both meteorological and crop data were recorded during the crop season. In order to compile the data of each development stage, weather data and basic crop information were put in "Weatherman" software of DSSAT crop model. Crop data including phonological stages and yield parameters observations were collected according to World Meteorological Organization (WMO) recommended criteria.

Data/Materials

The Agro meteorological parameters used in DSSAT Model during the experiments are listed in table 1.

Methodology

Three years crop and weather data were entered in four different programs i. e X Build, G Build, S Build and Weatherman. X Build program requires utility data entry like institute code, site code , name of crop, cultivar or variety, Research station with address and crop management data viz. date of sowing, date of harvesting, type of irrigation used in the experiment, fertilizer and method of application , tillage and organic amendments if applicable, pesticides. G Build program needs utility of output graphic form to carry out results in Excel and text forms. While in S Build program, utility of Soils data such as type of soil, soil series required to be incorporated to get the results, and in Weatherman program, Agro meteorological data like air temperature (min. & max.), solar radiation, & precipitation on daily basis was used to get the expected results. After fulfilling all respective requirements, the results were obtained on daily basis from simulation to date of maturity of a crop.

DSSAT V4.0

Data Management Tools

•XBUILD -Input Crop Management Information in Standard Format
•Weatherman-Assist Users in Cleaning, Formatting, Generating Weather Data
•SBUILD -Create Soil Files for Particular Fields
•GBUILD –Assist in viewing graphical output (seasonal and end-of-season)

RESULTS AND DISCUSSION

In Pakistan maize crop is sown in two seasons i.e spring maize sowing in February to March and seasonal maize in which sowing is started from last week of June and continued up to July. Farmers of the rainfed areas prefer July sowing due to potential of sufficient moisture availability from monsoon rains. Kharif season starts from mid June in the irrigated areas of Pakistan, but main activity starts in June-July over rainfed areas and continued till the end of July. In some cases when precipitation periods starts earlier then farmers also start sowing their crops earlier as well, however, Agriculture Department recommends sowing in July. In plain areas of Rawalpindi early monsoon rains provide favorable moisture for growing various Kharif crops. In this research, weather parameters viz. precipitation, air temperature (Min. & Max.), solar radiation, used to run the DSSAT Model was simulated on daily basis and was compared with observed data which was recorded at RAMC, Rawalpindi during 2005 to 2007 as shown in Table-1. From the figures it was concluded that there were similarity between simulated data and observed data, because both values overlapped each other. Simulation started one month before planting for each experiment conducted through DSSAT Model. During crop season 2005 simulation date is mentioned as 7th June, 2005, whereas data of sowing is 7th July, 2005 and the same practice was continued for other crop season.

Maize Crop 2005

The daily rainfall data from simulation to maturity during 2005 is indicated in Figure 7. Where, 193.5 mm and 214.1 mm rain were recorded during July and August as compared to normal 267.0 mm and 309.9 mm. Crop phonological stages from Emergence up to Floral initiation and Siliking were completed during these two months. During September 58.6 mm rain is recorded which is also important for plant growth stage as grain filling is completed during September and continued up to 15th of October. Precipitation remained below normal during 2005. Water and Nitrogen stress was noted during grain filling to end grain filling stage as shown in Table-2. The simulated grain yield was recorded as 2393 Kg/ha as compared with recorded yield (Field) of 2627 Kg/ha, While the range of normal yield in rainfed areas of Rawalpindi region was 2000-2200 Kg/ha as accessible in (Table-3) a minor deficit of rainfall during maturity stages affected on yield. Simulated yield parameters i.e stem weight and grain weight are shown in Figure 6. Simulated and observed Air Temperature (Min. & Max.) of maize crop during 2005 is shown in Figures. 8-9. As the dry period prolonged during maturity, temperature increase and non-availability of sufficient moisture ultimately affected yield, where as Solar Radiation is shown in Figure 10 shows variation in solar radiation with respect to rainy days and clear skies.

Maize Crop 2006

The results for weather parameters of maize crop during 2006 season are listed below. The rainfall was above normal as shown in Fig-17. The rainfall during July and August (550.9 mm and 327.2 mm) had good impact on maize crop (from germination to silking stage) But in September and October 13.9 and 40.8 mm rain was recorded, which was below normal, and which affected the beginning of grain filling up to end grain filling stages was affected. Water and Nitrogen stress was noted during these stages as shown in Table-4. As a results simulated grain yield was recorded as 2083 Kg/ha as compared with recorded yield (Field) 2287 Kg/ha. This is below normal during 2006 due to less water availability and nitrogen. The yield parameters (stem weight) was 3186 Kg/ha (Figure16). Simulated and observed Air Temperature (Min. & Max.) of maize crop during 2006 is shown in Figures 18-19. Dry period prolonged during maturity stage, temperature increased and non-availability of sufficient moisture caused reduction in yield. The Solar Radiation was recorded on daily basis as shown in Figure 20.

Maize Crop 2007

In 2007, the weather parameters were favorable and above normal rain were recorded. Simulated and observed data is shown in Figure 26. During the month of July and August 262 mm and 486 mm of rainfall was recorded against normal i.e. 267 mm and 309.9 mm respectively. In September only 2001 mm rainfall was recorded. Availability of sufficient moisture provided favorable environment to the maize crop from germination to maturity stage. Simulated crop growth at main development stages and simulated yield parameters of maize crop, such as crop growth stages with dates, biomass weight, leaf area, crop nitrogen and water stress from simulation to maturity stages (Tables 5) were also noted. No water stress was observed during the entire growth period. Only Nitrogen stress was noted during Floral initiation to Maturity stages. Simulated grain yield during the crop period was recorded as 2757 Kg/ha as compared with 3000 Kg/ha in field which was above the normal yield (Figure 3). By applying 2nd dose of Nitrogen fertilizers during Juvenile stage by keeping forecasting of rain yield may further be increased. The monthly rainfall data from date of simulation to maturity for the three consecutive years (2005 to 2007) of maize crop in given in Table 6. The simulated yield parameters were recorded with the help of DSSAT model on daily basis at different crop growth stages (phonological phases) as shown in Figure 25. Simulated and observed Air Temperature (Min. & Max.) during 2007 are shown in Figures 27-28. There was a decreasing trend is shown in minimum temperature during the maturity of maize crop which is useful for ripening of crop. The Solar Radiation is shown in Figure 29. Soil temperature plays an important role in growing period of crops, right from the germination to maturity. Simulated Soil temperatures data generated with the help of model at different depths were compared with mean recorded data. The recorded data was collected from RAMC, Rawalpindi, where the soil thermometers were installed at various depths. The depths of Soil temperatures recorded include 5 cm, 10 cm, 20 cm, 30 cm, 50 cm & 100 cm. It was noticed during crop season 2005 that there was no significant difference between simulated soil temperatures and recorded one except at 100 cm. The results are mentioned in Figures 1-5. In 2006 and 2007 there was small difference between simulated Soil temperature and recorded Soil temperature which can be accessible in the (Figures11-15 and Figures 21-24, respectively).

A. MANAGEMENT / SENSITIVITY ANALYSIS OPTIONS DURING KHARIF- 2005.

1. Simulation timing.......	Jun 7, 2005
2. Crop...................	Maize
3. Cultivar...............	Agaiti- 2002
4. Weather................	RFGA (Rawalpindi)
5. Soil...................	Loam
6. Initial conditions......	As reported
7. Planting...............	Jul 7, 2005; Row Spacing: 75 cm. Plants/m^2: 8.00
8. Harvest................	At harvest maturity
9. Water and irrigation...	On reported date(s)
10. Nitrogen...............	On reported date(s)
11. Phosphorus...........	On reported date(s)
12. Residue................	No residue application
13. Pests and diseases.	Pest & disease interaction not simulated
14. Field...........	RFGA (Rawalpindi).
15. Crop process options....	H_20: Yes, Nitrogen: Yes, Pest: No, Photosynthesis: Canopy Curve, weather: measured, ETo: Penman
16. Output control.........	Frequency: 1, Output: Yes, Summary: Yes, Growth: Yes, H_2O: yes, Nitrogen: Yes, Pesticide: No

B. Management/ Sensitivity Analysis Options during Kharif- 2006.

1. Simulation Timing......	May, 28, 2006
2. Crop...................	Maize

3. Cultivar................	Agaiti- 2002
4. Weather.................	RFGA (Rawalpindi)
5. Soil....................	Loam
6. Initial Conditions......	As reported
7. Planting............	Jun 28, 2006, Row Spacing: 75 cm. Plants/m^2: 8.00
8. Harvest.................	At harvest maturity
9. Water and irrigation.	On reported date(s)
10. Nitrogen................	On reported date(s)
11. Phosphorus............	On reported date(s)
12. Residue.................	No residue application
13. Pests and diseases.	Pest & disease interaction not simulated
14. Field............	RFGA (Rawalpindi).
15. Crop process options....	H_20: Yes, Nitrogen: Yes, Pest: No, Photosynthesis: Canopy Curve, weather: measured, ETo: Penman
16. Output control.........	Frequency: 1, Output: Yes, Summary: Yes, Growth: Yes, H_2O: yes, Nitrogen: Yes, Pesticide: No

C. Management / Sensitivity Analysis Options during Kharif- 2007.

1. Simulation Timing	Jun 13, 2007
2. Crop	Maize
3. Cultivar	Agaiti-2002
4. Weather	RFGA (Rawalpindi)
5. Soil	Loam
6. Initial Conditions	As Reported
7. Planting	Jul 13, 2007 Row Spacing: 75 cm. Plants/m^2: 8.00
8. Harvest................	At harvest maturity
9. Water and irrigation.	On reported date(s)
10. Nitrogen................	On reported date(s)
11. Phosphorus............	On reported date(s)
12. Residue.................	No residue application
13. Pests and diseases.	Pest & disease interaction not simulated
14. Field............	RFGA (Rawalpindi).
15. Crop process options....	H_2O: Yes, Nitrogen: Yes, Pest: No, Photosynthesis: Canopy Curve, weather: measured, ETo: Penman
16. Output control.........	Frequency: 1, Output: Yes, Summary: Yes, Growth: Yes, H_20: yes, Nitrogen: Yes, Pesticide: No

CONCLUSIONS

- Obtaining maximum yield from maize crop in rainfed areas of Potohar region by applying all agronomic practices (from simulation to harvesting, well-timed sowing, normal temperature and availability of rain water during early stages) resulted in good impact on grain yield of maize crop.

- Recommended first dose of fertilizers at the time of sowing and 2nd dose at Juvenile stage by keeping rain forecasting, as well as deep ploughing before start of monsoon season for moisture conservation increased the yield of maize crop.

- For maximum grain production, timely planting is of vital importance Drought and disease resistant varieties of maize are recommended to suit the demand of water during the months of September.

- For better yield, temperature should be within the range of 20-30 C^0 in September with required amount of rainfall due to silking and grain filling phonological stages of maize crop.

- By using basic weather parameters (such as air temperature (Min. & Max.), solar radiation & precipitation, yield forecasting) and yield parameters (such as grain yield, stem weight, root weight, crop nitrogen and water stress at different phonological stages) can also be obtained on daily basis from DSSAT Model.

- Significant weather data like Soil temperature and soil water at different depths during crop growing season can also be generated.

Table 1: Simulated and Observed Soil Temperature at Different Depths During 2005

S. NO.	Meteorological Parameters
1.	Solar Radiation(MJ/M^2)
2.	Maximum Temperature (^{O}C)
3.	Minimum Temperature (^{O}C)
4.	Precipitation (mm)

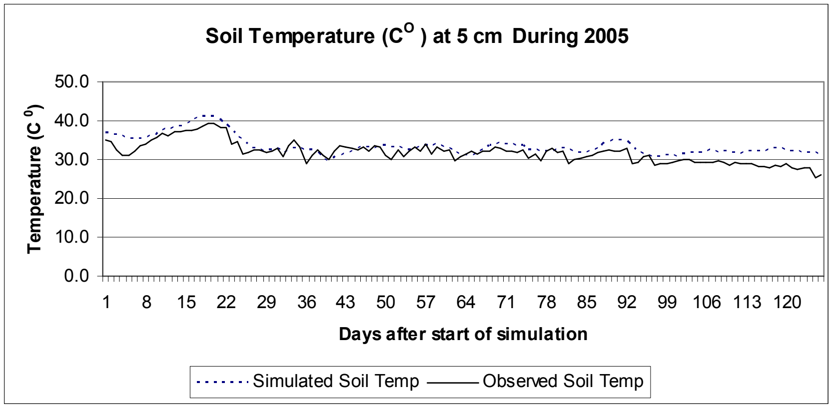


Figure 1:

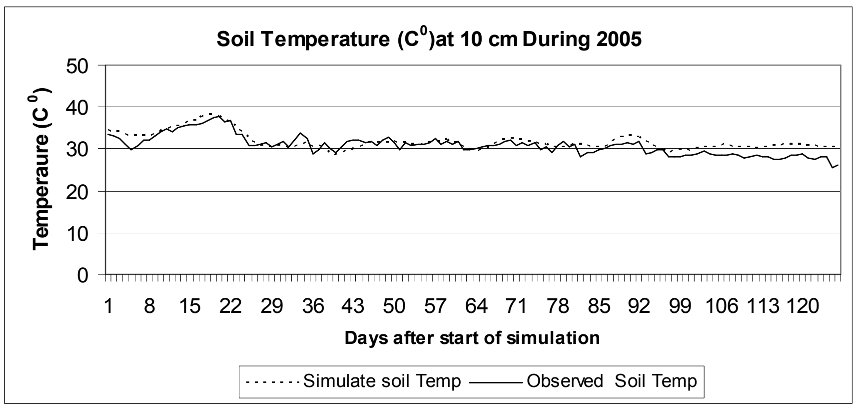


Figure 2:

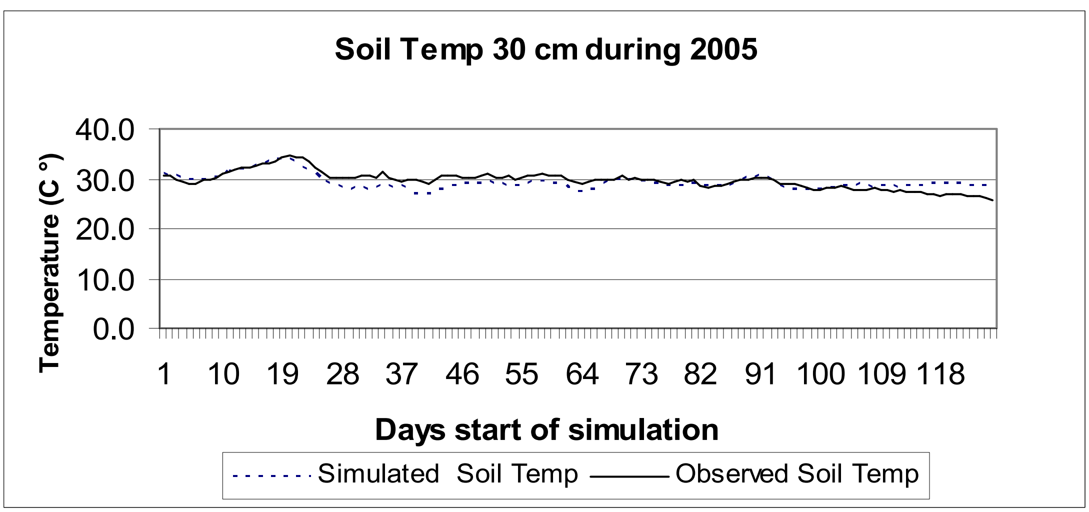


Figure 3:

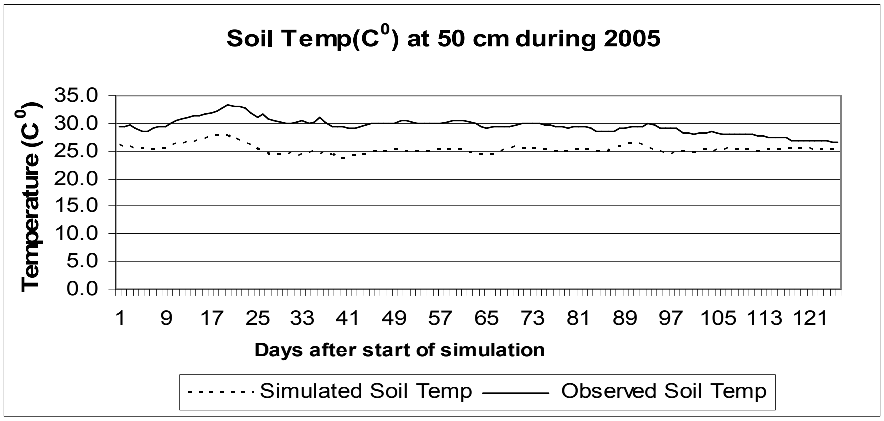


Figure 4:

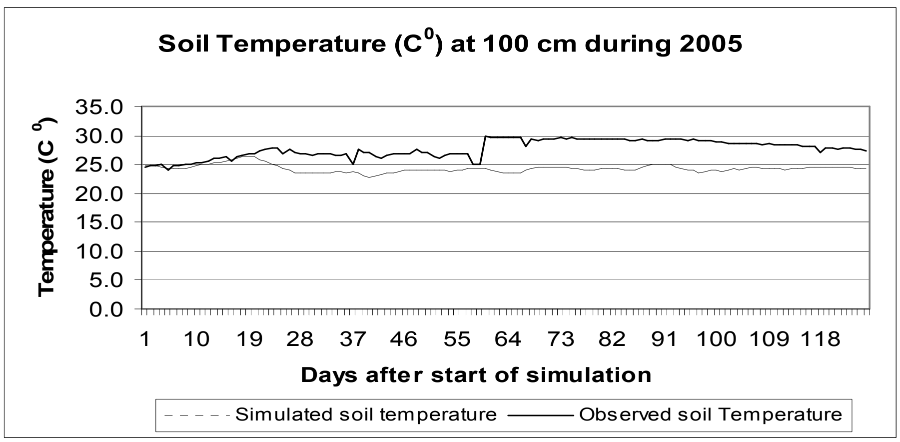


Figure 5:

Table 2: Simulated Crop Growth at Main Development Stages During Kharif- 2005

CROP	GROWTH		BIOMASS	LEAF		CROP N		STRESS	
Date	Age	Stages	kg/ha	LAI	NUM	kg/ha	%	H2O	N
7 Jun	0	Start Simulation	0	0.00	0.0	0	0.0	0.00	0.00
7 Jul	0	Sowing	0	0.00	0.0	0	0.0	0.00	0.00
8 Jul	1	Germinate	0	0.00	0.0	0	0.0	0.00	0.00
12 Jul	5	Emergence	32	0.01	2.2	1	4.4	0.00	0.00
25 Jul	18	End Juvenile	473	0.84	10.0	18	3.9	0.00	0.00
31 Jul	24	Floral Initiation	1409	2.02	13.2	49	3.4	0.00	0.00
31 Aug	55	75% Silking	8333	2.99	29.0	80	1.0	0.00	0.25
8 Sep	63	Beginning Grain Filling	9785	2.48	29.0	85	0.9	0.00	0.19
8 Oct	93	End Grain Filling	11810	1.08	29.0	93	0.8	0.37	0.15
10 Oct	95	Maturity	11810	1.08	29.0	93	0.8	1.00	0.09
10 Oct	95	Harvest	11810	1.08	29.0	93	0.8	0.00	0.00

LAI= Leaf Area Index, NUM=Number, N= Nitrogen

Table 3: Results of Maize Crop Yield Estimation at Regional Agromet Centre, Rawalpindi

VARIABLE	SIMULATED	OBSERVED	Crop Year
Yield at maturity (kg [dm]/ha)	2393	2627	2005
Yield at maturity (kg [dm]/ha)	2083	2287	2006
Yield at maturity (kg [dm]/ha)	2757	3000	2007

[dm]= Dry Matter, Normal Yield= 2000-2200 Kg/ha,

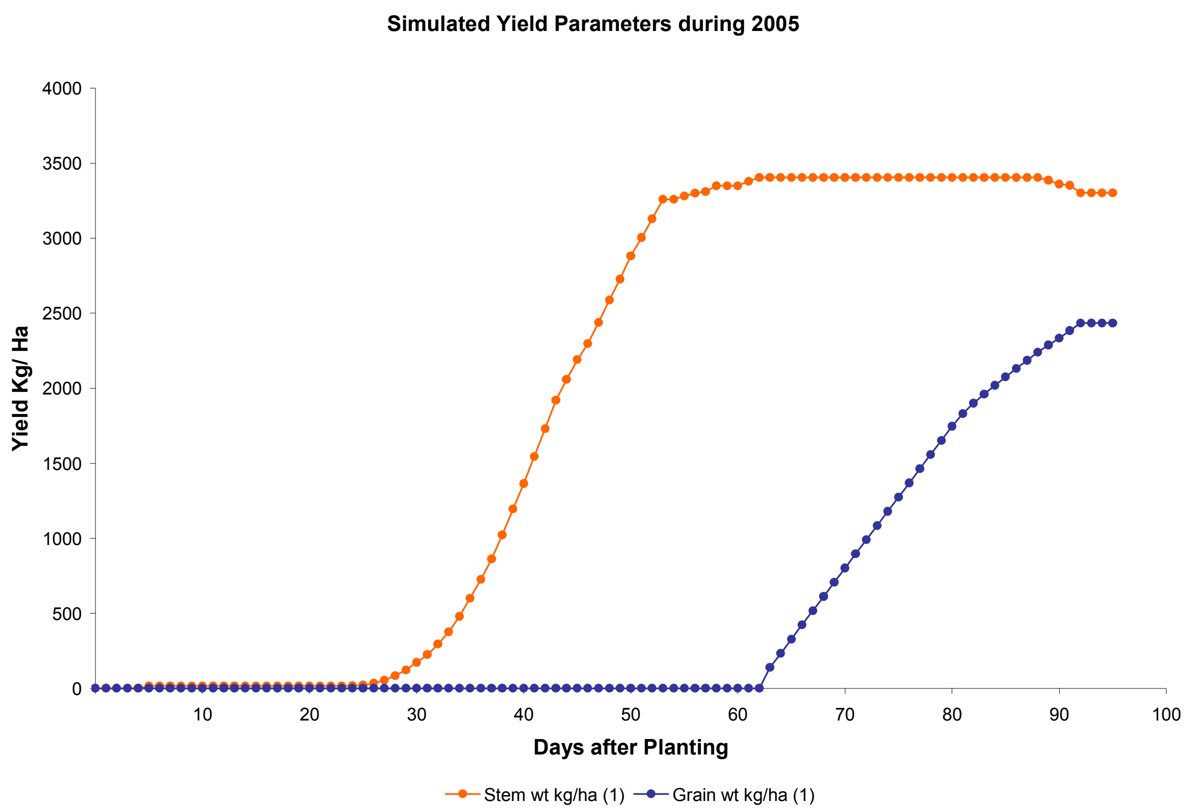


Figure 6:

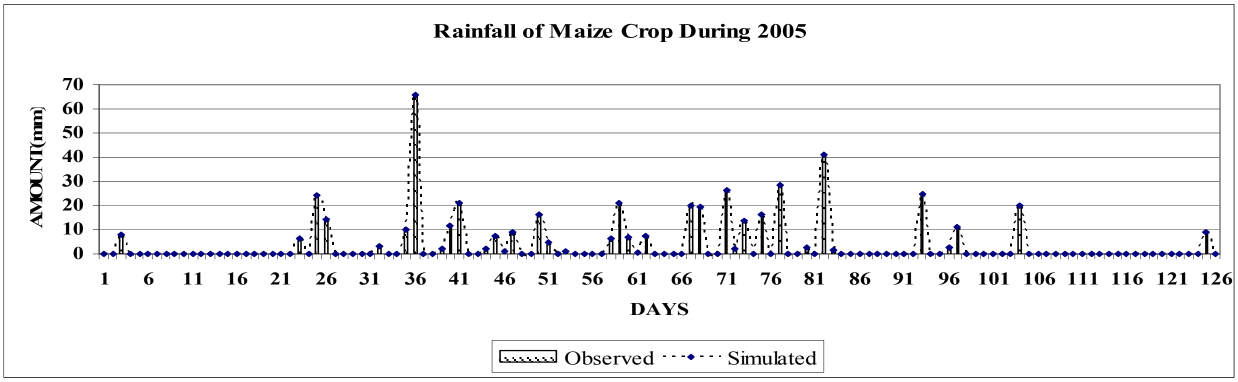


Figure 7:

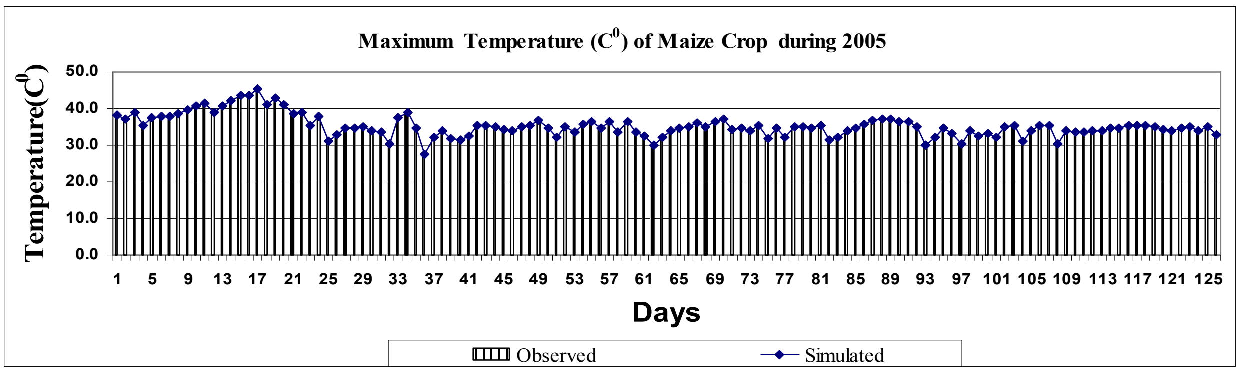


Figure 8:

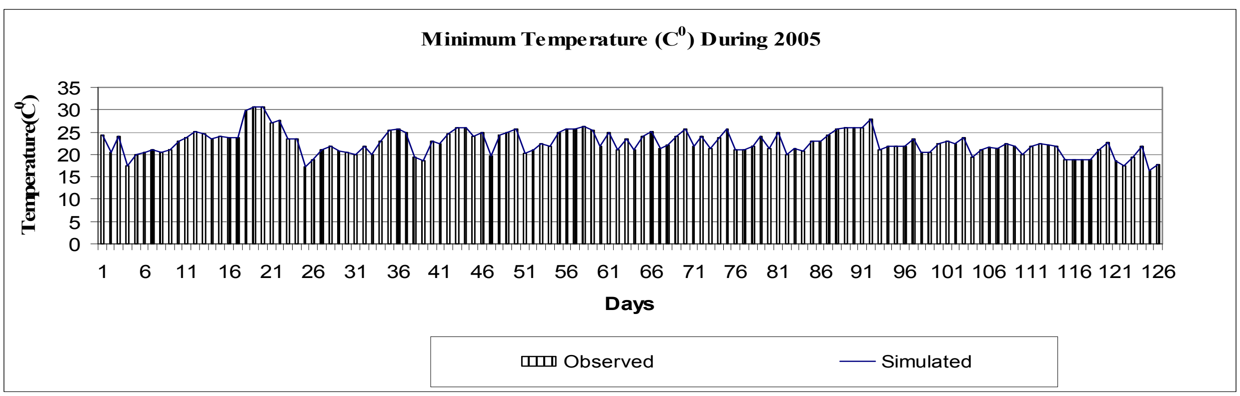


Figure 9:

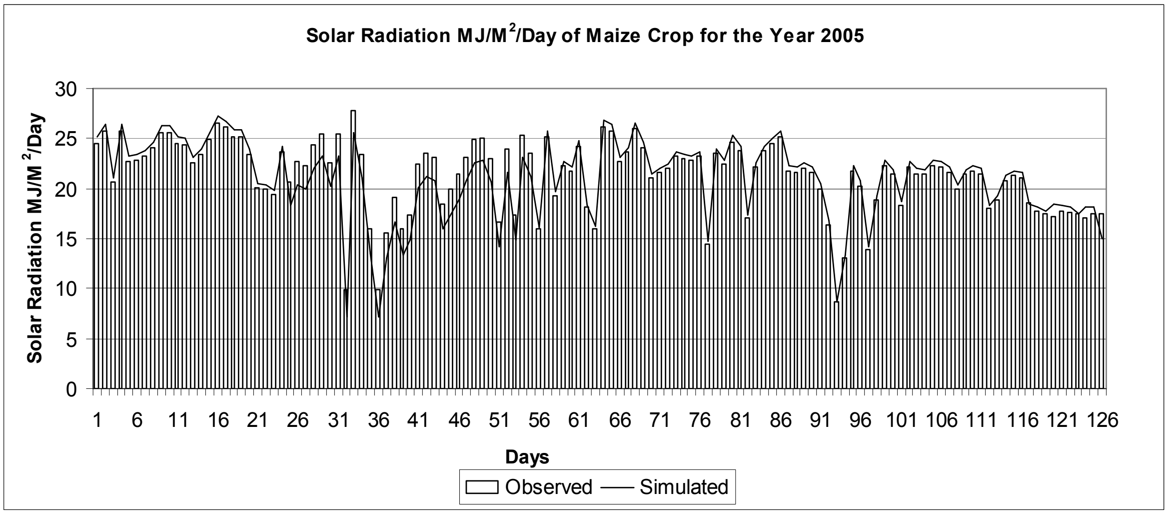


Figure 10:

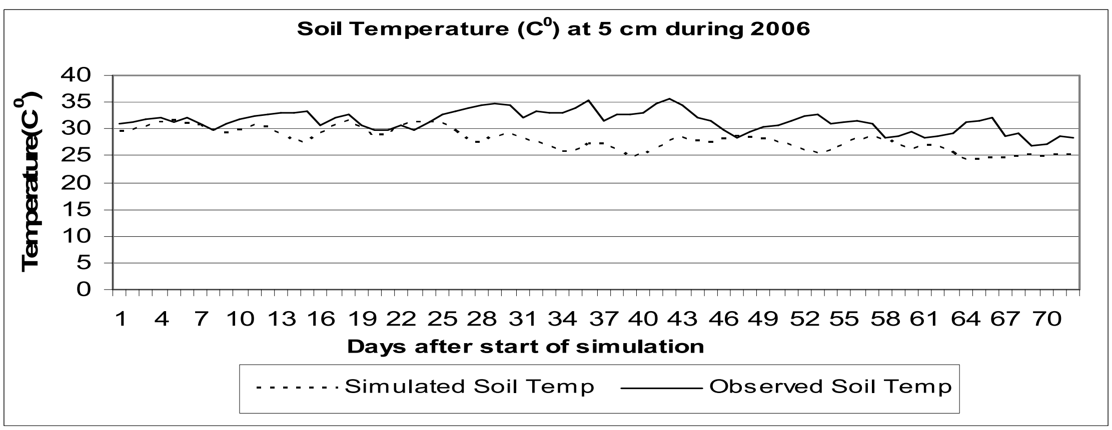


Figure 11: Simulated and Observed Soil Temperature at Different Depths During 2006

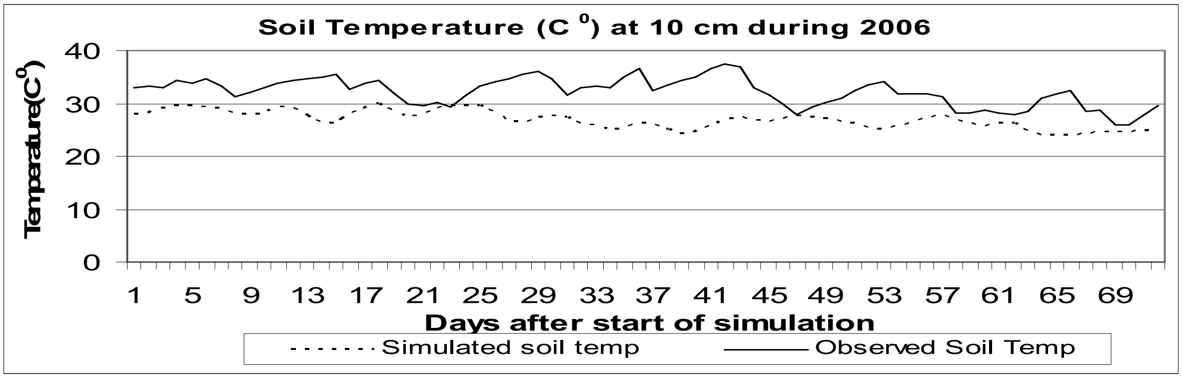


Figure 12:

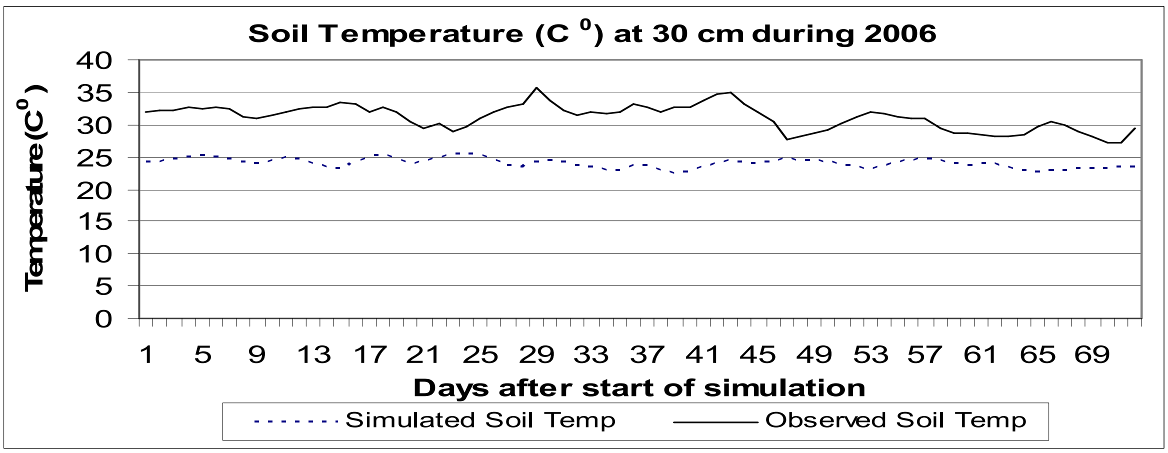


Figure 13:

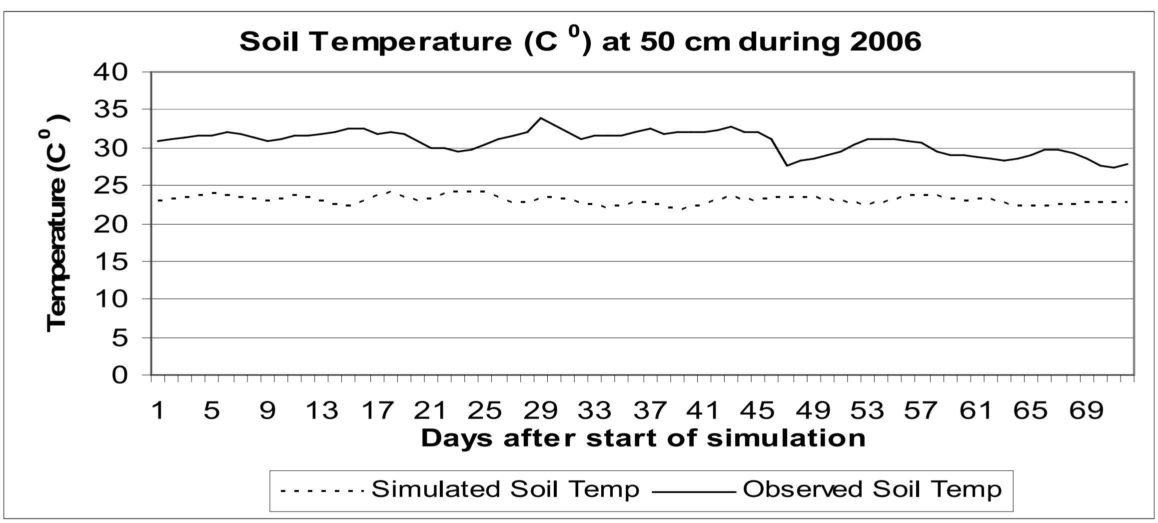


Figure 14:

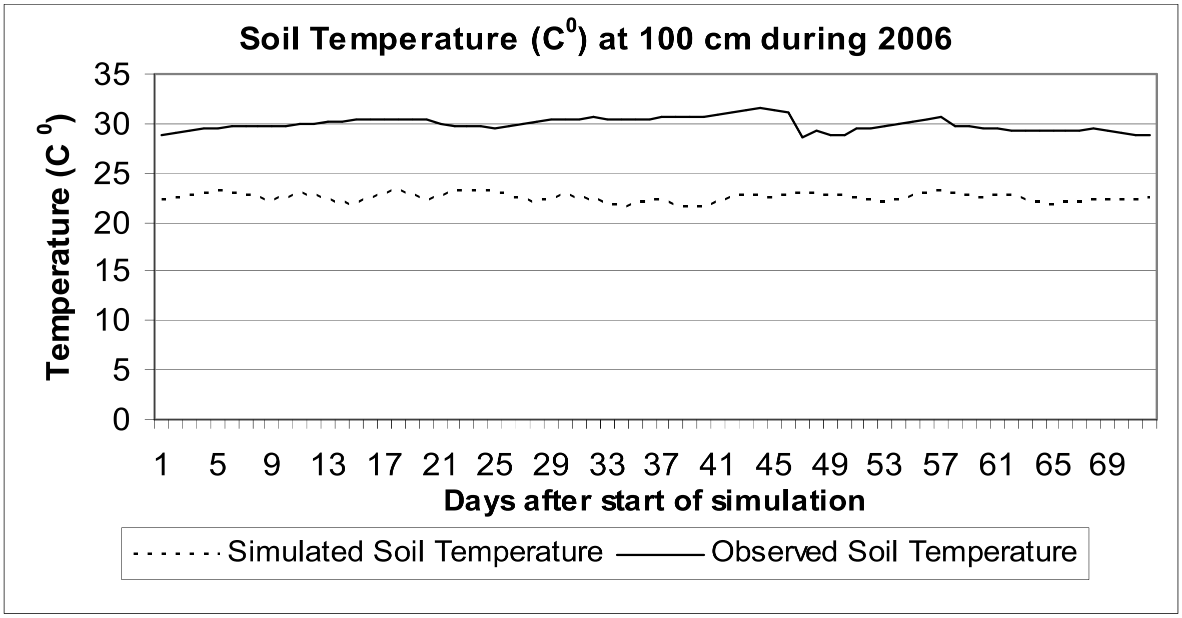

Soil Temperature (C0) at 100 cm during 2006
Temperature (C 0)
35
30
25
20
15
10
5
0
1 5 9 13 17 21 25 29 33 37 41 45 49 53 57 61 65 69
Days after start of simulation
Simulated Soil Temperature
Observed Soil Temperature

Figure 15:

Table 4: Simulated Crop Growth at Main Development Stages during Kharif- 2006.

CROP	GROWTH		BIOMASS	LEAF		CROP N		STRESS	
Date	Age	Stages	kg/ha	LAI	NUM	kg/ha	%	H2O	N
28 May	0	Start Simulation	0	0.00	0.0	0	0	0.00	0.00
28 Jun	0	Sowing	0	0.00	0.0	0	0	0.00	0.00
29 Jun	1	Germinate	0	0.00	0.0	0	0	0.00	0.00
3 Jul	5	Emergence	32	0.01	2.2	1	4.4	0.00	0.00
17 Jul	19	End Juvenile	485	0.86	10.1	19	3.9	0.00	0.00
23 Jul	25	Floral Initiation	1345	1.94	13.1	41	3.0	0.00	0.01
28 Aug	61	75% Silking	6337	1.95	29.0	57	0.9	0.00	0.34
02 Sep	71	Beginning Graining Filling	9628	1.51	29.0	62	0.8	0.00	0.23
03 Oct	109	End Grain Filling	11313	0.43	29.0	67	0.7	0.54	0.20
05 Oct	112	Maturity	11313	0.43	29.0	67	0.7	0.88	0.17
05 Oct	112	Harvest	11313	0.43	29.0	67	0.7	0.00	0.00

LAI= Leaf Area Index, NUM=Number, N= Nitrogen

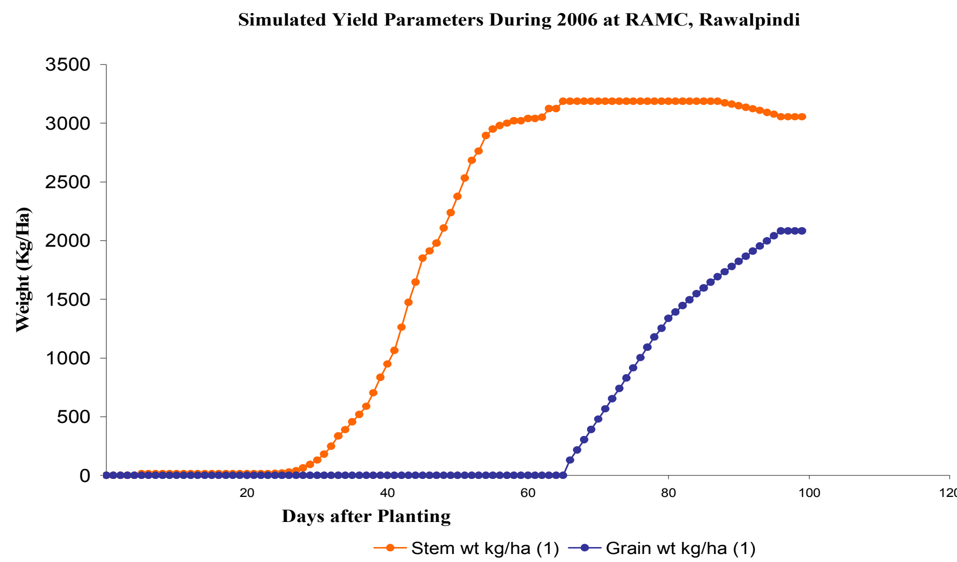


Figure 16:

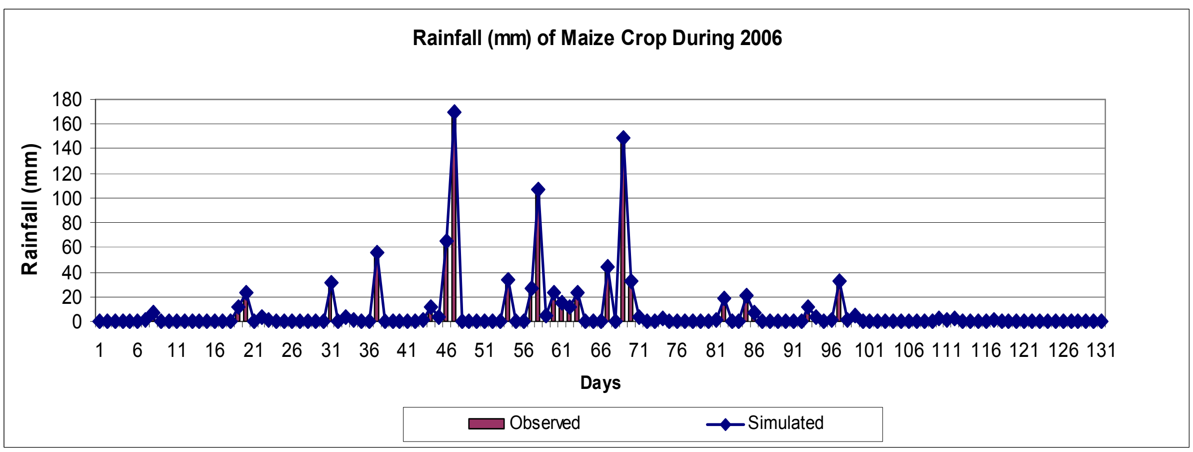


Figure 17:

