

Seed developmental and maturation studies in davana (*Artemisia pallens*)

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Abstract: *Davana (Artemisia pallens)* is an important high valued annual medicinal and aromatic herb of India belonging to the family Asteraceae. India has a monopoly in production and export trade of davana oil and India stands 3rd in essential oil production in the world. This study was conducted at Department of seed science and technology, TamilNadu Agricultural University, Coimbatore to determine the seed developmental and maturation studies in davana. The bulk davana crop was raised in the field. Individual flower heads were tagged at the time of flower opening. The seeds were collected at 5 days intervals and subjected to the following seed quality assessment. The observation made on seed moisture content (%), 1000 seed weight (mg), germination %, seedling length (cm), dry matter production and vigour index. The results revealed that physiological maturity of davana seeds was attained on 35th day after anthesis, where in germination percentage (86), seedling length (2.3), vigour Index (198) and dry matter production (1.23mg) were higher.

Keywords: *Davana*, seed development and maturation, germination %, seedling length, drymatter production, vigour index.

I. Introduction:

Aromatic plants are the natural source of perfumes and fragrance widely exploited by essential oil industries across the world. India stands 3rd in essential oil production in the world, the first being France while Britain takes the 2nd place. *Davana (Artemisia pallens)* is an important high valued annual aromatic herb of India belonging to the family Asteraceae and commercially cultivated in south India as a short duration crop from November to march. India has a monopoly in production and export trade of davana oil and India stands 3rd in essential oil production in the world. *Davana* is traditionally used in religious ceremonies and in making garlands, bouquets, floral decorations and floral chaplets, lends an element of freshness and a rich sumptuousness of fragrance to religious occasions (Narayana *et al.*, 1998) [1]. The essential oil of davana extracted from air dried flowering herb, is a brown viscous liquid with deep mellow, persistent, rich fruity odour and it is recognized as one of the most useful essential oils for formulating natural flavours that are used in cakes, pastries, beverages in United States of America, Europe and Japan (Pisana 1989) [2]. *Artemesia pallens* possesses anti-inflammatory, antipyretic and analgesic properties it is used in Indian folk medicine for the treatment of Diabetes mellitus. (Al-Harbi *et al.*, 1994) [3]. Seed maturity is the crucial and most important factor determining the seed quality under successful seed production programme (Austin, 1972) [4]. It is understood that seed maturation is the gradual preparation for germination (Bewley and Black, 1994) [5]. The development process during seed growth and maturity interacts with the production environment to determine the planting quality of a seed. It is well established that seed quality is the highest at physiological maturity which precedes harvestable maturity. This practice would permit quick harvesting at appropriate timings, resulting in better field management (Delouche, 1973)[6]. Hence, knowledge on development of seed from fertilization to maturity is highly warranted.

II. Materials and methods:

The study was conducted with davana seeds obtained from Horticultural college and Research Institute, Periyakulam formed the base material for this study. The experiment was conducted at Department of seed science and technology, TamilNadu Agricultural University, Coimbatore to determine the physiological and harvestable maturity status of the seed. The bulk davana crop was raised in the field. Individual flower heads were tagged at the time of flower opening. The seeds were collected at 5 days intervals and subjected to the following seed quality assessment. Seed moisture content, 1000 seed weight, Germination percentage, seedling length, drymatter production and vigour index are the observations recorded. Seed moisture content estimated by the following method. In each developmental stage four replicates of hundred seeds each were weighed (M₁). The seeds were shade dried followed by oven drying in a hot air oven maintained at 103 ± 2°C for 17 h and then the seeds were cooled in desiccator with calcium carbonate for 30 min. and the dry weight was taken in an

electronic balance (M_2). Adopting the following formula the seed moisture content was calculated and the mean expressed as percentage.

$$\text{Moisture content (\%)} = \frac{M_1 - M_2}{M_1} \times 100$$

Where, M_1 = Weight of the sample before drying, M_2 = Weight of the sample after drying

For 1000 seed weight, the freshly harvested seed were counted in eight replications of 1000 seeds each, weighed in precision balance and mean weight was recorded in mg. Germination Percentage (ISTA, 1999) [7]. The germination test was carried out as per the procedure prescribed by ISTA with four replicates of 100 seeds each in roll towel medium. The test conditions of $25 \pm 2^\circ\text{C}$ and 95 ± 3 per cent RH were maintained in a germination room illuminated with fluorescent light. After eight days, the normal seedlings produced were counted and expressed as percentage. Seedling length (cm), Ten normal seedlings were selected at random from each replication and the seedling length was measured from the tip of primary root to the tip of the primary leaf and expressed in cm. Drymatter production (mg seedlings⁻¹⁰), Randomly selected ten normal seedlings used for seedling measurements were dried under shade for 24h and then dried in hot air oven maintained at $85 \pm 1^\circ\text{C}$ for 48h. It was cooled in a desiccator for 30 min. and weighed. The values were expressed as mg seedlings⁻¹⁰. Vigour index (Abdul-Baki and Anderson, 1973) [8], Vigour index (VI) was computed using the following formula and expressed as whole number. VI = Germination percentage x Seedling length (cm). The data obtained from experiments were analyzed by the 'F' test for significance following the method Factorial Completely Randomized Design as described by Panse and Sukhatme. 1985.[9]. Wherever necessary, the percent values were transformed to angular (Arc-sine) values before analysis. The critical differences (CD) were calculated at 5 per cent probability level. The data were tested for statistical significance.

III. Results:

The results of table 1 were followed. The highest moisture content (%) was recorded at 5 DAA (83.1%) which declined during subsequent stages and attained 12.7 per cent at 40 DAA. For 1000 seed weight (mg), the highest 1000 seed weight was recorded at 15 DAA (142 mg) which declined during subsequent stages and attained 123 mg at 40 DAA. Germination percentage in developing seed, initiated germination from 15 DAA (7%) which attained the maximum of 86 per cent at 35 DAA. Thereafter it decreased to 69 per cent on 40 DAA. The seedling length increased significantly with stages of maturity from 1.5 cm to 2.3 cm from 15 DAA to 35 DAA and decreased to 2 cm at 40 DAA. The dry matter production of the seedlings was the maximum at 35 DAA (1.23 mg) which were on par with 40 DAA (1.2 mg). Highest vigour index value of 198 was recorded at 35 DAA, which decreased to 138 in 40 DAA.

IV. Discussion:

In seed production, the time of harvest is a critical factor determining the seed yield and quality. The unevenness of the performance of a seed lot is due to the differential condition of the mature plant and the environment interaction, which affects seed development.

Seed maturation refers to the physiological and functional changes that occur from time of anthesis until the seeds are ready for harvest. Studies on the pattern of seed development and assessment on time and indices of maturity have greater practical utility on production of quality seeds. Malarkodi and Srimathi (2007) [10] found that stages, symptoms and days for seed development and maturation vary with crops and studies on seed maturation are warranted not only for individual species but also for various locations. According to Harrington (1972) [11], physiological maturity is the stage at which the seed reaches its maximum dry weight and nutrient flow into the seed from mother plant is ceased due to breakage of vascular connection by the formation of abscission layer (Eastin *et al.*, 1973) [12]. In the present study, the pattern of seed development and maturation in davana was traced out to fix the optimum time and indices of physiological maturity for harvesting quality seeds.

The rapid seed growth after fertilization to 5 DAA might be due to more uptake of water, nutrients and also accumulation of photosynthates from source to sink (Patel *et al.*, 1977) [13] which increases with maturity, recording the highest fresh weight at 20 DAA. Venudevan (2008) [14] in glory lily also observed similar growth pattern in orthodox group of medicinal plants. The fresh weight of seed attained their maximum at 18 DAA and decreased thereafter due to disintegration occurred between source to sink and depletion of moisture content from seed. But, (Delouche, 1973; Rao and Rao 1975) [6 & 15] opined that reduction in weight is also due to the depletion of volatile substances in semi fluid state that might have escaped along with water. Similar reductions in weight due to desiccation drying that is specific to orthodox species was also reported in *Phyllanthus niruri* (Revathi, 2001) [16] and *Ocimum* (Swapna, 2003) [17], the medicinal plants of tropical region.

The present study also indicated that the moisture content of seeds were maximum (83.1%) at 5 DAA and decreased rapidly up to 40 DAA (12.7% seed). The loss of water during maturation is considered as inherent phase of development (McIlrath *et al.*, 1963) [18] and its decrease beyond 40 DAA might be due to desiccation and dehydration as opined by Abdul-Baki and Anderson (1973) [8] that is common to all tropical crops. Similar reduction in moisture even after physiological maturation was also reported by Kalavathi (1996) [19] in *Cassia angustifolia*, *Catharanthus roseus* and *Hibiscus sabdariffa*.

Germination capacity is an indicator of seed maturation and in davana, the seeds collected between 5 and 10 DAA failed to germinate due to immaturity of the embryo, while the seeds collected at 15 DAA attained germinability to a minimum of 15per cent, which steadily increased to the maximum of 86 per cent at 35 DAA, but decreased to 69 per cent with advances in maturation (40 DAA) based on normal seedling count. The maximization of germination at 35 DAA might be due to attainment of potentiality for reproduction as spelt through mature embryo with essential structures and activation of the enzymes and nutrients required for regeneration of miniature plant). The increasing trend in germination percentage during the development stages which attained the maximum on 35 days after anthesis might be attributed to the maximum dry matter content in seeds (Plate 1).

Woodstock and Combs (1964) [20] expressed seedling length as measures of seedling vigour that aided the expression of their performance under given environmental conditions. The growth of seedlings in the present study increased with advances in maturation and were the maximum at 35 DAA, which was in coincidence with stages of dry weight of seed and seed germination. The similar results were obtained to Swapna (2003) [17] in *Ocimum* and Manimohan (2008) [21] in Kalmegh. The seed vigour which is another parameter was in increasing order attained maximum vigour on 35 DAA (197.8) due to accumulation of higher quantum of dry weight in seed till it reaches the maximum on 35 DAA (1.23 mg) (Fig.1). Heydecker (1972) [22] opined seed vigour as an inherent ability to survive well under wide range of conditions. The computed vigour index value was also the maximum at 35 days after anthesis coinciding with the higher germination and seedling length. Since the vigour index was the product of these two parameters, it was highest at 35 days after anthesis and this is in conformity with findings of Vakeswaran (2001) [23] in Ashwagandha and Gunasekaran (2003) [24] in *Solanum nigrum*. Thereafter drymatter production decreased slightly due to development of inbuilt mechanism involved in the disorganization of cell organelles within a few days after physiological maturity as reported by Mathews (1973) [25].

From this study, it is inferred that the physiological maturity of davana seeds was attained on 35th day after anthesis, where in germination, seedling length, vigour and dry matter production were higher.

V. Conclusion:

The bulk davana crop was raised in the field. Individual flower heads were tagged at the time of flower opening. The seeds were collected at 5 days intervals and subjected to the following seed quality assessment. Seed moisture content, 1000 seed weight, Germination percentage, seedling length, drymatter production and vigour index are the observations recorded. Studies on tracing the pattern of seed development and maturation through physical and physiological characters indicated that the seeds attained physiological maturation on 35 DAA with maximum of dry weight (129 mg), germination (86%) and vigour index (197.8).

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Table 1. Developmental variation in physical and physiological characteristics of seed during seed development and maturation

Days After Anthesis (DAA)	Moisture content (%)	1000 seed weight (mg)	Germination (%)	Seedling length (cm)	Dry matter production (mg seedlings ⁻¹⁰)	Vigour index
5	83.1	126	-	-	-	-
10	75.4	139	-	-	-	-
15	63.9	142	7 (15.34)	1.5	0.93	11
20	51.5	140	14 (21.97)	1.5	0.98	21
25	42.7	137	38 (38.05)	1.6	1.00	61
30	28.6	132	56 (48.44)	1.7	1.12	95
35	20.3	129	86 (68.02)	2.3	1.23	198
40	12.7	123	69 (56.16)	2.0	1.20	138
SEd	1.30	3.29	1.13	0.05	0.02	2
CD (P=0.05)	2.76	6.97	2.40	0.10	0.06	5

(Figures in parentheses indicate arc sine transformed values)