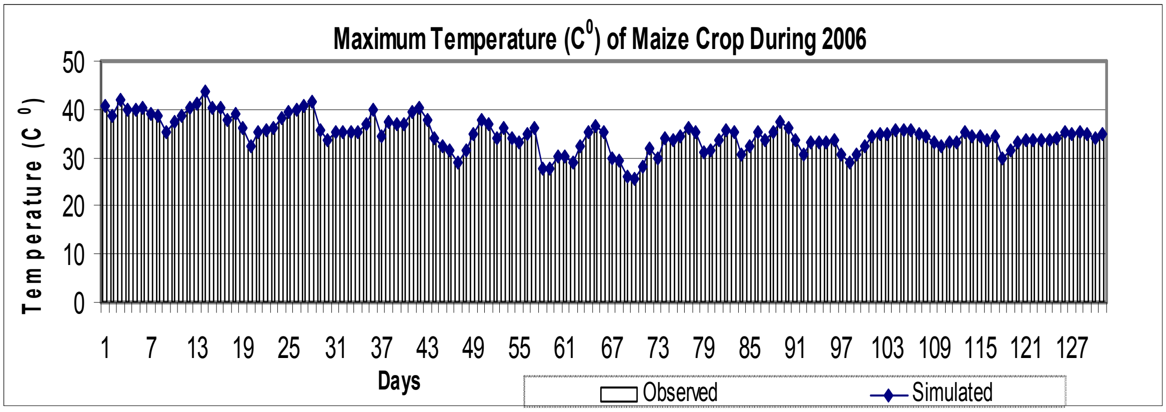


Figure 18:

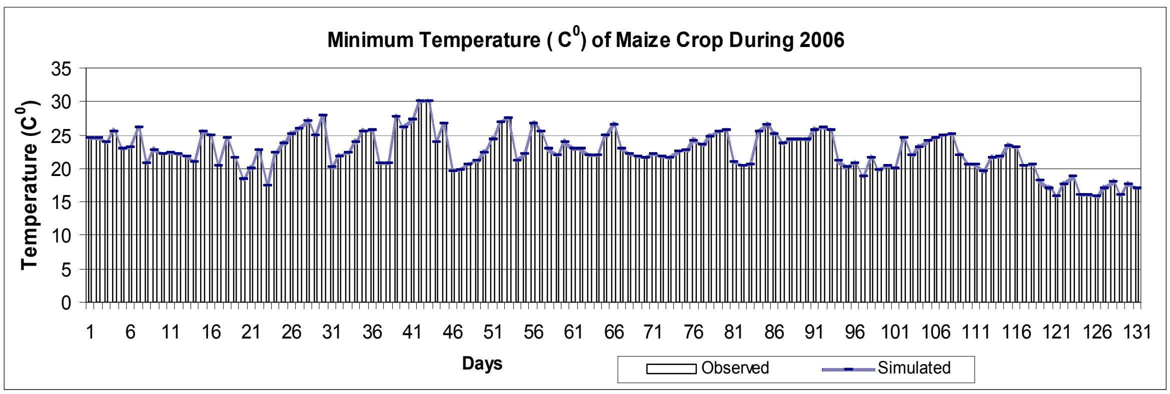


Figure 19:

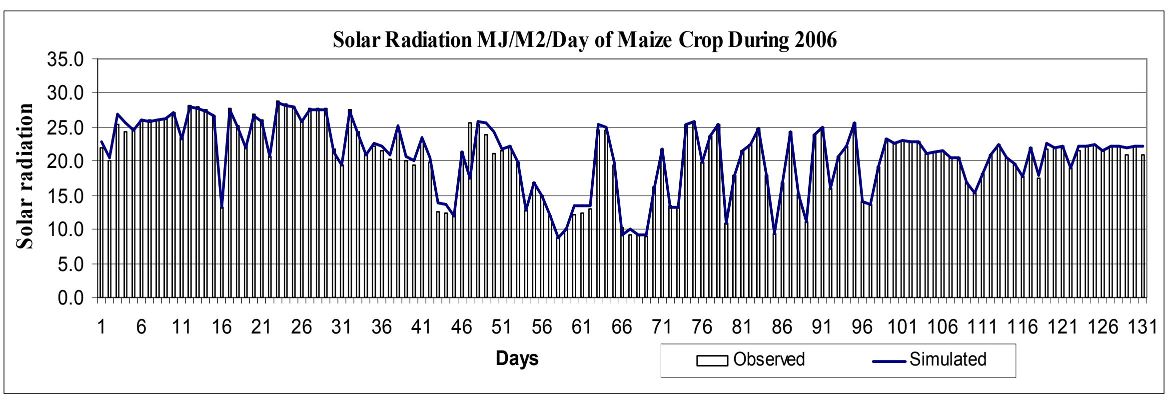


Figure 20:

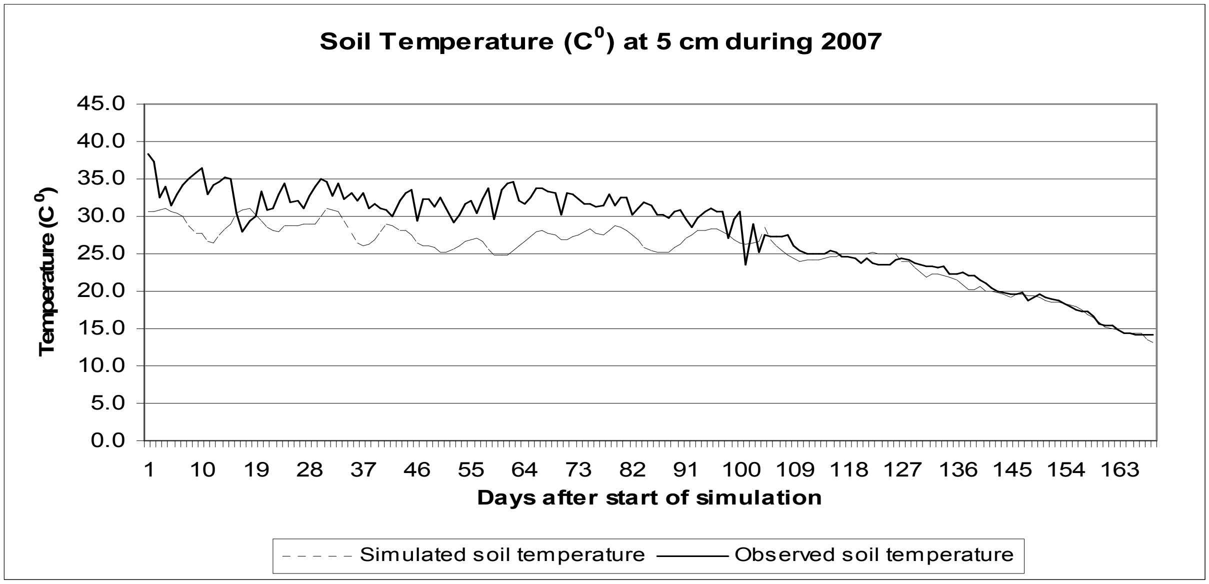


Figure 21:

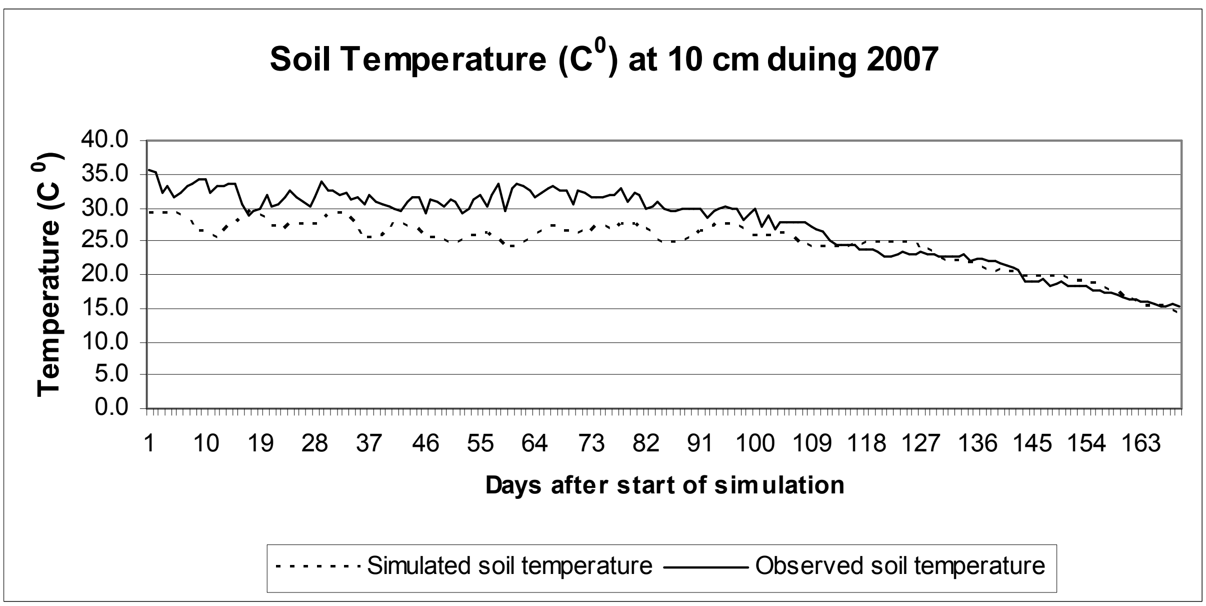


Figure 22:

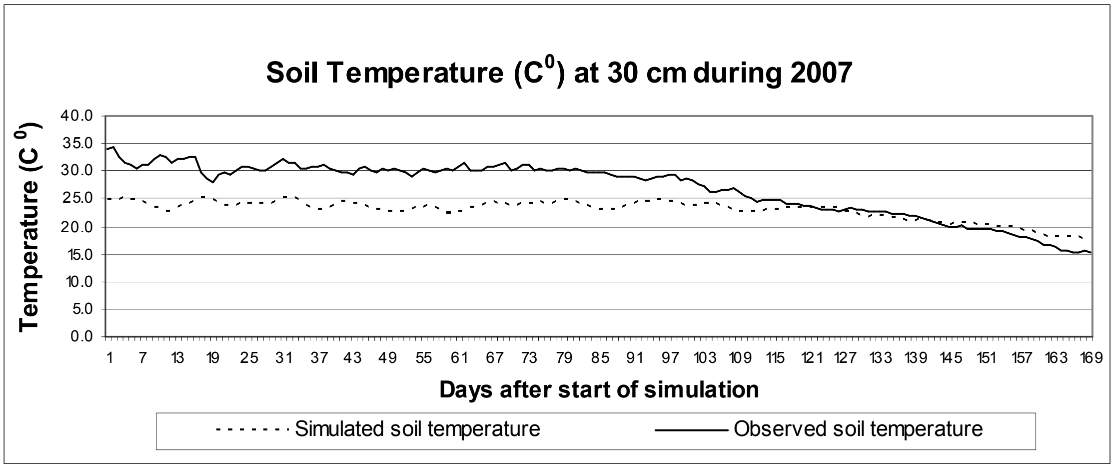


Figure 23:

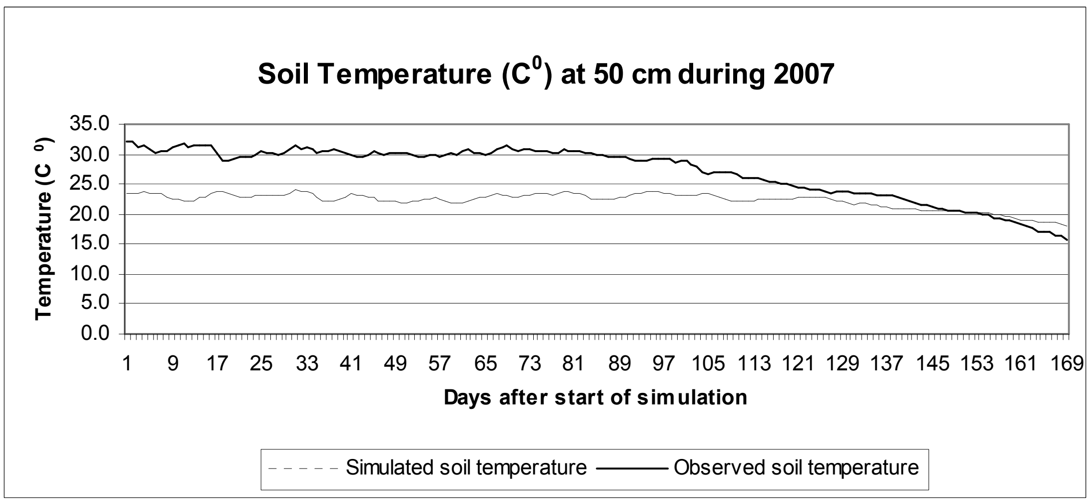


Figure 24:

Table 5: Simulated Crop Growth at Main Development Stages during Kharif- 2007

CROP	GROWTH		BIOMASS	LEAF		CROP N		STRESS	
DATE	AGE	STAGE	Kg/ha	LAI	NUM	kg/ha	%	H2O	N
13- Jun	0	Start Simulation	0	0	0	0	0	0	0
13-Jul	0	Sowing	0	0	0	0	0	0	0
14-Jul	1	Germinate	0	0	0	0	0	0	0
19-Jul	6	Emergence	32	0.01	2.2	1	4.4	0	0
04-Aug	22	End Juvenile	517	0.79	9.8	17	3.9	0	0
10-Aug	28	Floral Initiation	1202	1.45	12.4	23	2.4	0	0.07
15-Sep	64	75% Silking	4216	1.22	27.4	37	0.9	0	0.45
26-Sep	75	Beginning Graining Filling	6649	0.89	27.4	41	0.7	0	0.28
21-Nov	131	End Grain Filling	9190	0.19	27.4	55	0.7	0	0.26
28-Nov	138	Maturity	9190	0.19	27.4	55	0.7	0	0.29
28-Nov	138	Harvest	9190	0.19	27.4	55	0.7	0	0

LAI= Leaf Area Index, NUM=Number, N= Nitrogen

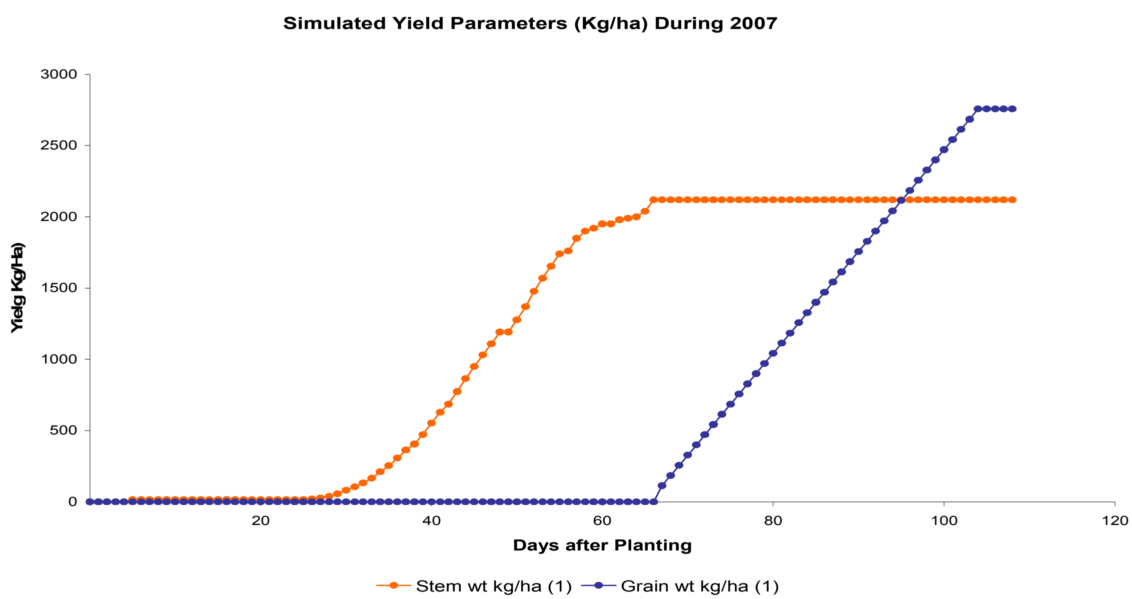


Figure 25:

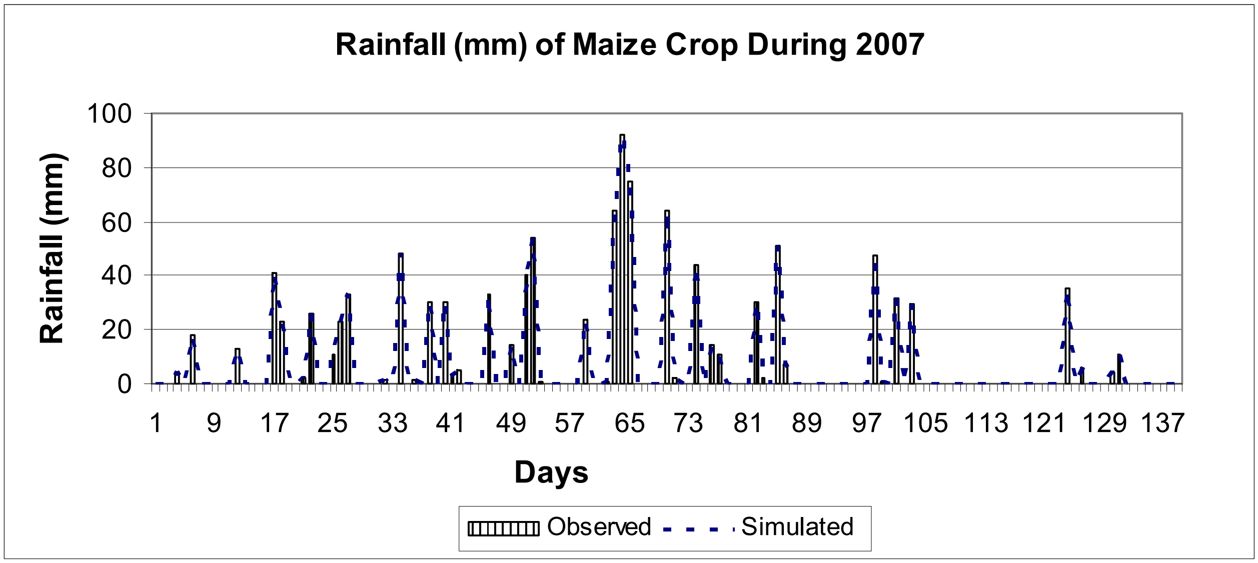


Figure 26:

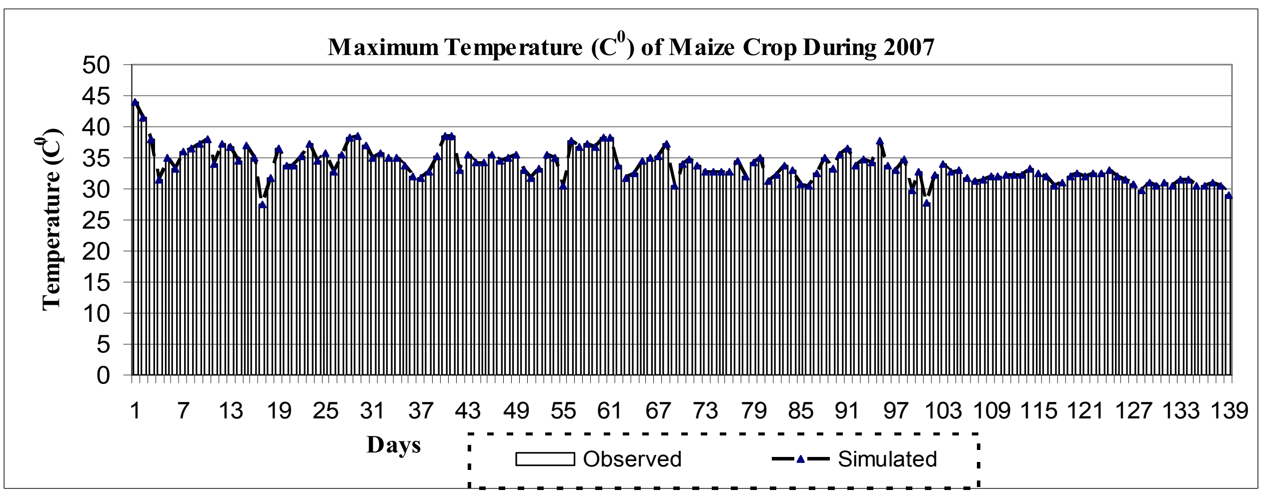


Figure 27:

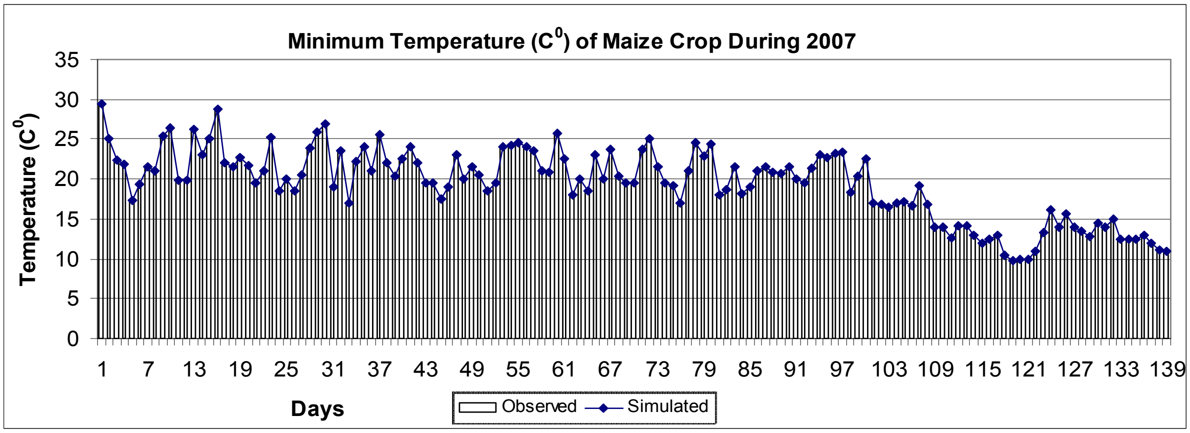


Figure 28:

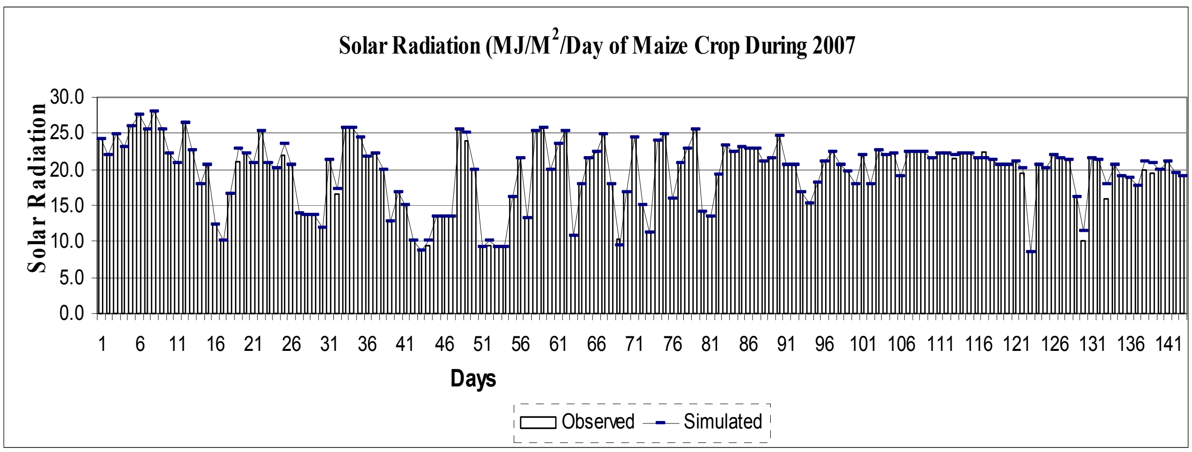


Figure 29:

Table 6: Recorded Rainfall (mm) from Date of Simulation to Date of Harvesting

Rainfall During 2005		Rainfall During 2006		Rainfall During 2007	
Month	**Rainfall (mm)**	**Month**	**Rainfall (mm)**	**Month**	**Rainfall (mm)**
7, June	14.00	28, May	0.20	13, June	99.60
		Jun	91.20	July	262.40
July	193.50	July	550.90	August	486.30
August	214.10	August	327.20	September	200.10
September	58.60	September	13.90	October	0.00
10, October	9.10	18, October	40.80	28, November	0.00
Total	**489.30**	**Total**	**1024.20**	**Total**	**1048.40**

REFERENCES

Chaudhry, Q. Z. 1988. Rainfall and Soil Water Averages and Probabilities and other Pertinent Agroclimatic data for Quetta, PMD Report.

Chaudhry, Q. Z. and G. Rasul. 2003. Agroclimatic classification of Pakistan. Science Vision., Vol (9) No. 1-2. P.59-66

Carlos P. C. and P. A. Pinto. 1998. Linking DSSAT V3 to a relational database: The AGROSYS–DSAAT Interface.

Electronics in Agriculture, Agricultural Department, Technical University of Lisbon, 1300 Lisbon, Portugal doi:10. 1016/S0168-1699(98)00017-9.

Jones, C. A. and J. R. Kiniry. 1986. CERES-Maize: A simulation model of maize growth and development. Texas A&M University Press, College Station.

Rao, Y. 1981. The Climate of the Indian subcontinent. In World Survey of Climatology, Ed: Takahashi, K. and Arakawa, H. Amsterdam, Elsevie Scientific Publishing Co.

Rasul, G. 1993. Water Requirement of Wheat Crop in Pakistan. Journal of Engg. & App. Scs. Vol. No. 2.

Sarkar R., Kar. S. 2006. Evaluation of management strategies for sustainable maize-wheat cropping system, using DSSAT seasonal analysis Journal of Agricultural Science , Vol. 144 (5), pp. 421-434 ISSN 0021-8596 CODEN JASIAB, Cambridge.

TUBER BULKING IN AUTUMN SOWN CARDINAL POTATO

Atiq Ahmad Khan*, M. Qasim Khan*, M. Saleem Jilani* and Sadaf Javaria*
*Faculty of Agriculture, Gomal University, Dera Ismail Khan, Pakistan

ABSTRACT

A field trial was conducted to optimize the planting date and crop growth period of potato during autumn 2003. The tubers were planted on four dates with one-week interval starting from October 03. Tubers planted at each sowing date were allowed to grow for six lengths of periods and harvested on six different dates starting from week-10 and ending at week-15. Total number of stems increased with the delay in planting. Total numbers of tubers per unit area and percentage of large sized tubers (> 55 mm) were the highest at Oct-03 planning. Smaller tubers (< 35 mm) also increased with delay in planting and small sized tubers were maximum at sowing date of Oct-24. Total tuber yield was also higher at earlier planting (Oct-03) as compared to planting at later dates. However, dry matter was higher at delayed planting (Oct-24). Plant dry bio-mass was also higher by planting the potato earlier at Oct-03. Harvesting potato at various intervals also affected these parameters significantly. Total number of tubers, percent larger and medium sized tubers, tuber yield and plant dry bio-mass increased with the delay in harvesting. However dry matter in tuber was found higher at earlier harvestings.

Key words: potato, dry matter, date of sowing, date of harvesting

INTRODUCTION

Potato is a cool-season crop and the development of sprouts from seed pieces depends on soil temperature. Very little sprout elongation occurs at 6°C or below, elongation is slow at 9°C and is maximized at about 18°C (Beukema and Vanderzaag, 1990). The optimum soil temperature for initiating tubers is 16-19°C whereas tuber development declines as soil temperature rises above 20°C and practically stops above 30°C. The number of tubers set per plant is greater at lower temperatures, whereas higher temperatures favor development of large tubers. Yields are highest when average daytime temperatures are about 21°C. Cooler night temperatures are important because they affect the accumulation of carbohydrates and dry matter in the tubers by slowing down the respiration rate. A minimum of 70-90 days of favorable cool season is required to obtain an economical yield. However, a longer favorable season up to 110-120 days results in substantially higher returns. Khan *et al*. (1990) reported that delay in harvesting till 100 days after planting results in higher yield. Sharma and Sharma (1991) reported that dry matter increased with the delay in harvesting irrespective of cultivars. De-Buchananne and Lawson (1991) obtained an alleviated yield and specific gravity for two cultivars when harvested after 16 weeks at two locations. Saunders and Hutchinson (1984) reported increased yields with successive delay in harvest for four years. In another study it was observed that potato tuber yield was increased by late harvesting (Workman and Harrison, 1982). Dera Ismail Khan District of Pakistan located at 31.8^{o}N 70.9 ^{o}E, gets plenty of sunshine year round except very few foggy weeks in December and January. The district has over 0.3 million acres of canal irrigated land and 150,000 acres will be adding up soon. The climatic conditions, soil and water characteristics and cropping patterns of D.I.Khan are quite fit for a successful potato cultivation, but due to lack of research work undertaken on this important vegetable, it could not get any share out of such huge acreage under cultivation. It was therefore felt outmost important to optimize the sowing time and regulate the harvesting time in order to achieve maximum yield and dry matter accumulation in autumn sown crop.

MATERIAL AND METHODS

This trial was laid out in RCBD (factorial) with four replications at Agricultural Research Institute, Dera Ismail Khan. Plot size was 4 x 3 m^2, having plant-to-plant and row-to-row spacing 10cm and 75cm, respectively. Red skin cultivar "Cardinal" was used in this experiment. Fertilizers NPK were applied @ 120:100:80 kg/ha. Weeds were controlled manually once 45 days after planting. To observe the effects of climate, tubers were planted on four different dates i.e. October 03, October 10, October 17, and October 24, 2003. The plots planted on each planting date were harvested after 10, 11, 12, 13, 14 and 15 weeks after planting. Observations recorded were number of stem/plant, total number of tubers, percent large (>55 mm), medium (35 to 55 mm) and small sized tubers (<35 mm), dry matter accumulation and potato vine dry weight. Growing degree days were calculated for each treatment and yield was compared with calculated growing degree days.

RESULTS AND DISCUSSION

Number of stems (plant^{-1})

A significant difference in average number of stems per plant was observed on October 24 and 17th planting dates are compared October 3rd (Table 1). Planting tubers on Oct. 03 resulted in lower number of stems per plant (3.38). Maximum number of stems was recorded in the plots planted on Oct. 24 followed by the plots planted on October 17. Bohl *et al.* (1995) compared the seed tubers of two ages; old vs young are reported that young seed grows slower and produces fewer stems per hill while older seed grows rapid and produces more stems per hill.

Total number of tubers

Planting on October 03, produced 42.13 tubers (m^{-2}) which were significantly higher than rest of the planting dates (Table 2). The numbers of tubers increased as the harvesting was delayed (Table-2). Maximum number of tubers (39.81 m^{-2}) was harvested after 15 weeks from the date of planting, while minimum (26.38 m^{-2}) was harvested after 10 weeks from the date of planting. Interaction between the sowing time and harvesting period was statistically non-significant statistically. Since earlier planting resulted in faster plant growth, probably because of optimal environment during the first few weeks of crop development and subsequently resulted in reflected in good tuber count. In addition when harvesting was delayed plants had more time to support the tubers initiated during the earlier period of plant growth. The results obtained are supported by the findings of other scientists. Sharma and Verma (1987) planted potato on different dates and found that earlier planting produced more number of tubers per plant. Robert *et al.* (1990) reported that delay in harvesting results in increased number of tubers per plant.

Number of large tubers (%)

Planting potato at the earliest dates i.e. Oct 03, 10, 17 produced significantly higher mean number of large sized tubers (11.38%, 10.71% respectively) as compared to October 27 (Table-3). It is interesting to note that the delay in harvesting increased the percentage of large sized tubers. Apparently 15 weeks of crop development resulted in maximum tubers of large size i.e. 16.81% which was followed by 14 weeks (15%), 13 weeks (12.88%) and 12 weeks (10.06%) respectively. The lowest percentage of large tubers per plot (3.31%) was obtained from plots harvested at 10 weeks after planting.{A significant relation was observed between sowing time and harvesting dates interaction (P >0.05)}. The highest percentage of large sized tubers (19.25%) was recorded when tubers planted on Oct-03 and harvested after the longest period of 15 weeks while the lowest percentage of large sized tubers (2.50%) was obtained in Oct-10 planting and harvesting after 10 weeks from the date of planting. The positive interaction indicated that it was not just the crop development period that affected the greater number of large sized tubers, the earlier planting when combined with the elevated crop development period (15 weeks) resulted in more tubers of large size. The phenomenon is well supported by Ahmad and Rashid (1980) and Niaz (1998) who recorded reduced tuber count with successive delay in planting. In the present studies, planting on Oct-03 provided maximum period of optimal temperature and sun shine for crop development (Fig-1) which resulted in excellent foliage growth with improved photosynthesis which ultimately helped in increasing the size of tubers.

Percent medium sized tubers

Significantly higher percentage of medium-sized tubers (14.13%) was recorded from the plots that were planted on Oct 03 as compared to other planting dates (Table-4). Difference among the percentages of medium size potato produced from other three planting dates i.e. Oct 10, Oct 17 and Oct 24 were statistically non significant. Delay in harvesting resulted in higher number of medium size tubers. Maximum medium size tubers were recorded in the plots harvested after 15 weeks. Interaction between sowing and planting dates was found non-significant.

Percent small tubers (<35 mm)

The highest percentage of small size tubers (77.92%) was recorded in later planting later in the season i.e Oct-24 (Table-5). Earlier harvesting also increased the percentage of small sized tubers. Significantly minimum number of small tubers (64.69%) were obtained by harvesting after 15 weeks while maximum number (90.75%) were obtained 10 weeks after planting which was the earliest date. Interaction was also found significant statistically. The lowest percentage of small tubers (60.50%) was recorded in 15 weeks harvesting and Oct-03 sowing. The same trend, as observed in present studies, has been reported by Torres (1979) who observed that late planting and early harvesting always produces higher percentage of small sized tubers. It was most likely that tuber initiated could get larger in size but poor vegetative growth, at late planting with shortened growth period, was unable to transform sufficient energy to the tubers probably due to sub-optimal environmental conditions.

Tuber Yield (t ha^{-1})

Planting the tubers on various dates significantly affected the tuber yield (Table-6, Fig-2 & Fig-3). Planting the tubers in the first week of October produced tubers yield of 11.26 (t ha^{-1}). The rest of the three planting dates (Oct. 10, Oct. 17 and Oct. 24) produced statistically similar yield. Delay in harvesting had also significant and positive effect on the yield produced. Harvesting at 10 weeks after planting produced only 6.00 (t ha^{-1}), but the yield linearly increased with each delay in harvesting (Fig). Interaction between the two factors, although non-significant, but showed the same trend that early planting combined with longer crop growth period produced greater yield per hectare. Planting in the first week of October and delaying harvesting till 15 week (105 days) produced 16.38 (t ha^{-1}). Similar results have also been reported by Khan *et al.* (1990). Other studies also confirm that potato tuber yield increases with late harvesting (Workman and Harrison, 1982).

Dry matter in tubers (%)

The delay in planting improved the dry matter accumulation (Table-7). The highest amount of dry matter (18.20%) was recorded when tubers were planted in the 3rd week of October (Oct. 24). Whereas the delay in harvesting resulted in decrease in dry matter accumulation. Interaction between the two factors also showed significant results statistically. Maximum dry matter (20.56%) was accumulated when tubers were planted on October 10 and harvested 12 weeks after planting. It is interesting to note that the potato utilized its reserve energy (tubers carbohydrate) during the adverse environmental conditions which resulted in low dry matter when harvesting was delayed.

Vines dry bio-mass (kg plant^{-1})

Better vine growth is important in producing higher tuber yield. The potato plant grows well at temperatures between 20 and 25 ^{o}C. Table-8 shows that maximum vine dry bio-mass (0.264 kg plant^{-1}) was recorded in plots planted at the earliest date (Oct. 03), which provided the maximum period of optimal environmental conditions (temperatures) to the plant (Fig-1). The dry vine weight decreased with each successive planting. However delay in harvesting improved vine dry weight. The highest vines dry weight (0.292 kg plant^{-1}) was recorded when plants were harvested 15 weeks after planting. Interaction between the two factors was found statistically non-significant.

Accumulated heat units

The correlation (R^2) between calculated heat units and yield for each treatment is shown in Fig-4 showed that accumulated heat units decreased with each successive sowings whereas the heat units increased with each successive harvesting. Maximum period of optimum growing temperatures (Fig-1) and maximum accumulated heat units during earlier sowings improved the vegetative growth and plant dry matter which ultimately resulted in higher marketable tuber yield.

Fig-1 Mean, maximum and minimum temperatures (^{o}C) during the potato growing season at D.I.Khan (Oct. 1, 2003 to Jan. 31, 2004)

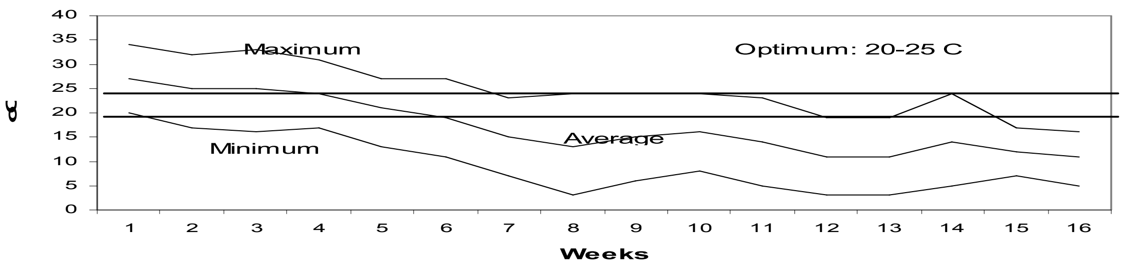


Fig-2 Potato tuber yield (ton/ha) as influenced by four sowing dates

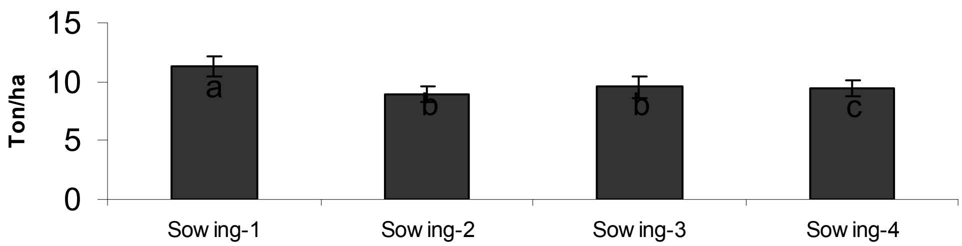
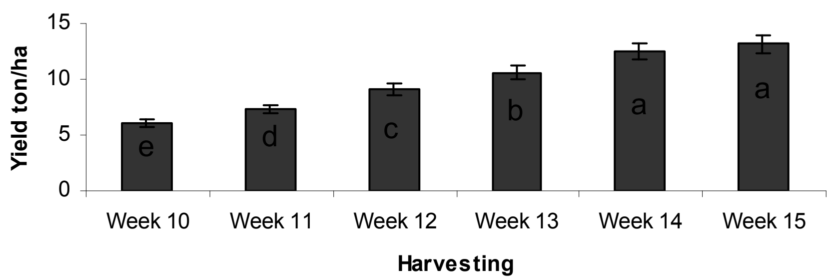


Fig-3 Potato tuber yield (ton/ha) as influenced by six harvesting dates



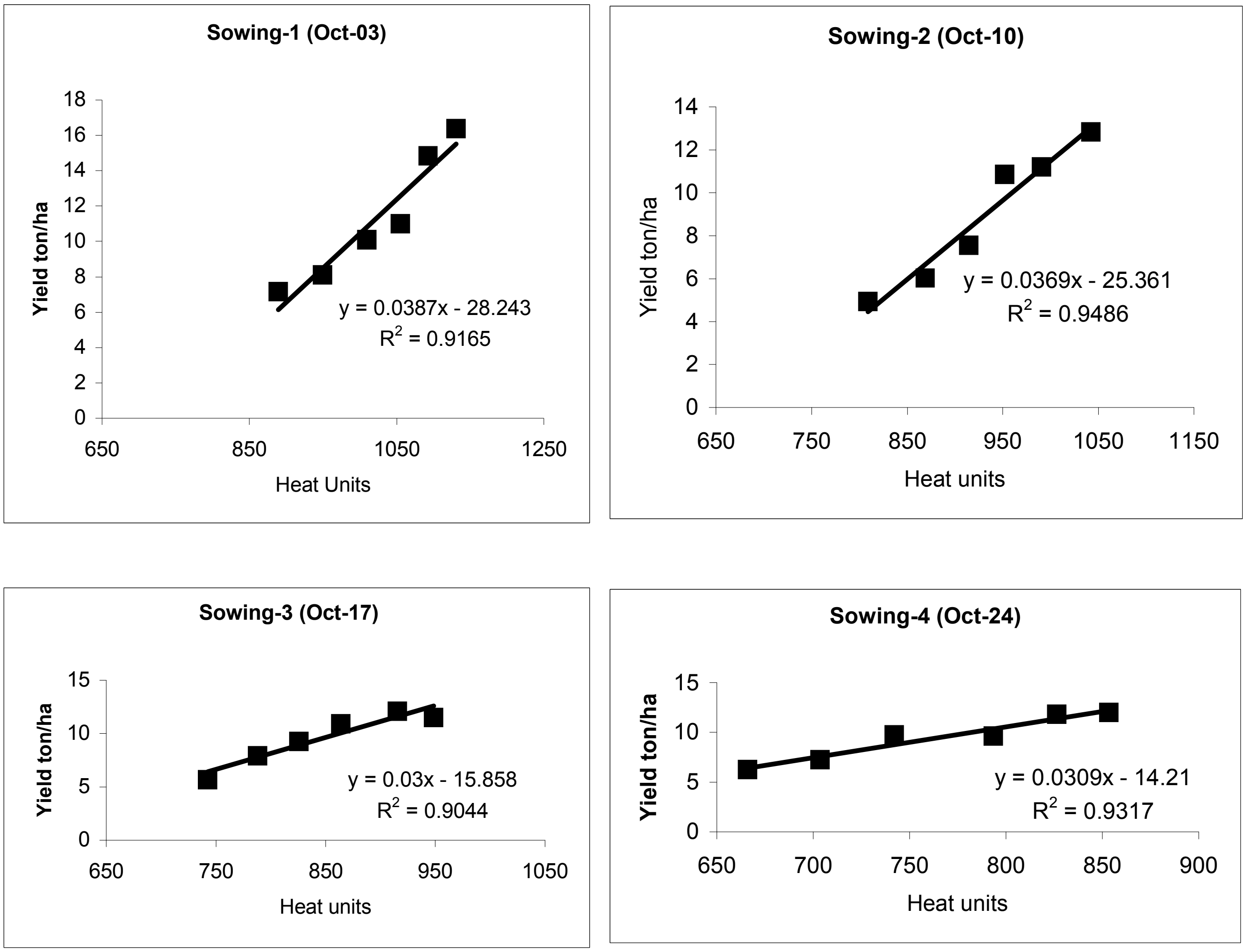


Fig-4 Relationship between heat units and potato yield at four sowing dates and six harvesting intervals.