Fig.1. Seed development and maturation

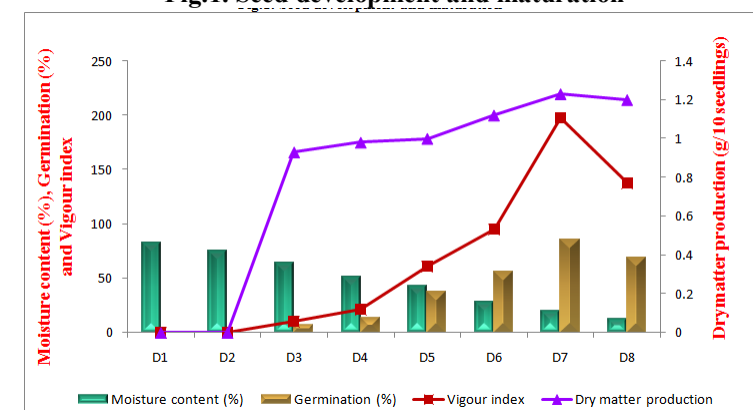


Plate 1. Development and maturation of seed.



Organic cotton – A new perspective

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Abstract: The organic cotton textiles are being used widely all around the globe. With the ban of lot of dye varieties and processes natural dyes and age old dyeing processes are coming back. In every part of the globe there were processes around textile spinning, dyeing, weaving and finishing which were followed meticulously with consciousness. In the last few decades due to massive technological advancement and in making everything in 100s and 1000s of pieces every country around the globe has lost lot of its unique treasures which could not stand up to the metal mechanics. Today lots of communities, cities and countries are in the mode of co-creating the old realms. Slow processes are coming back in textiles and apparel. Products with consciousness, environmental tags, and sustainable designs are being made. Water, yarn and fabrics are tested with poly interference photography, GDV and EIS ,pre and post detoxification process. Significant changes were observed in the values in organic cotton, naturally dyed materials, after the detoxification process of water, yarn and fabric. Methods used for detoxification had a positive impact on the fabric which will be passed on to the wearer for improvements in long term physical, physiological and emotional state.

Keywords: Consciousness, Detoxification, Natural dyes, Organic cotton, Energy fields

I. Introduction

India is the most powerful nation today with its diversity and knowledge in varied fields. Its art and craft is known all over the globe for its history, age old techniques, processes, craftsmanship and fineness. The land of Bharath has intrigued experts from all walks of life be in the nano technology, space technology or grass root technology. The world over is spending time to understand what we do, how we do and why we do things the way we do things. As an emerging powerful economy India is a happening research ground.

The world's greatest civilizations have been exposed to the cycle of human intelligence and experiences. What was the perfect solution for an era was questioned, debated and scrutinized in another era of that country and the world. There remained a balance between the fast and the slow, high technology to low technology around life.

Every country of the world had its own system of consciousness to keep its flora and fauna, its rivers and mountains, its human and animal population in perfect tuning for a harmonious living. With the advent of technology, information and super human intelligence came the use, over use and abuse of certain resources there by creating depletions and piling up of residues.

The world stuck in fast forward and obsessed with speed, with doing everything faster, with cramming more and more into less and less time. Every moment of the day feels like a race against the clock. Carrie Fisher (2004) says "These days even instant gratification takes too long." We try to make things better by speeding them up, so we used to dial; now we speed dial. We used to read; now we speed read. We used to walk; now we speed walk. And even things that are by their very nature slow we try and speed them up too like speed yoga (Carl Honoré, 2004).

In the process of speed, technology and manufacturing more and more for cheaper products and sourcing all across the globe the process has lost the conscious connections of the artisans, weavers and tailors. Consumers are picking up products which are more convenient easy to handle and wear, cheaper as they are mass manufactured and ending up with goods with no human emotion and soul to it. Handmade textiles and garments are losing ground for lack of speed, technology, mass production, uniformity, and price.

The art of natural dyeing has come full circle – essentially due to the bans being imposed on synthetic dyes by European Governments. As a result of health risks from synthetic dyes, there is a new interest in natural dyes. Once again the ancient textiles and dyers of South Asia are coming back to haunt the modern day textiles. This is evident from the discovery of a dyer's workshop at Mohenjodaro. *Indigofera Tinctoria*, the most fabled, ancient plant for the indigo dye also grew in abundance on the banks of River Indus.

The waters were clear, raw materials pure, land natural and the fiber which grew was as sweet as candy. Today with the bombardment of chemicals and GMO s in all spheres of existence human beings are craving for something pure and natural which can be used with confidence even without looking at the label or tag.

This research was under taken to bring back the goodness of organic cotton(GoTs), natural dyes, hand loom, textile design (Colour Horoscope Weaving) and custom clothing. The objective was to show consciousness in all the processes in the supply chain can imbibe positive energy. To prove that slow processes not only make products with conscious core but also influence the health parameters of the wearer. Twenty men and twenty women subjects were chosen for this study.

II. Methods

2.1 Detoxification

The process of cleansing is called detoxification. In this study music was used in detoxification of water and yarn. Music (Strotras) from the Vedas was used in a particular sequence for every procedure. Lalitha Sahasranamam, Totakastakam, Aditya Hridayam and Kanadhara Stotram were played on the audio for detoxification.

The weavers themselves believe that the whole weaving process is a ritual than a mere mechanical work. Women were not allowed in the dyeing and weaving section if they are in their menstrual cycles. It is believed that certain natural colours don't ferment well especially indigo.

2.1.1 Yarn

The yarn came in bundles of 4.6-4.8 kgs. These were stored in a small storage under plastic sheets. The yarn bundles to be dyed were arranged in a pile and detox music was played for one hour before it was dipped in the water which was already detoxed.

The dried yarn was kept separately under cotton cloth covers after detoxification and music was played again to repeat the detoxification procedure before dyeing process.

2.1.2. Fabric

The fabric was woven on a handloom in a unique textile design called the Colour Horoscope Weaving which is a copyright design of Ms Bonnie Tarses a textile designer from Rhode Island School of Design, USA. This created horizontal stripes of all colours of colour wheel in different numbers depending on the horoscope. For comparison a fabric was woven in bands of 120 yarns each of all the 12 colours of the colour wheel to create a fabric with horizontal equal width stripes.

2.2 Energy Fields

2.2.1 PIP Poly contrast interference Photography

Polycontrast Interference Photography (PIP) is an energy field video imaging process. This is new experimental technology reveals patterns of light that are not visible to the naked eye. PIP, in and of itself, is not merely a device or product. It is a method, or process, which requires copyrighted materials, and is driven by an intricate system of calculations and formulas. In other words, PIP is really intellectual property, integrated into software that performs a technical process to generate images. (Harry Oldfield 1986). The equipment needs standard setting up procedures which is prescribed.

Even though many millions of different colours that can be detected by the human eye. However only 256 colours are possible on the computer screen which is sufficient for analytical purposes in **PIP**. Colour is vital as it reveals "life-force". The colour spectrum starts with white and includes tones of all colours that follow.

The interpretation of the PIP pictures was carried out by the customized software and the colours (Appendix O) which were analyzed mainly are explained below:

- Blue: Blue is a cooling colour. Blue colour in the bio field indicated soothing and healing energy process.
- Green: Green colour was associated with balance.
- Pink /Violet: It was the highest and fastest vibrating colour showing spiritual, soothing spectrum in relaxation and in healthy states of spirituality and meditation.
- Yellow: Yellow was found in the bio field indicated vitality and general wellness.
- Orange: Orange in a bio field indicates hyperactivity in a negative scenario orange like red was related to lower energy.
- Red: Where there was an imbalance of energy flow it appeared as thickened red lines or congested pools.

2.2.1.1 Pre testing of naturally dyed cotton yarn

The yarn was tested pre and post detox. The yarn skein about 50 grams was placed on a stool covered with white cloth.

- Cotton yarn regular was placed in the center space on the stool and a PIP shot is taken.
- Normal 100 % organic cotton yarn skein is placed at the center of the stool and a shot is taken with the camera.

- Normal 100 % organic cotton yarn skein which was detoxed by the standard procedure is placed at the center of the stool and a shot is taken with the camera.
- 100 % naturally dyed organic cotton yarn which was detoxed by the standard procedure is placed and the above procedure is followed to get the picture of the yarn.

2.2.1.2. Post testing of organic cotton naturally dyed horoscope fabric.

- The fabric is woven in 12 colours of the colour wheel was tested in the same procedure.
- The colour horoscope fabric was also tested in the standard PIP procedure and results are compared with the above mentioned fabric for the energy levels.

2.2.2 Gas Discharge Visualization – Electro Photon Imaging (GDV –EPI)

A wide range of instruments makes it possible to use GDV techniques in various fields of human activities—medicine, professional sports, fitness, spa, areas of psychology, psycho-physiology, and also in basic and applied research.

GDV programs were formed as a sequence of pages leading the user step by step along the accepted scheme of GDV image analysis. This made the study process maximally convenient and clear. The programs for diagnostics (sector analysis) work with lists of subjects that enable the user to store not only personal information (name, gender, age, etc.) but also comments about GDV capturing.

The energy field created a model of human energy field on the basis of the topic map correlation between the glow of separate sectors of human fingers and his/her biological systems and organs. The output given was an image around human contour; numeric presentation of data in tables and diagrams, calculation of energy field parameters: area, entropy and fractality.

A pre-analysis (BF) was done which will be used as a standard against which the post analysis (AF) (after wearing the organic clothing) will be compared. This makes three energy projections-fronts, left and right. This provides means for a detailed analysis of the state of the whole organism.

The following parameters were calculated and analyzed in Table no:

- Area: This parameter describes the size of the bio-energy field, measured in the number of pixels. This parameter is calculated for all three projections separately.
- Entropy: Reflects the level of functional ability of the organism in the process of exchange of matter, information and energy with the environment.
- Fractality: The parameter Fractality describes the irregularity if the outer contour of the bio- energy field. It is a measure of the uneven distribution of the energy field and the different levels of the body.

2.2.2.1 Process of data collection

GDV machine takes finger impression of all the ten fingers. The subject stood straight with no foot wear and placed the thumb on the glass plate of the GDV camera. Index, middle, ring and small finger impressions were taken on that order one after the other for the right and the left hands. Precautions were taken to remove all the metal ornaments on the body. Electronic devices like cell phones etc are kept away as these interfere with energy fields.

The finger impression snap shots were taken with filter (on glass) and without filter which give physical and emotional state of the person respectively. Once the data was collected it was saved with the subject's unique code to maintain secrecy of information. It was the processed and harnessed to get data in the form of numerical charts, graphs, pictures and integral diagrams.

III. Results

3.1 Yarn:

The energy field of the organic yarn was tested before and after detoxification and dying with natural dyes.

The analyzed data is captured in the table below:

TABEL1: Energy fields in Organic Cotton yarn

	Negative (Orange Pixels)	Soothing (Blue Pixels)	Spiritual (Pink Pixels)	Balance (Green Pixels)
Organic Cotton Yarn	21049	14860	39547	30874
Organic Cotton Yarn Charged	14111	9653	23546	43284
Percentage Gain / Loss (+ / -)	-32.96	-35.04	-40.46	40.20

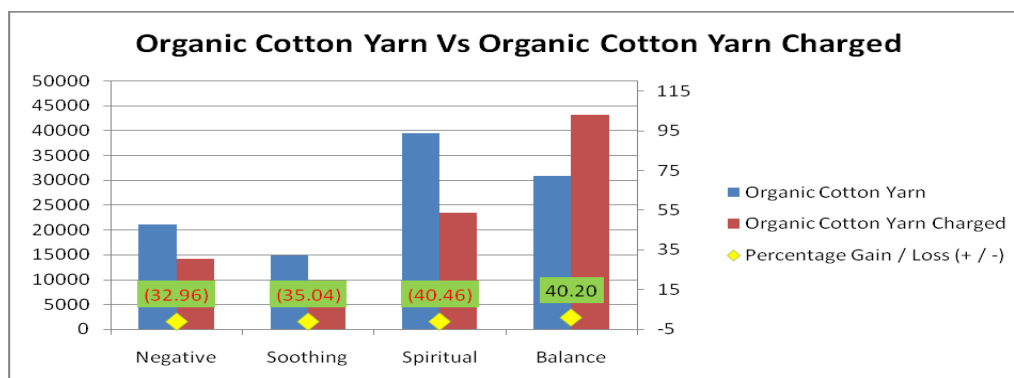


Figure 1: Energy fields in Organic Cotton yarn.