Table 1: Number of stems (plant^{-1}) as affected by sowing and harvesting times.

	Harvesting (Weeks after Planting)						Mean
Sowing Time	10	11	12	13	14	15	
03-10-03	3.22	3.07	3.91	3.37	3.53	3.17	3.38 c
10-10-03	3.88	3.09	3.31	3.61	3.50	3.50	3.48 bc
17-10-03	3.46	4.19	3.42	3.76	4.28	4.25	3.89 ab
24-10-03	4.40	3.66	4.76	3.85	3.51	4.17	4.06 a
Mean (N.S.)	3.74	3.50	3.85	3.65	3.70	3.77	

LSD value for sowing time = 0.4283

Table 2: Total number of tubers m^2

	Harvesting (Weeks after Planting)						Mean
Sowing Time	10	11	12	13	14	15	
03-10-03	36.00	37.75	41.50	42.25	46.25	49.00	42.13 a
10-10-03	21.75	26.25	29.00	29.75	31.75	34.75	28.88 c
17-10-03	24.50	28.25	30.75	35.25	36.50	40.00	32.54 b
27-10-03	23.25	29.00	29.50	31.50	33.00	35.50	30.29 bc
Mean (N.S.)	26.38 e	30.31 d	32.69 cd	34.69 bc	36.88 ab	39.81 a	

LSD value for sowing time = 2.438
LSD value for harvesting time = 2.987

Table 3: Large tubers (%) per plot

	Weeks after Planting						Mean
Sowing Time	10	11	12	13	14	15	
03-10-03	3.00 m	4.00 m	10.25 hi	14.50 cdef	17.25 ab	19.25 a	11.38 a
10-10-03	2.50 m	6.50 kl	11.25 ghi	14.50 cdef	15.25 bcde	16.75 bc	11.13 a
17-10-03	4.50 lm	7.00 jk	9.50 i	12.50 fgh	14.25 def	16.50 bcd	10.71 a
27-10-03	3.25 m	6.75 kl	9.25 ij	10.00 i	13.25 efg	14.75 cdef	9.54 b
Mean (N.S.)	3.31 f	6.06 e	10.06 d	12.88 c	15.00 b	16.81 a	

LSD value for sowing time = 1.005
LSD value for harvesting time = 1.231
LSD value for harvesting X sowing time = 2.462

Table 4: Percent medium tubers

	Weeks after Planting						Mean
Sowing Time	10	11	12	13	14	15	
03-10-03	8.50	11.50	14.75	15.25	16.25	18.50	14.13 a
10-10-03	4.75	7.25	11.50	15.25	17.25	20.25	12.71 b
17-10-03	5.25	9.50	12.50	13.25	16.00	18.50	12.50 b
27-10-03	6.00	8.50	13.25	14.25	16.50	16.75	12.54 b
Mean (N.S.)	6.13 e	9.19 d	13.00 c	14.50 c	16.50 b	18.50 a	

LSD value = 1.294
LSD value = 1.585

Table 5: Percent small tubers

	Harvesting time (Weeks after Planting)						Mean
Sowing Time	10	11	12	13	14	15	
03-10-03	92.25 a	88.75 a	78.25 cd	70.25 gh	65.50 i	60.50 j	75.92 bc
10-10-03	89.00 a	82.00 bc	74.00 fg	70.25 gh	68.50 hi	64.75 i	74.75 c
17-10-03	90.25 a	83.50 b	78.00 de	74.25 ef	69.75 h	65.00 i	76.79 ab
27-10-03	90.75 a	84.75 b	77.50 def	75.75 def	70.25 gh	68.50 hi	77.92 a
Mean (N.S.)	90.56 a	84.75 b	76.94 c	72.63 d	68.50 e	64.69 f	

LSD value (Sowing time) = 1.580
LSD value (Harvesting time) = 1.935
LSD value (Sowing X Harvesting time) = 3.870

Table 6: Total yield ton ha^{-1}

	Weeks after Planting						Mean
Sowing Time	10	11	12	13	14	15	
03-10-03	7.17	8.11	10.10	10.99	14.83	16.38	11.26 a
10-10-03	4.92	6.02	7.55	10.86	11.20	12.83	8.98 b
17-10-03	5.66	7.92	9.25	10.91	12.09	11.50	9.56 b
27-10-03	6.26	7.23	9.73	9.61	11.81	12.00	9.44 b
Mean	6.00 e	7.32 d	9.16 c	10.52 b	12.68 a	13.18 a	

LSD value (Sowing time) = 0.9995
LSD value (Harvesting time) = 1.224

Table 7: Percent Dry Matter

	Weeks after Planting						Mean
Sowing Time	10	11	12	13	14	15	
03-10-03	15.38 j	16.75 ghij	15.93 ij	19.63 abc	17.95 c-i	16.95 e-j	17.10 b
10-10-03	18.56 a-g	18.31 b-h	20.56 a	18.11 c-h	15.90 ij	12.66 k	17.35 ab
17-10-03	18.88 a-f	18.44 a-g	16.30 hij	18.92 a-e	16.79 f-j	17.46 d-j	17.80 ab
27-10-03	20.28 ab	15.72 j	16.21 hij	18.25 b-h	19.52 a-d	19.25 a-d	18.20 a
Mean	18.27 ab	17.30 bc	17.25 bc	18.73 a	17.54 bc	16.58 c	

LSD value (Sowing time) = 0.8644
LSD value (Harvesting time) = 1.059
LSD value (Sowing X Harvesting time) = 2.117

Table 8: Vine dry weight

	Weeks after Planting						Mean
Sowing Time	10	11	12	13	14	15	
03-10-03	0.207	0.225	0.249	0.295	0.290	0.320	0.264 a
10-10-03	0.172	0.200	0.240	0.280	0.305	0.313	0.252 b
17-10-03	0.192	0.205	0.227	0.258	0.288	0.290	0.243 c
27-10-03	0.150	0.185	0.200	0.220	0.230	0.245	0.205 d
Mean	0.181 f	0.204 e	0.229 d	0.263 c	0.278 b	0.292 a	

LSD value (Sowing time) = 0.005759
LSD value (Harvesting time) = 0.007053

REFERENCES

Ahmad, U. K. and A. Rashid. 1980. Effect of date of planting on the production of potatoes. Bangladesh J. Agric. Res. 5(2): 21-26.

Beukema, H. P. and D. E. VanDerzaag. 1990. Introduction to potato production. Centre for Agril. Publishing and Documentation, Wageningen. ISBN 90-220-0963-7

Bohl, W. H., P. Nolte, G. E. Kleinkopf and M. K. Thornton .1995. Potato Seed Management, Seed size and age. Cooperative Extension Bulletin. CIS 1031.College of agriculture, Univ. of Idaho, USA.

Robert, K. Prange, K. B. McRae, D. J. Midmore and R. Deng. 1990. Reduction in potato growth at high tmerarture: Role of photosynthesis and dark respiration. American Potato J. Vol 67 (6): 357-369.

Sharma, I. P. and U. K., Verma. 1987. Effect of planting and harvesting dates on yield and yield attributes of potatoes. J. of Potato Association. 14 (1 &2): 48-51.

Torres, W. 1979. Influence of different planting dates on the growth of potatoes cultivar Desiree. Cultivars Tropicales 1(3): 151-169.

De-Buchananne, D. A. and V. F. Lawson. 1991. Effect of plant population and harvest timing on yield and chipping quality of Atlantic and Nor Chip potatoes at two Iowa locations. American Potato J. Vol. 68: 287-297.

Saunders, A. R. and R. W. Hutchinson. 1984. The effect of sprouting and harvest date on the yield and dormancy of Arran Banner seed potatoes. Record of Agric. Res. 32: 1-6. Field Crop Absts. 1986. 39(6): 4510.

Niaz, A. 1998. Effect of date of planting and date of harvesting on yield and other characteristics of potato cultivar cardinal. M.Sc. Thesis. NWFP Agric. Univ. Peshawar, Pakistan.

Workman, M., and M. D. Harrison. 1982. Influence of harvest date on yield, early-blight tuber infection and chipping characteristics of potatoes grown with sprinkler irrigating. General Series, Experiment Station, Colorado State University, No. 989. 14pp. Potato abstracts. 35 (4): 3357).

Khan, M. A., H. Rahman, and C. M. Yaqub. 1990. Effect of different harvesting dates on the performance of spring and autumn produced cardinal potatoes. Pak. J. Agric. Res. 11 (2):93.

COMPARATIVE EVALUATION OF MIXED INSECTICIDES (Larsban, Confidor, Actara, Tamaran) AGAINST CORN JASSID AND MAIZE STEM BORER

Salahuddin*, Habib ur Rahman*, Mishkatullah, Muhammad Daud***and Muhammad Tariq Khan**.**
*Faculty of Agriculture, Gomal University, Dera Ismail Khan,
**NARC Islamabad and
***Department of Biotechnology, Kohat University of Science and Technology, Pakistan.

ABSTRACT

A field experiment was conducted at Agriculture Research Institute, Tarnab, Peshawar to determine the efficacy of different mixed insecticides against corn jassid (Amrasca devastans) and maize stem borer (Chilo partellus). The experiment was laid out in Randomised Complete Block Design with five treatments and four replications including control. Larsban (chloropyriphos, 40%) alone and mixed with other three insecticides namely Confidor (Amida chloroprid, 20 sc), Actara (Thiamethaczam 25%) and Tamaron (Endoralphon 32.9%) were tested on Maize cv. "Azam" against jassid and maize stem borer. The highest percent reduction (70.93) in jassids population was recorded in plots treated with Larsban and Confidor, while control plots showed increase in the jassid population. Similarly, a combination of Larsban and Confidor was also found to be the best mixture to obtain the highest percent reduction (54.74) in maize stem borer infested plants. All the treated plots significantly reduced the insect population than the control. Highest yield was obtained from the plots treated with Larsban and Actara (2011.5 kg/ha).

Key words: Maize, insecticides, corn jassid, maize stem borer, chemical control.

INTRODUCTION

Maize (Zea mays) is one of the most important cereal crops of the world. It occupies 27 percent of the world acreage and accounts for about 34 percent of the world production of grains. In Pakistan among cereals, maize ranks third in acreage, production and yield. In Pakistan, the area under maize crop in year 2003-04 was 941.6 thousand hectare with the total production of 1664 thousand tons and the average yield was 1768 kg per hectare (MINFAL, 2004). In NWFP the area under maize crop during the same year was 540.8 thousand hectare with a total production of 1695 thousand tonnes (MINFAL, 2004). Maize possesses a wide range of adaptation and diversity of uses as food, feed and use in Agro industry. It is estimated that about 75 % of the total production of maize is directly used by the farming community while the rest is used in products manufacturing industries such as poultry and livestock feed {Mohammad *et al.,* 1986}. Maize being a high yielding cereal crop can help to increase the farmer's income. The growing demand of corn oil as a part of human diet in the country has further increased the importance of maize cultivation. It is mainly consumed in form of bread by human beings and grain or flour in animal and poultry feed. It is also used in browning, leather, match and sweet meat industries. The oil extracted from maize is described for heart patient as non-fattening cooking oil. Several factors are responsible for low yield and among them, the insect pests are considered very important. In Pakistan, a large number of insects attack on the maize crop, thereby deteriorating the quality and reducing the yield of crop. Of all the insects, maize stem borer (Chilo partellus) and corn jassids (Amrasca devastans) are highly injurious for causing low corn vigor and yield. The present study was undertaken to determine the efficacy of different mixed insecticides against corn jassid and maize stem borer.

MATERIALS AND METHODS

The experiment was designed in a randomized complete block with five treatments and four replications including check. Plot size was maintained at 2.74 x 3.8 metres, with 5 rows per treatment having row to row distance of 0.76 metres. Thiodan 35 EC alone, Thiodan + Confidor SL200, Thiodan + Actara and Thiodan + Tamaron SL600 were sprayed in treatment 1, 2, 3 and 4 consecutively, while treatment 5 was kept untreated throughout the growing season (control). All the four insecticides including granule were dissolved in the water for spray.

DATA RECORDING PROCEDURE

For corn jassid, data were recorded by counting number of these insects on 15 randomly selected leaves from 15 plants, in such a way that 1st leaf from upper portion of 1st plant, 2nd leaf from middle portion of 2nd plant and 3rd leaf from lower portion of 3rd plant were averaged to mean sample/leaf. For maize stem borer, data was recorded by counting the infested plants and the total number of plants to workout the percent infestation. Dead heart, larval excreta in the funnel portion of the plants and the effected leaves were taken as criteria for infestation. Efficacy of the insecticides sprayed against maize stem borer was determined by counting the infested plants in 3 middle rows of each treatment and then percent infestation was calculated by subtracting the post spray data from pre spray data. Similarly, arrangement for second spray was carried out and the pest infestation data were recorded as mentioned earlier. Observations were for corn jassids, after 1, 3, 7, 10 and 14 days of spraying the insecticides, whereas, after 7, 10 and 14 days of spraying the insecticide harvesting, yield data were recorded. The entire data were statistically analyzed using ANOVA and DMR test (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

Corn jassid

It is apparent that Larsban applied alone caused up to 83% reduction in the corn jassid population after 1 day of the 1st spray. However, when it was applied with Confidor, Actara and Tamaron, caused 98, 95 and 93% reduction. The reduction in corn jassid population gradually decreased during 3, 7 and 10 days of the 1st spray with respect to each treatment. The pest gradually increased in the unsprayed plots, during 1 to 10 days of the 1st spray. The initial population of the corn jassid nearly completely, dropped in the treated plot after the 1st spray. However, corn jassid relatively increased in the sprayed plots which could be mainly attributed to the migration of the adults from the nearby field of the maize and hence this shuffled the reduction level of the previously existing population of the corn jassid. In the second spray, Larsban alone caused up to 78% reduction in the corn jassid population during 1 day. When it was mixed with the Confidor and Tamaron it caused up to 88% and 81% reduction in the corn jassid population during 1 day. On the other hand mixing with the Actara resulted up to 71% reduction which is very low when compared to that existed in the 1st spray. The reduction slightly dropped during 3 days of the spray. It gradually declined during 7-15 days (Table 2). This could be mainly attributed to the migration of the corn jassid from the nearby maize field and hence this imbalanced the reduction of the previously counting population of the corn jassid. Corn Jassid population increased in the unsprayed plots during 7 days but the level of increase decreased during 10 to 14 days, results of which are in close association with Haile and Hafsvang, (2002). The over all effect of the 1st and 2nd spray also showed that Larsban + Confidor was the best combination as highest average percent reduction was recorded in it i.e 70.93.

Maize stem borer

A combination of Larsban + Confidor was found very effective against maize stem borer. The data after both the two sprays showed that highest average percent reduction (54.74) in maize stem borer infested plants was observed, followed by Larsban + Tamaron (53.74), Larsban alone (51.03) and Larsban + Actara (49.04), while the lowest average percent reduction (+12.58) was recorded in control plot as indicated by "+" sign (Table 3), which are in agreement with Rami, (2004) and Khan, *et al*. (2007).

Yield

Table 4 shows that plots treated with Larsban + Actara gave the highest yield of 2011 Kg/hectare, followed by Larsban + Confidor, being non significant. The lowest yield (516.5 kg/ha) was obtained from control plot, being significantly lower than the treated ones. The yield achieved with insecticidal sprays showed that there was no significant difference among the treatments, however, each one was significantly different from the control. Mustea *et al*. (1970) applied three insecticides against stem borer. Endosulphon was effective in increasing maize yield. Halimie *et al*. (1989) recommended corbofuran as a whorl treatment to reduce infestation of stem borer and resulted in higher yield, Mathur *et al*. (1992) tested eight insecticides to control stem borer. Endosulphon was the best against stem borer and increasing maize yield. It is concluded that a combination of Larsban + Confidor was found the best combination of insecticides in this study against corn jassid and maize stem borer, which successfully controlled the pests. Ultimately the yield increased. Farmers are advised to use a combination of Larsban + Confidor against corn jassids and maize stem borer.

Table 1: Insecticides with their doses used in experiment.

Treatment No.	Insecticides	Dose rate (ml/100 lit. water)
1	Larsban 40EC	250
2	Larsban+ Confidor SL200	150
3	Larsban + Actara	50
4	Larsban + Tamaran SL600	250
5	Untreated	

Table 2: Percent reduction/increase in jassid population following the sprays of different insecticides.

			Mean percent reduction/increase in days after respective spray										
			First spray (days)					2nd spray (days)					
S.No	Treatments	Dose rate (ml/ 100 lit. water)	1	3	7	10	14	1	3	7	10	14	Average
1	Larsban 40EC	250	82.63B	71.98B	71.23B	56.31A	30.37A	78.18AB	70.32A	70.09A	57.57AB	46.89AB	63.49
2	Larsban + Confidor SL200	150	97.53A	81.57AB	75.69AB	63.51A	32.11A	88.30A	81.75A	74.96A	65.63A	48.33A	70.93
3	Larsban + Actara	50	94.66A	85.29A	71.08B	54.42A	29.84A	70.85B	73.18B	67.25A	55.13B	41.98B	64.36
4	Larsban + Tamaron SL600	250	93.03A	75.08AB	79.16A	60.10A	29.14A	80.91AB	80.46A	72.66A	57.96AB	41.67B	67.01
5	Untreated		+12.79C	+14.36C	+17.80C	+21.35B	+23.06B	+10.23C	+12.55C	+15.00B	+10.28C	+7.213B	14.46

"+" sign indicates increase, where as figures followed by same letters are not significantly different at 5% level of significance.

Table 3: Percent reduction/increase in maize stem borer population following the sprays of different insecticides.

			Mean percent reduction/increase in days after respective spray						
S.No	Treatments	Dose rate (ml/100 lit. water)	First spray (days)			2nd spray (days)			Average
			7	10	14	7	10	14	
1	Larsban40EC	250	70.53AB	55.65AB	34.67B	56.61A	52.26A	36.50A	51.03
2	Larsban+Confidor 200SL	150	66.31AB	59.03A	45.88A	63.62A	53.35A	40.22A	54.74
3	Larsban+Actara	50	60.35B	48.45B	38.61AB	57.85A	50.80A	38.17A	49.04
4	Larsban+Tamaron 600SL	250	73.93A	63.15A	42.56A	55.00A	49.70A	38.07A	53.74
5	Untreated		+7.66C	+16.53C	+21.81C	+9.015B	+12.70B	+7.74B	+12.58

+ sign indicates increase, where as figures followed by same letters are not significantly different at 5% level of significance.

Table 4: Effect of insecticides on the grain yield of field grown maize

S.No.	Treatments	Dose rate (ml/100 lit. water)	Yield (Kg/ha)
1	Larsban 40EC	250	1567AB
2	Larsban + Confidor200SL	150	1721.5AB
3	Larsban + Actara	50	2011.5A
4	Larsban + Tamaron600SL	250	1228.5BC
5	Untreated		516.5C

Figures followed by same letters are not significantly different at 5% level of significance.

REFERENCES

Anonymous. 2001. Agric. Stat. Pakistan. Govt. pak., MINFAL, Economic Wing, Islamabad. pp. 289.

Haile, A and T. Hafsvang. 2002. Host plant preferences of the stem borer Busseola fusca (Fuller) (Lepidoptera: Noctuidae). Crop protection. 21(3): 227-233.

Halimie, M. A., M. S. Mughal, S.A.Mehdi and Z. A.Rana.1989.Response of different timings of carbofuran (Furadan3G) on the maize stem borer incidence and yield of the crop. J. Agric. Res. Lahore.27 (4):337-340.

Khan, M. R. and B. M. Khan. 1969. Biology and control of maize stem borer C. partellus (Swinhoe) in Peshawar Sc and Indus. 6(1/2):6(10):3875,(1973).

Khan, R. R., B. Ahmed and S. Ahmed. 2007. Comparative efficacy of need stem powder granules and the insecticides against chilo partellus swin. (Pyralidae: Lepidoptera) on autumn maize. Pak. Entomol. 29(1): 33-36.

Mathur, Y. K, Satyadev and P. Kishore. 1992. Evalustion of some important insecticides against C. partellus (Swinhoe) and Marasmia trapezailis (Guen.) infesting maize crop. J. Entomol. Res. 16(4):227-282.

MINFAL. 2004. Ministry of Food, Agriculture and Livestock. Agricultural Statistics of Pakistan 2003-2004. Government of Pakistan, Islamabad.

Mohammad, Q. C., A. Shakoor, H. Nawaz and M.Naeem. 1986. Maize situation in Pakistan. Maize production Manual, Pak. Agric. Res. Council, Islamabad. 64pp.

Mustea, D., A. Barleuleseu., S. Peteanu., M. Matier., V. Apetri and I. Sandru. 1970. Chemical control of maize stem borer.Anal. Instt. de cerecet. Pentru Prot. Plant. 6:153-265. (Rev.App.Ent.62;131).

Rami, K. 2004. Increase in cereal stem borer populations through partial elimination of natural enemies. Entomologia Experimentalis at Applicata. 104(2-3): 299-306.

Steel, R. G. D. and J. H. Torrie. 1984. Principles and procedures of statistics. Mc. Graw Hill Brok Company Inc. New York. Simulated Crop Growth at Main Development Stages during Kharif- 2006.

EFFECTS OF INSECTICIDES (Thiodan, Confidor, Actara, Tamaran) ON JASSID (*AMRASCA DEVASTANS*) AND STEM BORER (C*HILO PARTELLUS*) ATTACK ON MAIZE CROP

Salahuddin[*], Habib ur Rahman[*], Mishkatullah[**], Muhammad Daud[***] and Muhammad Tariq Khan[**].

[*]Faculty of Agriculture, Gomal University, Dera Ismail Khan,

[**]NARC Islamabad

[***]Department of Biotechnology, Kohat University of Science and Technology, Pakistan.