As read from the above table 1 and Fig 1 the organic cotton yarn had recorded negative energy of 21049 Pixels which was reduced by 1/3rd due to detoxification. The balancing energy had increased to a greater extent of 40.20 per cent. The remarkable energy reduction was observed which can be attributed to the transport of materials from Hyderabad to Pune for testing and also due to handling by people. Though the soothing and spiritual energies have reduced it could be enhanced by detoxification of waters and yarn.

TABLE 2: Energy fields in Organic Cotton Yarn and Natural Dyed

	Negative (Orange Pixels)	Soothing (Blue Pixels)	Spiritual (Pink Pixels)	Balance (Green Pixels)
Organic Cotton Yarn	21049	14860	39547	30874
Organic Cotton Yarn Natural Dyed	17303	16712	25271	39657
Percentage Gain / Loss (+ / -)	-17.80	12.46	-36.10	28.45

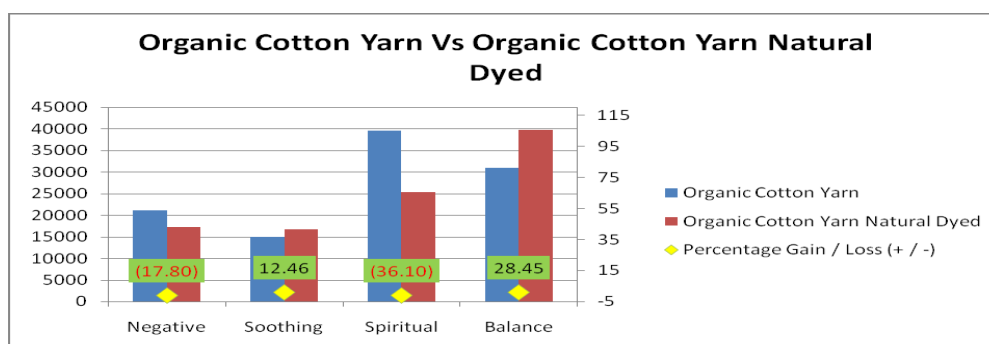


Figure 2: Energy fields in Organic Cotton Yarn and Natural Dyed.

An attempt was made to see the effect of natural dye on organic cotton yarn without detoxification. A significant reduction in negative energy was found in natural dyed organic cotton yarn proving that the natural colours inherently have good energy imbining elements. As per the data the dyeing process had reduced the negative energy by 17.80 per cent. The balancing energy had increased by 28.45 per cent. There are so many factors in today's world which affect the material and process due to handling, pollution, adulteration, improper storage etc. Though the spiritual energies had reduced, it could be enhanced by detoxification of waters, yarn, and dye used.

TABLE 3: Energy fields in Dyed Organic Cotton yarn

	Negative (Orange Pixels)	Soothing (Blue Pixels)	Spiritual (Pink Pixels)	Balance (Green Pixels)
Organic Cotton Yarn Natural Dyed	17303	16712	25271	39657
Organic Cotton Yarn Natural Dyed + Charged	16360	27364	28798	49767
Percentage Gain / Loss (+ / -)	-5.45	63.74	13.96	25.49

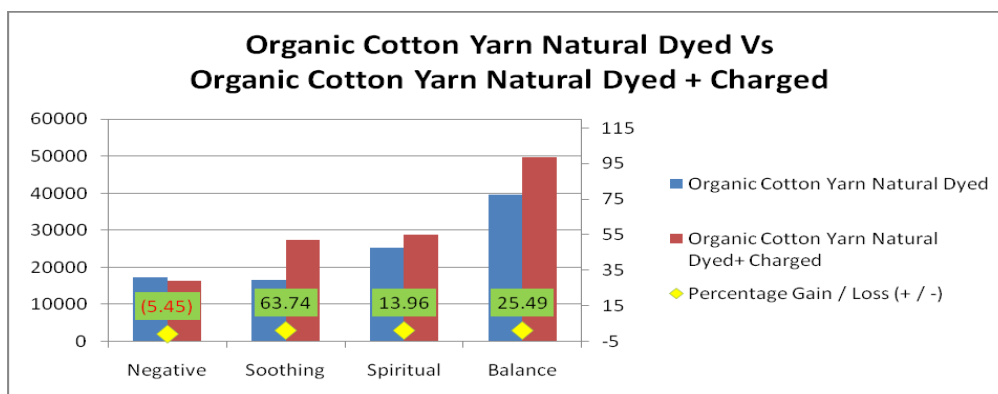


Figure 3: Energy fields in Dyed Organic Cotton yarn.



Figure 4: Naturally Dyed 100% Organic Cotton.

Table 3 and Fig 3 explain that the organic cotton yarn natural dyed showed negative energy which was reduced by detoxifying. As per the data the natural dyeing and detoxification process had reduced the negative energy by 5.45 per cent. The soothing, spiritual and balancing energy were increased by 63.74 per cent, 13.96 per cent, and 25.49 per cent respectively.

From the above analysis and data interpretation it is proved that the detoxification methods significantly enhanced the energy fields in the materials. Using natural dyes for dyeing regular or organic cotton showed significant positive results in the energy fields. The organic yarns after detoxification had been woven on handloom in a unique textile design technique called the colour horoscope weaving.

The resultant fabrics were tested and compared with a fabric woven using all the 12 colours of the colour wheel.