ABSTRACT

A field experiment was conducted at Agriculture Research Institute, Tarnab, Peshawar to determine the efficacy of different mixed insecticides against corn jassid (*Amrasca devastans*) and maize stem borer (C*hilo partellus*). The experiment was laid out in Randomized Complete Block Design with five treatments and four replications including control. Thiodan (Endoralphon 32.9%) alone and with combination of Confidor (Amidachloprid 20 Sc), Actara (Thiamethaczam 25 %) and Tamaron (Methamedaphos 60 SL) were tested against corn jassid and maize stem borer on maize crop cv. "Azam". In corn, the highest percent reduction (72.17) of jassid was recorded in the plots treated with a combination of Thiodan and Confidor, while control plot showed further increase in corn jassid population. Regarding maize stem borer, highest percent reduction (52.76) in infestation was recorded in the plots sprayed with Thiodan alone. Pest infestation increased in control plots. Highest yield of maize grains was obtained in plots treated with a combination of Thiodan and Confidor (1174 kg/ha), whereas lowest yield was obtained in control plots.

Key words: Maize, insecticides, corn jassid, maize stem borer.

INTRODUCTION

Maize (*Zea mays*) is one of the most important cereal crops of the world. It occupies 27 percent of the world acreage and accounts for about 34 percent of the world production of grains. In Pakistan among cereals, maize ranks third in acreage, production and yield. In Pakistan, the area under maize crop is 944000 ha which is 4.28 % of the total cultivated area. While the production is 1643200 tonnes with average yield per hectares of 1741 kg. In NWFP the area under maize crop is 536500 hectare with a total production of 887800 tonnes, which is 54 % of total maize production in Pakistan. Where as the average crop production per hectare is 1655 Kg, which is a below the world standards.(Anonymous, 2001). It possesses a wide range of adaptation and diversity of uses as food, feed and use in Agro industry. It is estimated that about 75 % of the total production of maize is directly used by the farming community while the rest is used in products manufacturing industries such as poultry and livestock feed (Mohammad *et al*., 1986). Maize being a high yielding cereal crop can help to increase the farmer's income. The growing demand of corn oil as a part of human diet in the country has further increased the importance of maize cultivation. It is mainly consumed in form of bread by human beings and grain or flour in animal and poultry feed. It is also used in browning, leather, match and sweet meat industries. The oil extracted from maize is described for heart patient as non-fattening cooking oil. Several factors are responsible for low yield and among them, the insect pests are considered very important. In Pakistan, a large number of insects attack on the maize crop, thereby deteriorating the quality and reducing the yield of crop. Of all the insects, maize stem borer (C*hilo partellus*) and corn jassids (*Amrasca devastans*) are highly injurious for causing low corn vigor and yield. The present study was undertaken to determine the efficacy of different mixed insecticides against corn jassid and maize stem borer.

MATERIALS AND METHODS

The experiment was designed in a randomized complete block with five treatments and four replications including control. Plot size was maintained at 2.74 x 3.8 metres, with 5 rows per treatment having row to row distance of 0.76 meters. Thiodan 35 EC alone, Thiodan + Confidor SL200, Thiodan + Actara and Thiodan + Tamaron SL600 were sprayed in treatment 1, 2, 3 and 4 consecutively, while treatment 5 was kept untreated throughout the growing season (control). All the four insecticides including granule were dissolved in the water for spray.

Data recording procedure

For corn jassid, data were recorded by counting number of these insects on 15 randomly selected leaves from 15 plants, in such a way that 1st leaf from upper portion of 1st plant, 2nd leaf from middle portion of 2nd plant and 3rd leaf from lower portion of 3rd plant were averaged to mean sample/leaf. For maize stem borer, data was recorded by counting the infested plants and the total number of plants to workout the percent infestation. Dead heart, larval excreta in the funnel portion of the plants and the effected leaves were taken as criteria for infestation. Efficacy of the insecticides sprayed against maize stem borer was determined by counting the infested plants in 3 middle rows of each treatment and then percent infestation was calculated by subtracting the post spray data from pre spray data. Similarly, arrangement for second spray was carried out and the pest infestation data were recorded as mentioned earlier. Observations were for corn jassids, after 1, 3, 7, 10 and 14 days of spraying the insecticides, whereas, after 7, 10 and 14 days of spraying the insecticide harvesting, yield data were recorded. The entire data were statistically analyzed using ANOVA and DMR test (Steel and Torrie, 1984, Ahmed, 2002).

RESULTS AND DISCUSSION

Corn jassid

Thiodan when sprayed alone caused up to 91% decline in the corn jassid population during 1 day of the 1st spray. The mixture with Actara and Tamaron resulted in percent reduction of 93.93 and 94.39 respectively. When mixed with Confidor, the reduction level reached to 74% which is relatively low. However, the level increased during the 3 days of the 1st spray .Reduction slightly dropped in case of the mixture and alone application. Corn jassid population gradually increased in the treated plots during 7-14 days .This could be mainly attributed to the migration of corn jassid from the nearby maize field. Corn jassid gradually increased in the sprayed plots during 1-14 days of the

1st spray. In the second spray, Thiodan when applied alone resulted in 88% reduction in the corn jassid population after 1 day. When mixed with Confidor, Actara and Tamaron, the reduction level reached to 90, 87 and 82%. Corn jassid gradually increased during 3-15 days in the sprayed plots. This could be mainly due to the migration of the corn jassid from the nearby maize field .Corn jassid increased in the untreated plots during 1-3 days and the level of increase gradually declined in the later period of the 2nd spray. The over all effect of the 1st and 2nd spray also showed that Thiodon + Confidor was the best combination as highest average percent reduction was recorded i.e 72.17 .

Maize stem borer

The highest average percent reduction in maize stem borer infested plants was recorded in plot treated with Thiodon alone which is 52.76, followed by Thiodon + Confidor (49.27), Thiodon + Tamaron (49.18) and Thiodon + Actara (47.72) after 1st and 2nd spray while control plot showed further increase in infestation of maize stem borer as indicated by plus sign i.e 10.45 .

Patel and Jotwari (1983) studied the effectiveness of the combination of several insecticides, Carbufuran, Aldicarb and Malathion in different formulation against the maize stem borer (*Chilo partellus*) .Except Malathion all treatments reduced the damage caused by *Chilo partellus* .However in the present study we used combination of different insecticides which reduced the damage caused by maize stem borer. Gerginov (1975) studied the effectiveness of 5 insecticides for the control of maize stem borer .Thiodan 35EC (Endosulphon) were the most effective in controlling the maize stem borer. The result of the present study also showed that Thiodan 35EC was the best insecticides and gave excellent control of maize stem borer as compared to the tested insecticides. Joia and Deshmukh (1975) studied the effectiveness of granular and spray able insecticides against maize stem borer.Sprays and granules of both Tricholophon and Endosulphon were the best results. Singh *et al*. (1989) practiced the effectiveness of 6 insecticides for the control of maize stem borer .Endosulphon was most effective against the stem borer. The result of the present study showed that Thiodan was the best insecticides as compared to the other tested insecticides against maize stem borer. Sekhon and Kanta (1992) evaluated 11 insecticides treatments against *Chillo partellus* on maize. Endosulphon and whorl application of granular Furadon were consistently effective. The results of the present study also showed that Thiodan was the best insecticides.

Yield

The highest yield (1174 Kg/ha) was recorded in plots treated with combination of Thiodan and Confidor, followed by Thiodan alone (1109 kg/ha). The yield achieved with insecticidal sprays showed that there was no significant difference among the treatments, However, each one was significantly different from the control. Mustea *et al.* (1970); Ahmed, *et al*. (2007) applied three insecticides against stem borer. Endosulphon was effective in increasing maize yield. The result of the present study showed that Thiodan was very effective in increasing maize yield. Halimie *et al.*1989) recommended corbofuran as a whorl treatment to reduce infestation of stem borer and resulted in higher yield, but the result of the study can not be compared as the author used different insecticides and in varying environmental condition. Mathur *et al.* (1992) tested eight insecticides to control stem borer. Endosulphon was the best against stem borer and increasing maize yield. The present results also revealed that Thiodan not only suppressed stem borer but also effectively increased the maize yield. It is concluded that a combination of Thiodan and Confidor was found the best insecticides in this study against corn jassid and maize stem borer, which has successfully controlled the pests. The yield was ultimately increased.

Table 1: Applied doses of different insecticides

Treatment No	Insecticides	Dose rate ml /100 lit. water
1	Thiodan 35EC	250
2	Thiodan+confidor SL 200	150
3	Thiodan+Actara	50
4	Thiodan+Tamaran SL600	250
5	Untreated	

Table 2: Percent reduction/increase in corn jassid population following the sprays of different insecticides.

			Mean percent reduction/increase in days after respective spray										
S. No	Treatments	Dose rate (ml/100 lit. water)	Ist spray					2nd spray					Avg
			1day	3 days	7 days	10 days	14 days	1day	3 days	7 days	10 days	15 days	
1	Thiodan35EC	250	91.41A	84.94A	74.27A	61.80B	46.44AB	87.84A	78.20AB	68.65B	60.42B	43.79A	69.77
2	Thiodan+confidorSL200	250	73.55A	88.94A	75.87A	73.08A	47.69A	89.81A	83.42A	75.99A	69.33A	44.03A	72.17
3	Thiodan+Actara	50	93.83A	87.96A	75.10A	71.72A	49.17A	87.03A	77.20AB	70.26B	60.72B	38.38A	71.13
4	Thiodan+Tamaron600SL	250	94.39A	85.26A	73.96A	63.24B	40.39B	81.98A	73.93B	65.82B	58.43B	39.67A	67.70
5	Untreated		+6.60B	+11.18B	+15.84B	+18.02C	+22.70C	+17.09B	+17.34B	+10.65C	+7.892C	+4.588B	13.21

+ sign indicates increase. Figures followed by same letters are not significantly different at 5% level of significance (DMR Test).

Table 3: Percent reduction/increase in maize stem borer population following the sprays of different insecticides.

			Mean percent reduction/increase in days after respective spray						
S.No	Treatments	Dose rate (ml/100 lit. water)	Ist spray			2nd spray			Avg
			7 days	10 days	14 days	7 days	10 days	14 days	
1	Thiodan35EC	250	72.01A	56.96A	41.92A	60.62A	49.05A	35.97A	52.76
2	Thiodan+confidor200SL	150	60.92B	51.55A	38.01A	59.46AB	49.00A	36.65A	49.27
3	Thiodan+Actara	50	59.81B	52.11A	38.38A	57.10AB	46.72A	32.22A	47.72
4	Thiodan+Tamaron600SL	250	65.64AB	54.44A	39.40A	53.15B	46.67A	35.80A	49.18
5	Untreated		+8.142C	+10.75B	+13.63B	+9.94C	+12.00B	+8.248B	+10.41

+ sign indicates increase. Figures followed by same letters are not significantly different at 5% level of significance (DMR Test).

Table 4: Yield of the maize grains as affected by different insecticidal sprays.

S.No.	Treatments	Dose rate (ml/100 lit. water)	Yield (Kg/ha)
1	Thiodan 35EC	250	1109.5AB
2	Thiodan + Confidor 200SL	150	1174A
3	Thiodan + Actara	50	1027.5AB
4	Thiodan + Tamaron 600SL	250	886B
5	Untreated		599.5C

Figures followed by same letters are not significantly different at 5% level of significance.

REFERENCES

Ahmed, S, A. Mushtaq, Saleem and I. Rauf. 2002. Field efficacy of some Bioinsecticides Maize and Jowar Stem Borer, Chilo Patellus (Pyralidae: Lepidoptera). Int.J.Agri. Bio., 4(3): 332-334.

Ahmed, S., O. U. Rehman, F. Ahmed, M. A. Riaz and A. Hussain. 2007. Varietals resistance in maize against chemical control of stem-borer, shoot-fly and termites in Sahiwal, Punjab, Pakistan. Pak. J. Agri. Sci., 44(3): 493-500.

Anonymous. 2001. Agric. Stat. Pakistan. Govt. Pak., MINFAL, Economic Wing, Islamabad. pp. 289

Gerginov, L. 1975. Result of testing pesticides for the control of maize stem borer. Restenivdni, Naukidi., 12(9): 121-137.

Halimie, M. A., M. S. Mughal, S. A. Mehdi and Z. A. Rana.1989.Response of different timings of carbofuran (Furadan3G) on the maize stem borer incidence and yield of the crop. J. Agric. Res. Lahore.27 (4): 337-340.

Joia, B. S and S. N. Deshmuk.1975.comparative evaluation of some insecticides for the control of maize stalk borer *C.partellus* . Infesting maize . Indian J.Ento., 35(2):127-129.

Mathur, Y. K, Satyadev and P.Kishore. 1992. Evalustion of some important insecticides against *C. partellus* (Swinhoe) and *Marasmia trapezailis* (Guen.) infesting maize crop. J. Entomol. Res. 16(4):227-282.

Mohammad, Q. C., A. Shakoor, H. Nawaz and M. Naeem. 1986. Maize situation in Pakistan. Maize production Manual, Pak. Agric. Res. Council, Islamabad. 64pp.

Mustea, D., A. Barleuleseu., S. Peteanu., M. Matier.,V. Apetri and I. Sandru. 1970. Chemical control of maize stem borer.Anal. Instt. de cerecet. Pentru Prot. Plant.6:153-265. (Rev.App.Ent.62;131).

Patel. J. R and M. G. Jotwari. 1983. Efficacy and economic of certain insecticides used for the control of stem borer (Swinhoe) R.A.E."A"(79):726.

Sekhon, S. S. and U. Kanta. 1992. Effect of seed treatment and other insecticidal formulations on the control of maize stem borer, C. partellus (Swinhoe). J. insect sci., 5(1):45-47.

Singh, S., P. Bahanot and J. P.Verma.1989.Chemical control of spotted stem borer forage sorghum.R.A.E. "A", 77(10):848.

Steel, R. G. D. and J. H. Torrie. 1984. Principles and procedures of statistics. Mc. Graw Hill Brok Company Inc. New York.

BETA CAROTENE IN DIFFERENT AGRICULTURAL PRODUCTS (CARROT, PUMPKIN, PAPRIKA, AND CORN) GROWN IN D. I. KHAN

Sadaf Javaria*, M. Niamatullah* , Kamran Tahir and M. Mohibullah***
*Faculty of Agriculture, **Department of Chemistry, Gomal University, D.I. Khan, Pakistan

ABSTRACT

The experiment was designed to quantify and compare naturally occurring beta carotene in different agricultural products viz. Carrot, Pumpkin, Paprika and Corn. The experiment was laid out in Completely Randomized Design. Beta carotene was extracted by using different organic solvent and quantified by Spectrophotometery. The highest concentration of beta carotene (8460 µg/100gm) was found in corn followed by Paprika (8000µg/100gm), carrots (6400µg/100gm) while minimum of (3168 µg/100gm) was found in Pumpkin. The amount obtained was much higher in all the products as compared to that reported earlier by different researchers with the exception of Pumpkin. These changes may be attributed to climate and genetic variations.

Keywords: Agricultural products, betacarotene, quantify, comparison, spectrophotometry

INTRODUCTION

Plant-based food offers a diverse mixture of nutrients that are essential for human nutrition and contribute to the promotion of good health. Epidemiological studies show that increased consumption of fruits and vegetables is correlated with a reduced risk of several diseases, including cancer and cardiovascular disease (Key et al.2002). There is considerable interest in the development of food products rich in vitamins, flavonoids and carotenoids because it is generally thought that they will be more beneficial to human health than dietary supplements (Cooper, 2004). Although conventional breeding is one means of achieving this goal, the genetic diversity available within sexually compatible species of any given crop will limit the extent of improvement. Transgenic approaches can provide an alternative, although there is currently public concern about their use in contemporary agriculture, particularly when genes derived from organisms other than plants are used (Arvanitoyannis, 2006; Arvanitoyannis and Varzakas, 2008). B-Carotene is the most potent precursor of vitamin A deficiency, which is the most common dietary problem affecting child worldwide. UNICEF has estimated that improved vitamin A nutrition could prevent up to 2 million deaths annually among children aged between 1 and 4 years (Humphrey *et al.* 1992). Vitamin A deficiency is a serious health problem among children and women in many developing countries (UNISEF, 1990), including Southeast Asia and some Pacific Islands. Low stores of vitamin A lead to increase mortality and morbidity and problems with vision and eye health, anemia and growth, whereas improving vitamin A status through a series of trials in several countries are shown to decrease overall child mortality by 23% (McLaren and Frigg, 2001). Supplementation with vitamin A has become a widely practiced public health measure in many countries. However, food have other advantages, including the provision of several nutrients simultaneously (Ruel, 2001), empowerment of individuals and households leading to family food production and to wise food selection and preparation methods and enhancement of cultural pride and identity (Kuhnlein and Pelto, 1997). Oxidative damage resulting from free radical attack has been linked to the onset of premature aging, cancer, atherosclerosis, cataracts, age-related muscular degeneration and an array of other degenerative diseases. At present, there is no officially recommended dietary intake for beta carotene. The recommended dietary intake for vitamin A is about 3 mg/g retinol equivalent. Moreover, Beta carotene is being used frequently in the food industry. Added beta carotene gives excellent stability in food products following processing and storage (Bauernfeind, 1981). Synthetic Beta carotene has apparently caused an increased risk of lung's cancer and disease of the blood vessels in double blind research and doctors are recommending that people supplement only with natural beta carotene (Anonymous, 2006). This study was carried out in Pakistan in order to give reliable information to the consumers and food industries about beta carotene contents in Corn, Carrot, Paprika, and Pumpkin.

MATERIALS AND METHODS

The study was carried out in the Faculty of Agriculture, Gomal University, D.I.Khan. The raw material Corn, Carrot, Paprika, and Pumpkin were purchased from local market and brought immediately to the laboratory. 10g of each sample was ground separately and subjected to extraction.

EXTRACTION OF BETA CAROTENE FROM DIFFERENT SAMPLES

1) Extraction of beta carotene from Corn:
   Extraction of beta carotene from Corn was done according to the method described by Schaub and Islam (2004).
2) Extraction of beta carotene from carrot and Paprika:
   Extraction of beta carotene from Carrots and Paprika was carried out according to the method of Ranganna (1997),
3) Extraction of beta carotene from Carrots:
   For the extraction of beta carotene from Pumpkin, The method described by Ranganna (1997) was followed.
4) Extraction of beta carotene from Pumpkin:
   For the extraction of beta carotene from Pumpkin, The method described by Seo *et al.* (2004) was followed.

ADSORPTION AND ELUSION OF SAMPLES

Adsorption and elusion of all the samples was done by the method described by Ranganna (1997)

PREPARATION OF STANDARD CURVE

Twenty five grams Beta carotene was dissolved in 2.5 ml of chloroform and made up to 250 ml with petroleum ether. Then 10 ml of this solution was diluted to 100 ml with petroleum ether. 5, 10,15,20,25, and 30 ml of this solution was taken in 100 ml volumetric flasks, each containing 3 ml of acetone. The concentration was 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0 microg/ml. Color was measured at 452nm. using Shimadzu spectrophotometer (model UV- 1601). Absorbance was plotted against concentration.

STATISTICAL ANALYSIS

The data obtained was analyzed using ANOVA and Completely Randomized Design at α 0.05 according to the method described by Steel and Torrie (1980)

RESULTS AND DISCUSSION

The data regarding the estimation of beta carotene in corn reveled that the amount of beta carotene calculated in Corn was quite high 8460 µg/100gm as compared to the amount described by Laura Crowley (2008) that was 1500 micrograms/100g. Similarly beta carotene estimated in Paprika in current study was 8000 µg/100g, while the amount described by Leavy *et al.* (1995) was 2000 µg/100g. The data related to the quantification of beta carotene in Carrots revealed that the amount calculated in the recent studies was 6400µg/100g; which was much higher then the amount detected by Singh, (1979) was 4950µg/100g. Beta carotene when extracted from pumpkin and quantified it gave unexpected results; the estimated amount was 3168µg/100g being quite low as compared to the amount calculated by Murkovic (2002) that was 7500µg/100 g. In this research pigments were extracted from Corn, Pumpkin, Paprika and Carrot and then quantified; the data regarding the comparison of beta carotene in these vegetables revealed that quantity of pigments extracted varied from one sample to other. Moreover, the results obtained were quite conflicting from those reported earlier. All the products investigated for beta carotene contained much higher value with the exception of Pumpkin. These variations in amount of beta carotene calculated in different agricultural products in the present and previous studies may arise due to climatic and genetic variations. Pakistan the weather remains usually warmer; beta carotene production is highly favored by high light intensity and warm weather (Shanmugavelu, 1985) so, it could be the reason of greater concentration of beta carotene in the present study. Soil N profile is also an important factor as Nitrogen plays an important role in the production of beta carotene Murthy *et al.* (1963). There were also tremendous variations in the amount of beta carotene among different Agricultural products, it may be due to Promoters, that are responsible for gene expression, (Anonymous, 2006) genes for beta carotene present in other vegetables other then corn may have promoters but the promoter strength seems to be less as compared to the promoter strength for beta carotene present in Corn. Regulatory proteins may bring variations in beta carotene amount in a plant product (Manitatis *et al*. 1989); it might be possible that in corn regulatory proteins favor the production of beta carotene as compared to the others, followed by paprika, carrot and Pumpkin. Specific proteins are present in plants which interact with the initiator and TATA box, it is known as TATA box binding protein (TBA). TBA recognizes not only the core promoter of protein genes but also RNA promoters. In different vegetables TBA acts differently (Anonymous, 2006); In corn it may favor the production of beta carotene more sturdily followed by the other three. Moreover, Regulatory regions that are enhancers, silencer (DNA), boundary elements/ insulators and promoter work collectively to direct the level of transcription of a given gene. In corn these may have more strength as compared to the other three. Some enzymes may also favor the production of Beta carotene in greater amount in one vegetable and at the same time reduces its production in the other (Shanmugavelu, 1985)

Table 1: The ANOVA (Analysis of variance) represented the clear picture of comparison of β- carotene in different samples.

Sample Name	Beta Carotene µg/100 gram
Corn	8460 a
Paprika	8000 b
Carrot	6400 c
Pumpkin	3168 d

ANOVA α =0.05

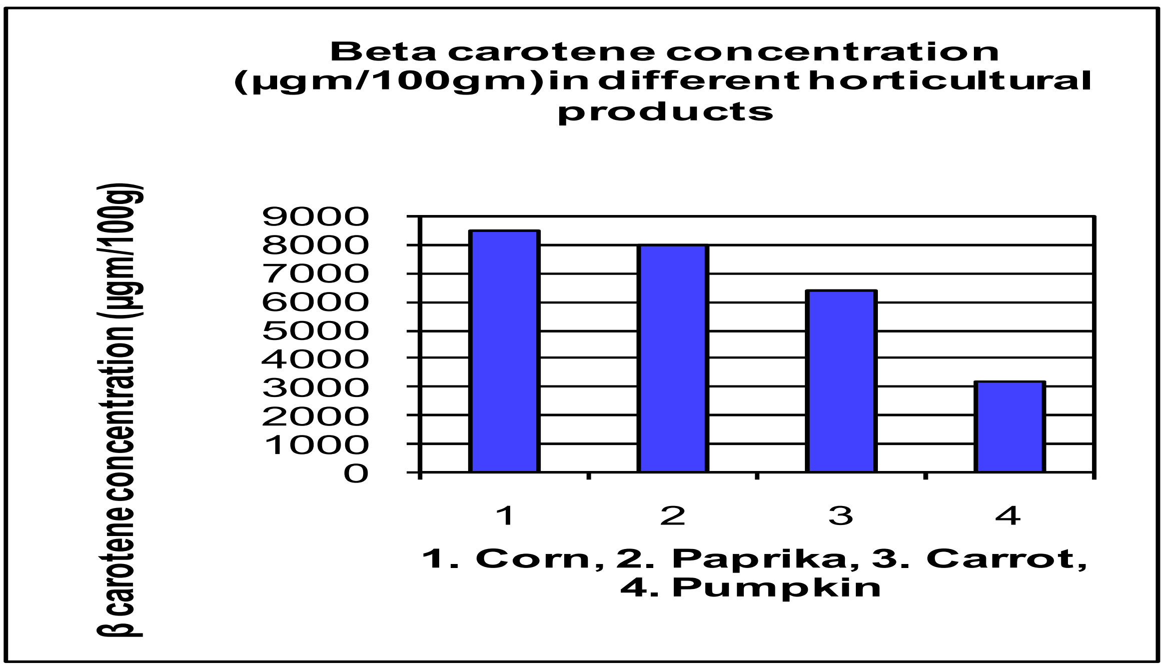


Figure 1: Beta carotene concentration (µgm/100gm) in different horticultural products

REFERENCES

Anonymous. 2006. Permotor. http://www.webbooks.com/MoBio/Free/Ch4Cl.htm. Assessed on July 2006.

Anonymous. 2006. Whole health. http://www. Wholehealthmd.com. Updated on 23 March 2006. Assessed on 2006 April.

Arvanitoyannis, I. S. 2006. Genetically modified plants: applications and issues. In: Microbial Biotechnology in Agriculture and Aquaculture (edited by R.C. Ray). Pp. 25–76. New Hampshire, USA: Science Publishers.

Arvanitoyannis, I. S. and T.H. Varzakas. 2008. Plant genetic engineering: general applications, legislations and issues. In: Microbial Biotechnology in Horticulture, vol. 2 (edited by R.C. Ray & O.P. Ward), Pp. 1–84. Enfield, NH, USA: Science Publishers.

Bauernfeind, J. C. 1981. Carotenoids as colorants and vitamin A precursors Technological and Nutritional applications. Academic Press, Inc. London, Pp: 62-74.

Cooper, D. A. 2004. Carotenoids in health and disease: recent scientific evolutions, research recommendations and the consumer. Journal of Nutrition, 134: 221-224.

Humphrey, J. H., K. P. West and A. Sommer. 1992. Vitamin A deficiency and attributable mortality among under 5 years olds. Bulletin World Health Organization, 70: 225-232.

Key, T. J., N. E. Allen, Spencer and R.C. Travis. 2002. The effect of diet on risk of cancer. Lancet, 360: 861–868.

Kuhnlein, H. V. and G. H. Pelto. 1997. Culture, Environment, and Food to Prevent Vitamin A Deficiency. Boston, Mass, USA: International Nutrition Foundation for Developing Countries.

Laura, C. 2008. New researchboosts vitamin A content in maize http://www.foodnavigator.com/SciComparative study of Beta carotene in different Agricultural products ence-Nutrition/New-research-boosts-vitamin-A-content-in-maize.

Leavy, A. S., D. Harel, B. Palevitch, Akiri, E. Menagem and J. Kanner. 1995. Carotenoid pigments and beta carotene in Paprika fruits with different genotypes. J. agric. Food chem.. Washington, D. C. American Chemical society, 43 (2): 362-366.

McLaren, D. S. and M. Frigg. 2001. Sight and Life Manual on Vitamin A Deficiency Disorders (VADD), 2nd edn. Basel: Task Force Sight and Life.

Murthy, N. S. R., E. Made and B. S. Murthy. 1963. Nutrient requirements of different vegetables. J. Andhrs Agri., 10: 54-57.

Murkovic, M., U. Mulleder and H. Neunteufl. 2002. Carotenoid content in different varieties of Pumpkins. Journalm of food composition and analysis, 15: 633-638.

Manitatis, T. E., F. Fritsch and J. Sambrook. 1989. Molecular cloning –A laboratory Manual (Cold Spring Harbor Laboratory) Cold Spring Harbor, N.Y. P.1:32-34

Ranganna. 1997. Manual of analysis of fruits and vegetable products. 2nd edn. Tata McGraw-hill Publishing Company Ltd, New Dehli, Pp: 73.

Ruel, M. T. 2001. Can Food-Based Strategies Help Reduce Vitamin A and Iron Deficiencies? Washington, DC:International Food Policy Research Institute.

Schaub, P. and S. Islam. 2004. Maize quick Carotenoids extraction protocol. Centre for Applied Biosciences, University of Freiberg, Germany.

Seo, S. J., B. J. Burri and Z. Quan. 2004. Extraction and Chromatography of carotenoids from Pumpkin. J. Chromatography. 1073 (2005): 371-375.

Shanmugavelu, K. G. 1985. Production Techn.Pp: 222-423.

Singh, H. B. 1979. Different technologies used in the production of vegetable crops in India. J. Ind. Hort., 12(3): 13.

Steel, R. G. D. and J. H. Torrie. 1980. Principles and Procedures of statistics. McGraw 3 Hill Book In. New York. USA.

UNICEF. 1990. World Declaration on the Survival, Protection and Development of Children. The World Summit for Children. New York, NY: UNICEF.

EFFECT OF DIFFERENT DOSES OF UREA ON THE GROWTH AND YIELD OF CORIANDER (*CORIANDRUM SATIVUM L.*) UNDER THE AGRO-CLIMATIC CONDITIONS OF DERA ISMAIL KHAN

Muhammad Iqbal*, M. Qasim Khan* and M.Munir*
*Faculty of Agriculture, Gomal University, D. I. Khan

ABSTRACT

An experiment was conducted at Horticultural Research Farm, Faculty of Agriculture Gomal University, during winter 2006 to assess the effect of different levels of Urea on the growth and yield of coriander (Coriandrum sativum L.) under the agro-climatic conditions of Dera Ismail Khan. The results revealed that all the parameters i.e. Plant height (cm), number of branches Plant^{-1}, days to first umbel appearance, days to last umbel appearance, days to first umbel maturity, days to last umbel maturity, number of umbels per plant, 1000 seed weight (grams) and seed yield ha^{-1} (kg) were significantly affected by different doses of urea. Urea application significantly affected all the growth parameters of coriander. The maximum number of branches plant^{-1}, number of umbels plant^{-1}, 1000 seed weight and seed yield were obtained by the application of 60 kg Urea ha^{-1}. Further increment in Urea level adversely affected the number of branches plant^{-1}, number of umbels plant^{-1}, 1000 seed weight and seed yield while days to first umbel appearance, days to last umbel appearance, days to first umbel maturity were increased with higher doses of Urea. It can be concluded that for good growth and yield of coriander, urea @ 60 kg ha^{-1} should be applied, under the agro climatic condition of Dera Ismail Khan.

Key Words: Urea doses, growth, yield, coriander, D.I.Khan.

INTRODUCTION

Coriander (Coriandrum sativum L.) belongs to family Umbelliferae (Apiaceae). It is native to the Mediterranean countries. It is cultivated throughout the world including Pakistan for its seed as well as leaves. In Pakistan, its average yield is low as compared to the other countries of the world. The yield depends upon certain production factors, amongst them appropriate and balanced nutrition plays an important role. Fertilizer application is one the most important factor for obtaining good yield of coriander. Nitrogen, for example, plays an important role in the plant growth and development. (Ali *et al.,* 1994) reported that the application of NPK at the rate of 60:60:20 kg ha^{-1} gave significant higher yield (1852 kg ha^{-1}). They also reported that leaf, branching, flowering and seed formation were enhanced at this rate. Baboo and Rana (1995) reported that application of 100 kg N ha^{-1} gave the maximum seed yield. Sharma (1996) concluded that the phosphorous application did not influence seed yield, however N application up to 120 kg ha^{-1} increased seed yield. Vinay *et al*. (1999) found that the application of nitrogen (40, 60 or 80 kg/ha) and phosphorus (20, 40 or 60 kg ha^{-1}) favorably increased the growth and yield of coriander. They noticed that the plant height, weight of dried plant, seed yield and 500 seed weight increased with the increase in nitrogen and phosphorus application rates and the response to N was greater than P. Arya *et al*. (1999) applied nitrogen at 25 and 50 kg ha^{-1} to coriander. They observed that the high doses of N increased the days to 50% flowering (e.g. 50 days with 50 kg N ha^{-1}). They recorded the minimum number of days to umbel appearance (70 days) and minimum number of days to seed maturity (81.32 days) with 25 kg N ha^{-1} and achieved the highest 1000-seed weight (16.78 g) with the application of 50 kg N ha^{-1}. They also recorded the highest seed yield of 1327 kg ha^{-1} with 25 kg N ha^{-1}. Garg *et al*. (2000) reported that 90 kg N and 50 kg P ha^{-1} was the best treatment for coriander that produced 37% higher seed yield over the control. Reddy and Rolston (2000) found that there were no significant differences in seed yield for N application rates ranging from 50 to 200 kg N ha^{-1}. (Concalves *et al*. (2000) applied nitrogen fertilizer to lettuce by using two sources of nitrogen i.e. urea and ammonium sulphate. They recorded the data on the production of fresh weight, leaf area, number of leaves and lettuce head diameter. The effect of urea was better than ammonium sulphate on crop yield. Mitova and Stancheva (2003) reported that equivalent nitrogen did not influence spinach yield. They studied the effect of 100 to 500-mg kg^{-1} Nitrogen rates on spinach fresh and dry biomass and plant growth and development. Abu Rayyan *et al*. (2004) investigated the effect of three forms of nitrogen fertilizers Ca $(NH_4)_2$ NO_3, $(NH_4)_2$ SO_4, Co $(HN_2)_2$ on lettuce. The results indicated that nitrogen @100 kg ha^{-1} significantly increased all the parameters. Premuzic *et al*. (2004) studied the effect of Ca $(NO_3)_2$ and NH_4 NO_3 on the yield of lettuce and reported best yield in case of the NH_4 NO_3. Dong-Yan *et al*. (2005) reported an increase in yield of lettuce by 15.3-27.6% in balance fertilizer treatments. Nitrogen plays role in photosynthesis, respiration, energy storage and transfer, cell enlargement and several other processes in coriander plant. Keeping in view the importance of fertilizer application, the present research was conducted to see the response of different levels of urea on the growth and yield of coriander under the Agro-climatic conditions of Dera Ismail Khan.

MATERIALS AND METHODS

This experiment was conducted at Horticultural Research Farm, Faculty of Agriculture, City Campus, Gomal University, Dera Ismail Khan during winter 2006. The seeds were planted on flat beds keeping 30 cm row space. Nitrogen fertilizer in form of urea was applied in spilt applications. First application was at full germination when the plants attained a height of about 3 to 4 cm. The 2nd application was 30 days after the first one. Triple Super Phosphate (TSP) and Potassium Sulphate fertilizers @ 20kg ha^{-1} each were applied at the time of soil preparation. All cultural practices were carried out uniformly. The experiment was laid out in a Randomized Complete Block Design (RCBD) having six treatments (Control 0 kg ha^{-1}, 30 kg ha^{-1}, 45 kg ha^{-1}, 60 kg ha^{-1}, 75 kg ha^{-1} and 90 kg ha^{-1}).

Soil Analysis

A composite soil sample from the experimental plot was collected and analyzed for physico-chemical characteristics at Soil Testing Laboratory of Agricultural Research Institute, Dera Ismail Khan.

Plot size: Each plot was 1 m^2 in area having 1 meter long and 1 meter wide.

Parameters Studied

Plant height (cm)
The plant height was measured with the help of a scale from the soil surface to the terminal end of the plant and then mean was calculated.

Number of branches per plant.
The number of branches per plant at harvest was counted and then the average number of branches per plant was recorded.

Days to first umbel appearance
The data on the number of days from the date of germination to the appearance of last umbel was computed.

Days to last umbel appearance
Data on the last umbel appearance on plants was recorded by counting the number of days from the date of germination to the appearance of last umbel.

Days to first umbel maturity
The number of days from the appearance of first umbel to its maturity in each treatment and the average was recorded.

Days to last umbel maturity
The number of days from the appearance of last umbel to its maturity in each treatment and the average was recorded.

Number of umbels per plant
The total number of umbels per plant for each treatment in each replication was counted and then average was calculated.

1000-seed weight (grams)
After harvesting the seed was separated from plants and 1000 seeds were weighted on an electronic balance.

Seed Yield ha^{-1} (kg)
Total yield for each treatment was measured and then was converted into yield $hectare^{-1}$ using the following formula.

$$\text{Yield ha}^{-1}\text{ (kg)} = \frac{\text{Yield in g x 10000 m2}}{1 \times 1\ m^2 \times 1000}$$

Statistical Analysis
All the data were statistically analyzed using the method of (Steel and Torrie, 1980), in which LSD was computed to check the least significant difference among the treatments means.

RESULTS AND DISCUSSION

Plant height (cm)

The data on plant height as depicted in Table 1 shows that different Urea doses had significant effect on plant height as compared to control. Maximum plant height of 59.43 cm was recorded by application of 90 kg urea ha^{-1}. The plant height of 57.56 cm, 55.23 cm was obtained by the application of 52.93 cm by 75, 60 and 45 kg N ha^{-1} respectively. The minimum plant height of 40.36 cm was recorded in control (no Urea). The mean difference in height of the plant for 45 and 75, 60 and 90 kg ha^{-1} Nitrogen was significantly different from each other. On the other hand, the mean difference in height of 45 and 75 treatments and 60 and 90 treatments were higher than LSD and the control was significantly lowest among all the other treatments. However 30 kg ha^{-1}, 45 kg ha^{-1}and 60 kg ha^{-1} was statistically similar, while 75 kg ha^{-1}, 90 kg ha^{-1} also statistically found similar. The increase in plant height is due to increase in level of nitrogen as it increases vegetative growth. Plant height was related to proper nitrogen doses for growth and development. These results are in agreement with findings of (Vinay *et al*., 1999), they noticed that plant height was increased with the application of N at higher rates.

Number of branches per plant

Data regarding number of branches per plant are shown in Table 1. Different levels of Urea have significant effects on number of branches per plant. Maximum braches per plant (23.23) were observed with application of 60 kg urea ha^{-1}, followed by 21.2 branches per plant by application of 75 kg urea ha^{-1}, where as minimum number of branches plant^{-1} (14.23) were recorded in control. Enhanced doses of Urea gives vigorous growth and increases vegetative growth, which ultimately increases the number of branches plant^{-1}. The increase in number of branches plant^{-1} might be due to proper fertilization, which was probably because of more photosynthetic activity, energy storage and cell division enlargement. Greater number of branches plant^{-1} has been noticed from higher doses of N by (Tomar *et al*., 1994) who studied the similar response of coriander to different levels of fertility.

Days to first umbel maturity

The data in days to first umbel appearance is represented in Table 1. Urea doses have significant effect on days to first umbel appearance. Maximum days to first umbel appearance (50.6) was recorded in control, followed by 44.96, 44.13, 43.5 and 41.6 days by plant receiving 30, 45, 75, and 90 kg urea ha^{-1} respectively. Minimum days to first umbel appearance (39.56) was recorded for (60 kg Urea ha^{-1}). Minimum days to first umbel appearance (38.56) recorded from the treatment receiving 60 kg urea ha^{-1}. (Arya *et al.,* 1999) also obtained the similar results, they observed the appearance of first development of coriander has significantly minimized the days to first umbel appearance. Nitrogen in correct quantity in soil promotes both the vegetative and reproductive growth of the plant.

Days to last umbel appearance

The data on days to last umbel appearance is given in Table 1. Different levels of Urea have significant effect on days to last umbel appearance. Minimum (71.33) days to last umbel appearance were recorded with the application of 60 kg urea ha^{-1}, while maximum days to (84.83) last umbel appearance were recorded for the control, followed by 78.7, 75.56 and 74.56 days for the treatments receiving 30, 45 kg and 75 kg urea ha^{-1}. The control and 30 kg ha^{-1} are statistically different from another, while 45 kg ha^{-1} and 90 kg ha^{-1} are also statistically similar. When nitrogen was applied at 60 kg ha^{-1}, the last umbel appearance occurred in minimum days (71.33) whereas; last umbel appearance took significantly more days (84.83) in plants which did not receive any amount of nitrogen (control). This could be attributed to the uptake and utilization of more nitrogen, which probably induced early flowering and also enhanced umbel appearance and maturity. These results are also supported by the findings of (Arya *et al*., 1999) as well as by (Maliav and Yadav 1997).

Days to first umbel maturity

The data of days to first umbel maturity is shown in Table 1. Different levels of Urea have significant effect on days to first umbel maturity. Minimum (55.13) days to first umbel maturity were recorded with the application of 60 kg urea ha^{-1}, while maximum days to first umbel maturity (69.83) were recorded for the control, followed by 58.8,, 57.73 and 56.7 days for the treatments receiving 30, 45 and 75 urea ha^{-1}. These results collaborate with (Arya *et al*., 1999), they obtained similar results and stated that nitrogen induced early maturity and therefore, days to first umbel maturity were less with higher dose of nitrogen. It could be attributed to the more availability and uptake of N resulting in induction of early maturity. Nitrogen plays an important role in the growth and development of plant, especially the synthesis of proteins is carried out in the presence of abundant amount of nitrogen in the cell. Protein enhances the reproductive growth and therefore, minimizes the days to first umbel maturity.

Days to last umbel maturity

The data of days to last umbel maturity is arranged in Table 1. Different levels of Urea have significant effect on days to last umbel maturity. The maximum days to last umbel maturity (87.3) were recorded for the control, while minimum (74.16) days to last umbel maturity were recorded with the application of 60 kg urea ha^{-1} followed by 84.1, 81.13 and 75.9 for the treatments applied 30,45 and 75 kg urea ha^{-1}. The 79.66 days to last umbel maturity were recorded for the treatment receiving 90 kg urea ha^{-1}. The control and 30 kg ha^{-1} were similar to one another, while 45 kg ha^{-1} and 90 kg ha^{-1} were statistically similar. The plots receiving nitrogen were better performance and gradual increase in nitrogen also gradually decreased the umbel maturity time. A further increase in nitrogen also increased the days to last umbel maturity due to increase in vegetative growth. (Arya *et al.,* 1999) also obtained the similar results and stated that nitrogen induced early maturity and therefore, days to last umbel maturity were less with higher dose of nitrogen.

Number of umbel per plant

The data regarding number of umbels per plant is given in Table 1. There is a significant difference in the number of umbels per plant. Statistically more umbels per plant (13.83) were recorded in the (60 kg urea ha^{-1}). The least number of umbels per plant (7.03) were noticed in control. It was followed by (75 kg urea ha^{-1}) and (90kg urea ha^{-1}), which produced 12.96 and 12.10 umbels per plant respectively. Likewise (45kg urea ha^{-1}) and (30kg urea ha^{-1}) produced statically similar number of umbels (11.0 & 10.4) respectively. (Manure *et al*., 2000) stated that nitrogen deficiency in control plants has depressed the growth and development which was the main cause of less number of umbels per plant. Proper dose of nitrogen improved the plant growth as well as initiates more umbels per plant.

1000-seed weight (grams)

Data regarding 1000-seed weight (grams) is given in Table 1. Urea doses have significant effect on 1000-seed weight (grams). Maximum 1000-seed weight (12.76 grams) was recorded in the treatment receiving 60 kg urea ha^{-1}. The lowest 1000-seed weight (9.22 grams) was recorded for the control. It was followed by 12.03, 11.60 and 10.67 gm of 1000 need weight obtained from (75kg urea ha^{-1}), (90kg urea ha^{-1}) and (45kg urea ha^{-1}). The 60 kg ha^{-1} and 75 kg ha^{-1} were statistically similar whereas 75 kg ha^{-1}, 90 kg ha^{-1} and 45 kg ha^{-1} were also significantly alike. Thousand seed weight gives us a general idea about the yield and size of the grain. Increase in 1000-seed weight indicates that high dose of nitrogen resulted in more protein accumulation in the seed. (Manure *et al*., 2000) reported that coriander in various combination of N has achieved higher seed weight per plant. (Vinay *et al*., 1999) found that the application of nitrogen favorably increased the seed weight and the response to N was greater than P.