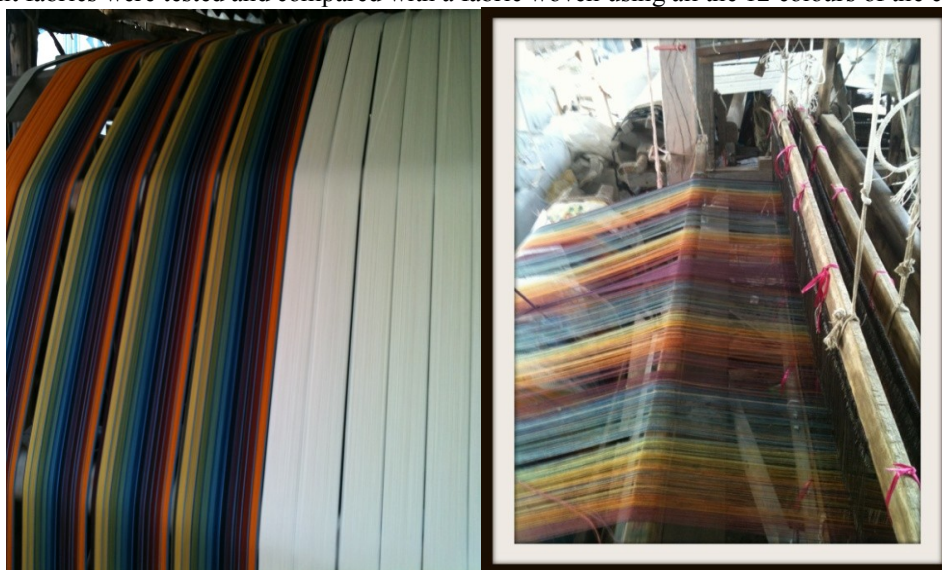


Figure 5: Colour Wheel Fabric (left) - Colour Horoscope Weaving (right)

The analyzed data is captured in the table below:

TABLE 4: Energy fields in Woven fabrics

	Negative (Orange Pixels)	Soothing (Blue Pixels)	Spiritual (Pink Pixels)	Balance (Green Pixels)
Colour Wheel Fabric	15645	8195	31817	39767
Average Of all Horoscope Fabrics	13462.33	19697.17	27001.5	42822
Percentage Gain / Loss (+ / -)	-13.95	140.36	-15.14	7.68

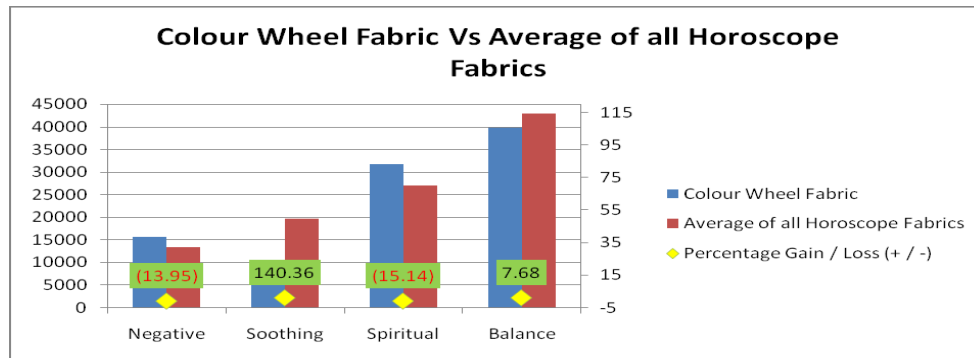


Figure 6. Energy fields in Woven fabrics.

Table 4. and Fig 6. explains that the organic cotton fabric woven in colour wheel pattern had more negative energy compared to the fabrics which were woven in horoscope design. The negative energy was reduced by 13.95 per cent. The colour horoscope weaving showed a very huge significant increase 140.36 per cent in soothing energy compared to the colour wheel pattern. The balance was enhanced by 7.68 per cent. The spiritual energy was reduced by 15.14 per cent which might be due to the handling which could be enhanced by the detoxification method.

The present life style brings in lot of stress in everyday living. The horoscope weaving has clearly shown that it can bring soothing energy which in turn could influence various factors such as de-stressing, bring calmness and also enhance concentration and focus in one's life.

3.2 Gas discharge visualization

The gas discharge visualization (GDV) software after capturing the finger readings facilitated analysis and documentation of the bio-energy field based in the calculation of special energy field parameters and their correlation to organs and organ systems of the subject. The reading without filter and with filter gave emotional and physical state of the subject respectively.

The possibilities of providing holistic medical screening through measurement of bioenergy fields which have both biophysical and biophysics bearings (Lee, 2005)

Picture (1) Energy field (Woman1) – Before and After Organic Clothing

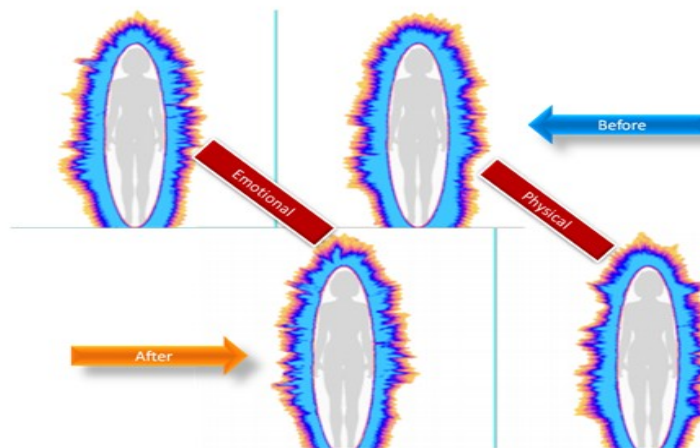


Figure 7: Energy Fields Woman 1 –Before and after wearing custom organic clothing

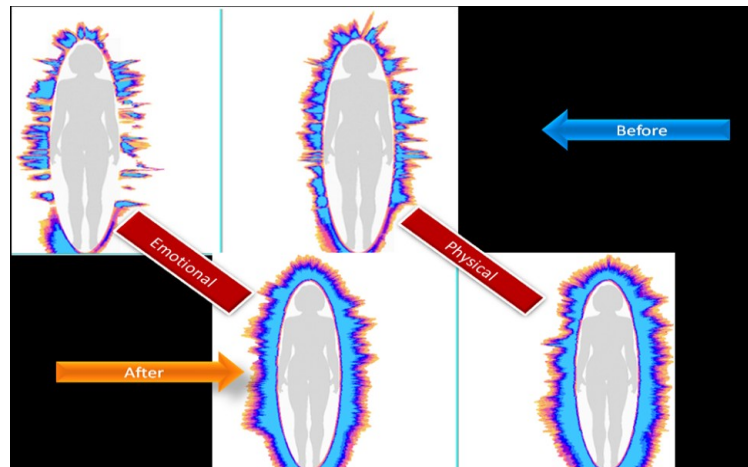


Figure 8: Energy Fields Woman 2 –Before and after wearing custom organic clothing

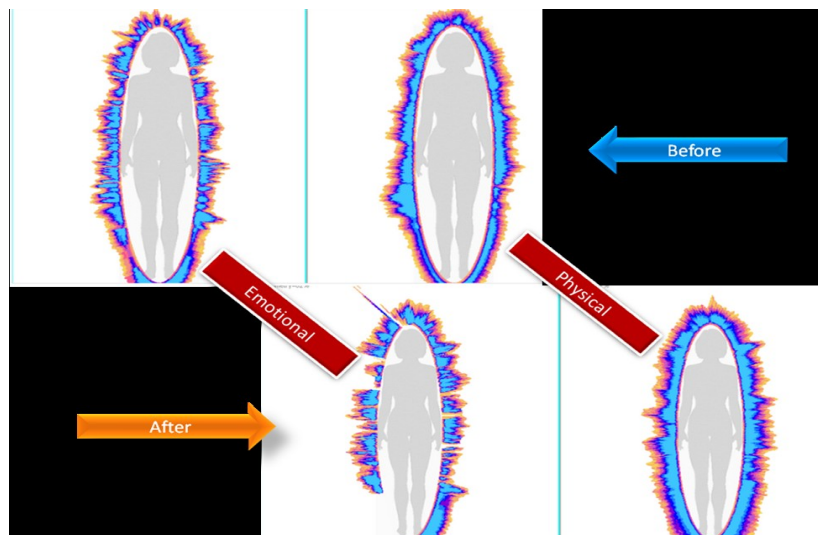


Figure 9: Energy Fields Woman 3 –Before and after wearing custom organic clothing