Seed yield ha-1 (kg)

Data considering seed yield ha^{-1} is given in Table 1. Urea doses have significant effect on seed yield ha^{-1}. Significantly more seed yield/ha (939 kg) was achieved by the application of 60 kg N ha^{-1}, followed by 725 kg ha^{-1}, 587 kg ha^{-1}, 440 kg ha^{-1} and 355 kg ha^{-1} by the application of 75, 90, 45 and 30 kg urea ha^{-1}. The minimum seed yield of 251 kg ha^{-1} was recorded in unfertilized plot (control). The treatment control and 30 kg ha^{-1} are statistically similar to one another while 60 kg ha^{-1} and 75 kg ha^{-1} were also similar to one another but were dissimilar to 45 kg ha^{-1} and 90 kg ha^{-1}. More yields with the application of 60kg urea ha^{-1} are due to greater number of braches plant^{-1} and number of mumbles per plant. The results collaborate with the findings of (Arya *et al.,* 1993).

CONCLUSION

Urea at the rate of 60 kg ha^{-1} is the best dose for getting increased production of coriander seed under the agro-climatic conditions of Dera Ismail Khan.

Table 1: Soil Analysis of Experimental plot.

S. No	Parameter	Unit	Value
1.	pH	-----	8.0
2.	Electrical Conductivity	ds m^{-1}	0.650
3.	Ca + Mg	me L^{-1}	6.40
4.	CO_3	meq L^{-1}	Nil
5.	HCO_3	meq L^{-1}	1.48
6.	C1	meq L^{-1}	2.38
7.	Organic matter	%	0.65
8.	Nitrogen (N)	%	0.032
9.	Phosphorus (P)	mg kg^{-1}	7.2
10.	Potash (K)	mg kg^{-1}	189
11.	Gypsum requirement	T ac^{-1}	Nil
12.	Lime ($CaCo_3$eq)	%	9.62
13.	Textural class	------	Clay loam

Table 2: The effect of different doses of Urea on plant height, No of Braches per plant, days to first umbel appearance, Days to last umbel appearance

Urea Doses	Plant height (cm)	Number of branches/plant	Days of first umbel appearance	Days to last umbel appearance	Days to first umbel maturity
Control	40.36 e	14.23 e	50.60 a	84.83 a	69.83 a
30	48.86 d	16.93 d	44.96 b	78.70 b	58.80 b
45	52.93 c	18.56 cd	44.03 b	75.56 c	57.73 c
60	55.23 bc	23.23 a	38.56 c	71.33 d	55.13 e
75	57.56 ab	21.2 b	41.60 bc	73.10 cd	56.70 d
90	59.43 a	19.4 bc	43.50 b	74.56 c	57.10 cd
L.S.D	2.3	1.1	4.2	2.2	0.18

Means followed by different letter show significant result at 5% level of significant.

Table 3: Showing the effect of different doses of urea on days to last umbel maturity, number of umbel per plant, 1000 seed weight (gm) and seed yield ha^{-1} (kg).

Urea Doses	Days to last umbel maturity	Number of umbels per plant	1000-seed weight (grams)	Seed yield/ha (kg)
Control	87.30 a	7.03 d	9.22 d	251 d
30	84.10 ab	10.4 c	9.28 d	355 d
45	81.13 bc	11.0 c	10.67 c	440 cd
60	74.16 d	13.83 a	12.76 a	939 a
75	75.90 cd	12.96 ab	12.03 ab	725 ab
90	79.66 b-d	12.10 b	11.6 bc	587 bc
L.S.D	10.15	0.24	0.4	127.25

Means followed by different letter show significant result at 5% level of significant.

REFERENCES

Abu-Rayyan, A, B. H. Kharawish and K. Al-Ismail. 2004. Nitrate contents in lettuce *(Lactuca sativa L.)* heads in relation to plant spacing, nitrogen form and irrigation level. Journal of Food science and Agriculture. 84(9):931-936.

Ali, S. A., R. K. S. Tomar and K. N. Maurya. 1994. Response of coriander to irrigation and nutrient levels. Bharitya Krishi Anusandhan Patrika. 9 (4):241-246

Arya, P. S. V. Sagar and S. R. Singh.1999. Effect of N, P and K on seed yield of coriander. Scientific Horticulure.6 (5): 137-139.

Baboo, R. and N. S. Rana. 1995. Effect of cutting management nitrogen and phosphorous on growth and yield or coriander. Indian Journal of Agronomy. 40(2):253-255.

Barreyro, R. A., V. G. E. Sanchez, A. M. Chamorro and V.G. Petruccelli.1993. Increase in coriander biomass and essential oil content as a result of nitrogen fertilizer application. Revista-de-Agronomia-la-plata.69 (1):59-61.

Dong-Yan, W. Z. Y , D. H. Ping, L. H. He, S. Shengqi and Z. Hong. 2005. Effects of balance fertilizer use on the yield and quality of lettuce. Journal of South west Agricultural University, Chongging, China.26(6):740-744.

Garg, V. K., P. K. Singh and R. S. Katiyar. 2009. Yield and nutrient uptake by some spice crops grown in sodic soil. Centennial conference on Spices and aromatic plants. Calcutta, Kerala, India. 133-134.

Malav, N. B. and S. N. Yadav.1997. Effect of row spacing and levels of phosphorus on growth and seed yield of coriander. Idian Cocoa, Areacanut and Spices Journal. 21(2):37-41.

Manure, G. R., B. Shivaraj, , A. A. Farooqui, and H. S. Surendra. 2002. Yield attributes, seed, essential oil yield and content of coriander as influenced by the graded levels of nitrogen, sulphur and zinc nutrition in red sandy loam soils. Centennial conference on Spices and aromatic plants. Calicut, Kerala, India. 139-144.

Mitova, I. and I. Stancheva. 2003. For reaching effects of increasing rates of the organic and mineral nitrogen fertilizers on the yield and some quality parameters in spinach. Ecology and Future, Bulgararian Journal of Ecological Science. 2(34).90-100.

Nehra, B. K., S. C. Rana and S. Narendra. 1998. Seed yield and quality of coriander as influenced by varieties, spacing and fertility levels. Water and nutrient management for sustainable production and quality of spices: Proceedings of the national seminar. Madikerik, Karnataka. India. 73-75.

Premuzic, Z., F. Villela, A .Qarate and I. Bonilla. 2004. Light supply and nitrogen fertilization for the production and quality of butter-head lettuce.Acta-Horticulutre. 59(2):671-678

Reddy, K. and M. Roslstion. 2000. Coriander seed production nitrogen, row spacing seed rate and time of sowing. Journal of applied seed production.17: (6) 49-53.

Sharma, T. N. 1996. Effect of date of sowing and levels of nitrogen and phosphorus on growth and yield of coriander. Bjartova Krishi Anusandhan Patrika. 11 (4):232-238.

Steel, R. G. D. and J. H. Torrie. 1980. Principles and procedures of statistics. McGraw-Hill Book Company, Inc. New York.481p.

Tomar, S. S., K. P. Gupta, M. Abbas and K. B. Nigam. 1994. Effect of irrigation and fertility levels on growth and yield of coriander Indian Journal of Agronomy. 39: (2) 442-447.

Vinay, S., R. K. Bisen and V.Singh. 1999. Response of nitrogen and phosphorus on seed crop of coriander. Environment and Ecology. 17 (1):238-239.

EFFECT OF STORAGE PERIOD ON THE QUALITY OF GUAVA SQUASH

Mehwish Zerlasht*, Habib Ur Rahman* and Sadaf Javaria*
*Faculty of Agriculture, Gomal University, D.I.khan

ABSTRACT

The main objective of this research was to investigate the changes in guava squash's various physicochemical and organoleptic characteristics during storage at room temperature (30-37 ºC). The data showed that in the present study, ascorbic acid content of the guava squash decreased from 6.3mg/100ml (fresh sample) to 4.0 mg/100ml (60-days). Statistical analysis showed that the results were significant ($P \leq 0.001$). Titratable acidity increased from 0.15% (fresh sample) to 1.15% at the termination of storage period. Statistical analysis showed linear relationship of ($P \leq 0.05$). The pH decreased from 3.140 to 2.35 at the end of during 60 days of storage period respectively. The 25.15% increasing change was observed during storage period and showed a significantly linear relationship ($P \leq 0.001$). Total Soluble Solids (TSS) contents were increased from 54.0 up to 55.0% in squash during observation after 15 days of storage period interval. The 1.81% positive change in total soluble solids contents of guava squash was recorded. Statistical analysis showed a positive linear relationship ($P \leq 0.05$) between total soluble solids and storage period. Oganoleptically for appearance factor, the mean score was obtained 7.8 and for appearance a decrease in score from 8.0 (fresh sample) to 7.6 (60-days) was recorded. A failing score for flavor and overall acceptability was also found during study.

Key words: Guava squash, storage period, quality parameters

INTRODUCTION

The Guava (*Psidium guajava*) is one of the most important pomiferous fruits of myrtaceae family. It is grown all over the world for its high dietary value and good taste. It is a major fruit grown almost every where in Pakistan. It is grown on a large scale in Sheikhupura, Gujranwala, and Lahore Districts, and on a smaller scale throughout the plains of Punjab. In sindh, excellent pear shaped guavas with a smaller seed core are grown in Larkana, Dadu, Shikarpur, and Hyderabad Districts. In NWFP, Mardan ,Hazara and Kohat districts are famous for excellent guavas (Malik, 1994**)**. Total area and production of guava in Pakistan are given in Table1. Guava is a very rich source of many important nutrients, like vitamin C, fair source of vitamin A, calcium and phosphorus (Malik, 1994). The fruit of common guava tree has a rough texture, yellow skin and varies in shape from round to pear shaped. The colour of inner flesh varies from white, deep pink to salmon red. A mean summer temperature of 20 ºC is a minimum requirement for commercial guava production; temperature lower than this may lead to loss of crop. The optimum temperature lies from 23 to 28 ºC. Guavas can not tolerate the high temperature of the dessert regions. A mild tropical climate induces fruiting throughout the year. The shelf life and quality of processed guava products like guava squash can be affected by several factors like cloudiness, microbial invasion, and temperature during storage (Hussain and Shah, 1991). Guava fruits with a thick out flesh and small seed cavity are desirable for food processing. The more acid fruits with pH 3.3 and 3.5 are better for processing than sweeter fruits (Malik, 1994). Guava is a rich source of vitamin C, like vitamin A, calcium, phosphorus and has an average protein content of 1.0g, energy content up to 108 Kcal/100g, 25.2 g/100g carbohydrates, 0.5g/100g fibre, 0.8g ash, 12mg calcium, 30mg phosphorus 0.8mg iron, and 71.9g/100g average water content as whole (Awan, 2000). A larger portion of the Guava production in Pakistan is lost due to lack of preservation and storage facilities. It is perishable fruit and may spoil through biological (microorganism, enzymes) as well as chemical and physical means during handling. People usually purchase squashes and keep in their houses at room temperatures for a long time because of unawareness of loss of nutritive quality of squash during that storage period (Shah *et al.* 1975).The present research was, therefore, initiated to evaluate the suitability of local guava cultivar for the preparation of guava squash and to investigate changes in its various physicochemical and organoleptic characteristics during storage at ambient temperature in Dera Ismail Khan.

MATERIALS AND METHOD

This research work was carried out in the laboratory of the Department of Food Sciences and Technology, Faculty of Agriculture, Gomal University, Dera Ismail Khan . Fresh, mature and healthy guava fruits of local variety were purchased from the local fruits and vegetables market. On the same day, the guava squash was prepared and stored at room temperature for a period of two months to access the effects of storage duration on its quality parameters.

1. Squash preparation:

The fruits were thoroughly washed with potable water to remove dust, dirt and other extraneous material. Sorting was carried out on the basis of size. The sorted fruits were cut into halves by stainless steel knife. The juice was extracted carefully with the help of juicer. The required sugar and water solution was heated at 70^{o}C for 15 minutes. After heating sugar solution was cooled and mixed with the guava squash by using following formula.

Guava Squash : 1.00L
Water : 0.75 L
Sugar : 1.25 KG
Potassium metabisulphite: 3.50 gm

2. Filling and Sealing:

The squash was filled in pre-sterilized transparent 1.5 litre plastic bottles. Bottles were sealed with plastic caps to protect them from contamination.

3. Storage:

The prepared samples were stored at room temperature (30-37^{o}C) for a period of 2 months and analyzed for physico-chemical and organoleptic characteristics at an interval of 15 days.

4. Physico-Chemical Analysis:

(a) *Ascorbic Acid:-* Ascorbic acid was determined by indo-phenol method by the standard method of A.O.A.C (1990)..

(b) Titratable Acidity

Titratable acidity was determined by the standard method of A.O.A.C (1990).

(c) Total Soluble Solids:-

The total soluble solids were determined by standard method as recommended by A.O.A.C (1990).

5. Organoleptic Evaluation

Samples were evaluated organoleptically for appearance, taste and flavour and overall acceptability by using 9-point hedonic scale as described by Larmond, (1977).

6. Statistical analysis:

All the data regarding different parameters were statistically analyzed using regression analysis.

RESULTS AND DISCUSSION

A) Physicochemical Analysis

i. Ascorbic Acid

Figure 1 shows that ascorbic acid decreased with an increase in storage period. The correlation between storage period and ascorbic acid content in squash (R^2 = 0.90) was negative but highly significant. Ascorbic acid content in guava squash showed a highly significant negative linear relationship ($P \leq 0.001$) with the storage period. At the start of experiment the ascorbic acid content in guava squash was 6.3mg/100ml which was gradually decreased up to 4.0mg/100ml. Similar result was recorded by Kalra *et al*. (1987), who found that about 30% vitamin C was lost with in 6 months at room temperature of (20-25C^o). Singh *et al* (2007) also found decrease in ascorbic acid contents in guava juice during storage period of 120 days. It is suggested that vitamin C (Ascorbic acid) content in squashes decreases with passage of time at higher room temperatures.

ii. Titratable Acidity (%)

Figure 2. depicts the effects of storage period on titratable acidity (%) in guava squash. Titratable acidity percentage in guava squash increased significantly ($P \leq 0.05$) increased with increase in storage period up to 60 days. Similar results were observed by Saito *et al.* (1974) who observed the quantitative changes in chemical components of fruit juice during storage. They reported that acidity in juices increased during prolonged storage.

3. pH

Figure 3 shows that pH of Guvava sqush decreased with an increase in storage

period. The correlation between pH of guvava sqush and storage period (R2 = 0.98) was linear but negative and highly significant .Guava squash was analyzed for pH during storage period of 60 days at 15 days of storage period interval. A constant decrease in pH was observed in squash during this time period. The pH decreased from 3.140 in fresh sample to 2.35 at the end during 60 days of storage period.
The results are similar to the observation recorded by Bajwa *et al*. (2002) who found a decreasing trend in pH while assessing the storage study of grape fruit and apple juice.

4. Total Soluble Solids (TSS)
Total soluble solids in guava squash were significantly ($P \leq 0.05$) increased with increase in storage period (Figure 4), at room temperature (30-37 ^{o}C) during summer days. Singh *et al.* (2007) also found increase in (TSS) total soluble solids in guava juice during storage period of 120 days. They suggested that in squashes total soluble solids increase with passage of time at higher room temperatures.

B. Organoleptic Evaluation
1. Appearance
In guava squash appearance score decreased from 8.0 to 7.6, 7.4, 7.2, and 7.0 during 0, 15, 30 ,45 and 60 days of storage interval respectively. The mean score obtained was 7.5.

2. Taste
In guava squash, the taste score decreased from 7.5 to 7.2, 7.2, 7.0, and 6.9 during 0, 15, 30, 45 and 60 days of storage interval period respectively. The mean score obtained was 7.2.

3. Flavor
The flavor score was also found to decrease in guava squash. The decrease was from 7.8 to 7.7, 7.5, 7.4, and 7.4 during 0, 15, 30, 45 and 60 day's storage period respectively. The mean score of these three values obtained from guava squash was 7.6.

4. Overall Acceptability
In Guava squash samples the overall acceptability decreased from 7.9 to 7.6, 7.4, 7.2 and 6.8 during 0, 15, 30, 45, and 60 days of storage period interval respectively. Table 2 shows the nine point hedonic scale of eight judges for assessing the sensory attributes of guava squash during 60 days of storage. The mean score obtained was 7.4 in over all acceptability values.

The results of sensory evaluation are in agreement with those of Singh *et al.* (2007) who reported similar results while studying the blends of guava and pineapple juice in different ratios for 120 days storage period.

Table 1: Area and Production in Pakistan

Year	Area in Thousandshectares	Production in Thousands tonnes
2004-05	63.5	571.8
2005-06	61.8	552.2
2006-07	62.5	555.3
2007-08	62.8	538.0

Source: Agricultural Statistics of Pakistan, (2005-06), Pakistan Economic Survey (2007-08).

Table 2: Organoleptic evaluation of guava squash during 60 days of storage.

Storage period	Appearance	Taste	Flavor	Overall acceptability
0	8.0	7.5	7.8	7.9
15	7.6	7.2	7.7	7.6
30	7.4	7.2	7.5	7.4
45	7.2	7.0	7.4	7.2
60	7.2	7.9	7.4	6.8
Mean score	7.5	7.2	7.6	7.4

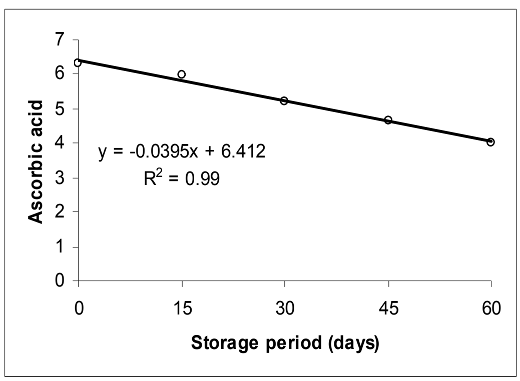


Figure 1. Effect of storage period on ascorbic acidity (%) in guava squash.

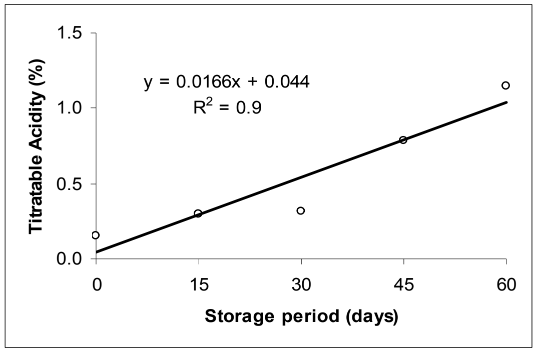


Figure 2. Effect of storage period on titratable acid in guava squash.

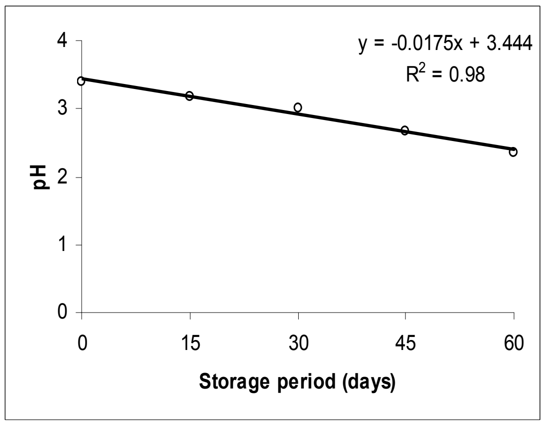


Figure 3. Effect of storage period on pH in guava squash

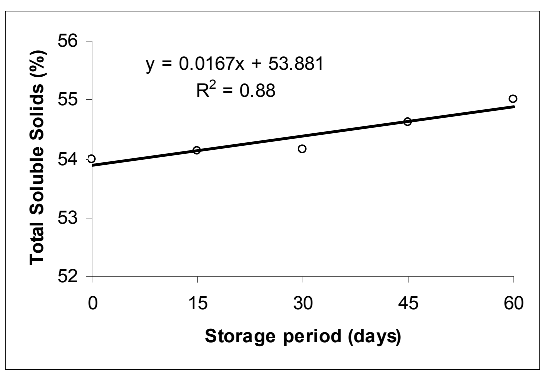


Figure 4. Effect of storage period on TSS in guava squash.

REFERENCES

Agricultural Statistics of Pakistan. 2005-06. Government of Pakistan, Ministry of food, Agriculture and Co-operatives, Islamabad.

A. O. A. C. 1990. Official methods of analysis. Assocition of Official Analytical Chemists. 15th Eddition. Verginia 22201, Arlington, 1264.

Awan, J. A. 2000. Elements of food and nutrition. ISBN 969-8543-03-1.

Bajwa, E. E. N. Z. Perwaz, A. Javed and N. Ahmed. 2002. Development, standardization and storage studies on grape fruit apple marmalade. Pak. J. Food Sci., 13 (3 - 4): 12 - 14.

Hussain, A. and W. H Shah. 1991. Preparation and evaluation of Guava product. Pak. J. Agri. Res., 12: 106-109.

Kalra, S. K., D. K. Tandon and H. C. Lohani. 1987. Prevention of discoloration in guava beverage during storage. Indian food packer, 41(1): 21-24.

Larmond, E. 1977. Laboratory method of sensory evaluation of food Publication, Canada Dept. of Agri: Ottawa.

Malik, M. N. 1994. Horticulture. National book foundation, Islamabad.

Singh, P. Shukla, A. Singh, R. Singh. 2007. Utilization of guava squash by value addition through blended beverages. J. of food processing & preservation, 25 (6): 411-430.

Shah, W. H, S. I. Zafar and N. A. Sufi. 1975. Studies on storage stability of guava fruit squash . Pak. J. Sci. Ind., 18: 344-348.

Saito, Y. T. Hatayana and H. Hosoda. 1974. Quantitative changes in chemical components of fruit juices during storage. J. Food Nutrients, 27(3): 134-141.