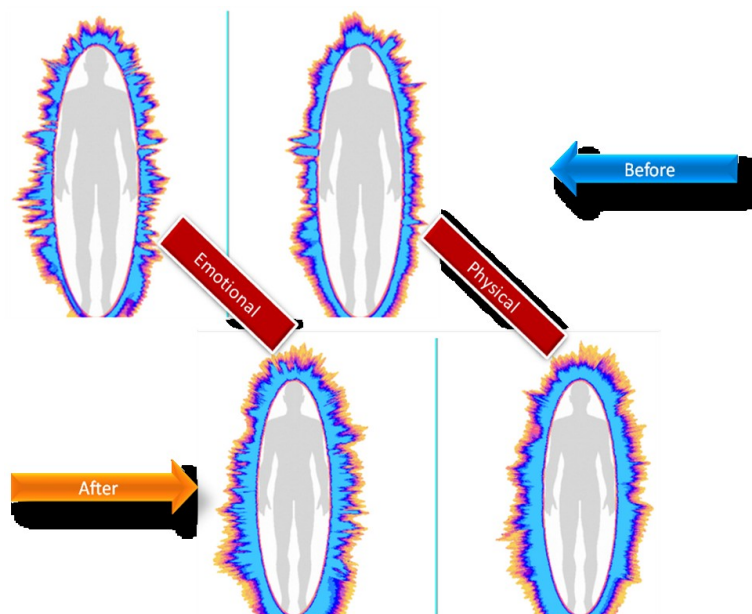


Figure 10: Energy Fields Man 1 –Before and after wearing custom organic clothing

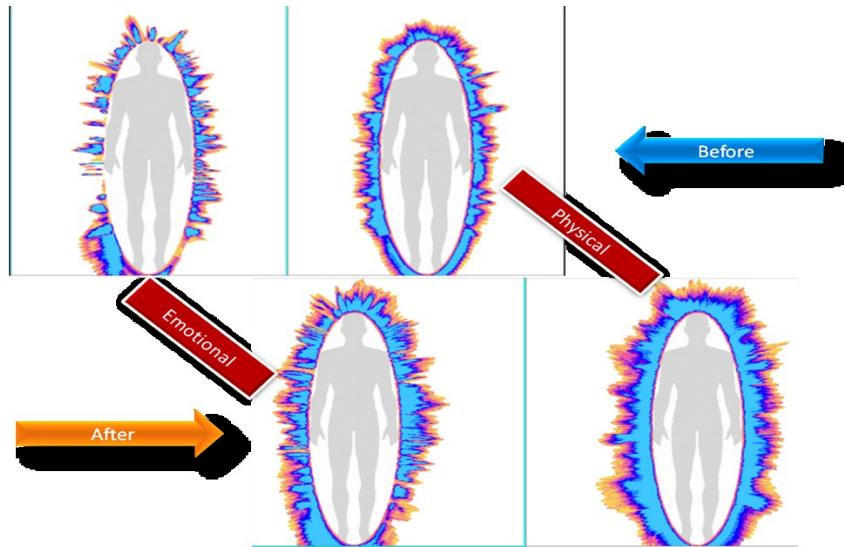


Figure 11: Energy Fields Man 2–Before and after wearing custom organic clothing

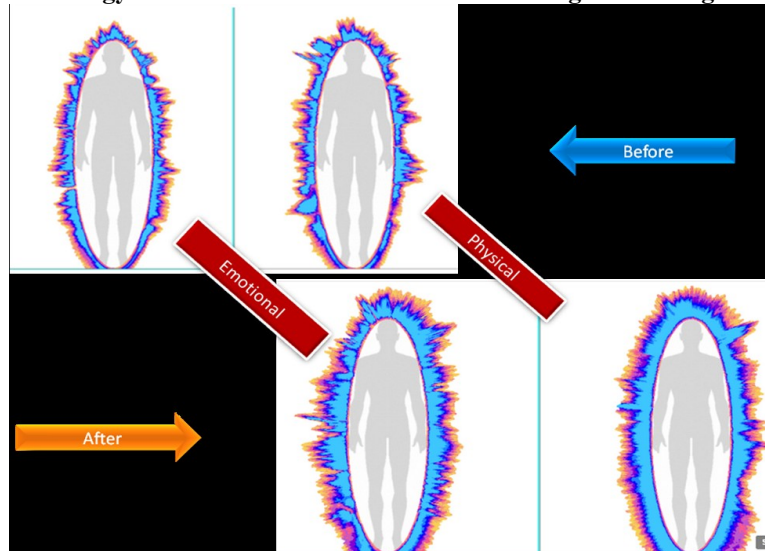


Figure 12: Energy Fields Man 3 –Before and after wearing custom organic clothing

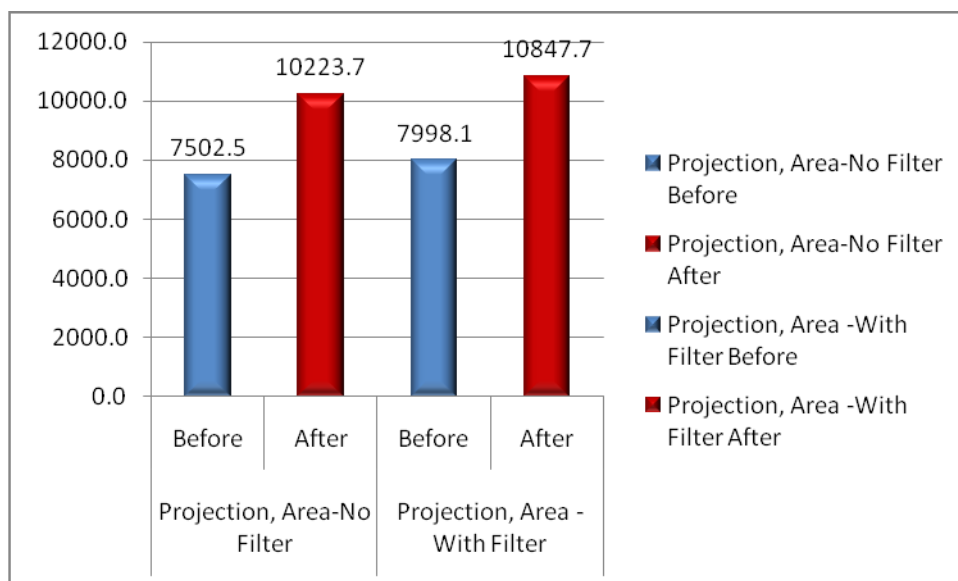


Figure 13: Total Average increase in Projection Area (No-Filter and With-Filter).

Figs 7- 12 show the significant differences in 3 women and 3 men. Fig 13 shows the average increase and decrease of the entire (40 subjects) projection area which clearly depicts that the emotional (no filter) and physical state (with filter) of the subject has been greatly influenced by the organic cotton naturally dyed custom clothing. The increase in the readings post organic clothing showed very significant increase in the size of the bio energy field by 36.3 per cent without filter and 35.6 per cent with filter, which indicates the state of well being of the subjects.

The bio-electrographic method understands the analysis of electro-photonic emission of human fingertips in a high intensity electromagnetic field and has significant dependence on human bio-responses to a disease, drug treatment or environment (Cohly et al, 2009)

IV. Conclusions:

The process of making organic cotton yarn and natural dyes is a slow process which results in a fiber and a dye which will survive hundreds of years. (The excavations of Mohenjodaro and Harappa proved the age of linen/cotton and indigo dyes). The Indian sub continent which nurtures various traditions and cultures which in turn have had their unique systems in making and using clothing in and around their families and community. Each of these processes and methods had ritual and steps which were followed astringently.

Now with few weavers left to do the craft it has remained a mere wage earning means with no rituals and consciousness. The detoxing method used introduced the conscious connections with the help of weavers. The organic cotton yarn GOTS approved in itself had good energy compared to a regular farm cotton. The organic cotton detoxed showed positive results.

The natural dye process is a slow process which introduces good positive and therapeutic qualities in any yarn. The results of tests conducted from a regular cotton yarn dyed with natural dye showed positive results and it was enhanced when organic detoxed cotton yarn was dyed with natural dye made with detoxed waters which proved that conscious connective processes imbibe positive energies in the materials. The 100% organic natural dyed handloom cotton horoscope fabric when compared with a colour wheel design in the same composition showed greater positive energies.

The detoxification processes proved that slowing down in all the processes of supply chain in textiles and apparel making imbibes positive energies in the hand made products. This research also introduced the age old practices of following rituals and conscious connections around weaving processes and proved that horoscope weaving which is the signature fabric of each of the subject had more positive energy. This reinstates that customized clothing (like in olden days of the kings) does have an impact on the energy fields of the material which will in turn enhance the energy fields of the person wearing the clothing. The gas discharge visualization machine which measures the energy field in humans showed significant and positive results pre and post 100% organic natural dyed handloom cotton horoscope fabric.

All the forty subjects were tested pre and post organic clothing. The energy fields were tested for right projection area. The total (right, left and front) projection area increased in 87 % of the subjects. The reading with filter which records the physical attributes and without filter which records the psycho emotional attributes showed significant positive increase in energy fields due to 100% organic natural dyed handloom cotton horoscope fabric.

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I wish to thank Dr. C. Devakumar, ADG (Education Planning Development), ICAR for seeing this as an innovative research, believing in the possibilities of this research and visioning what can come forth from this. I am in deep gratitude for having received a sustainable grant through the development funds of the ICAR.

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Extent of adoption of the recommended Sweet Pepper production technology by the Sweet Pepper producers

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Abstract: Sweet Pepper/Bell Pepper (*Capsicum annum*) is one of the most favored species of chilli and widely used universal spice, named as wonder spice. Different varieties of it are cultivated for varied uses like vegetable, pickles, spice and condiments. Sweet pepper, the gifted plant of nature is generally regarded as the king of cultivated crops has 80 per cent consumption in food purpose and others is using in industry. In India, the farmers grow hybrid sweet pepper and deshi sweet pepper. At present an area of 98 thousand hectare is occupied by hybrid sweet pepper, which constitutes 86 per cent of total sweet pepper area. India contributes 17.9 per cent of the total production. Out of total pesticide usage, Sweet pepper crop alone consumes 2.6 per cent. Adoption pattern of the recommended cultivation practices of the sweet pepper growers. The Study has been conducted in Raipur district of Chhattisgarh Out of thirteen blocks the TILDA block has been selected randomly with 750 respondents. For the study of adoption behavior nineteen recommended practices of Sweet Pepper production technology were selected and found complete adoption in maximum practices.

Key Words- Sweet Pepper, Adoption Behavior

I. Introduction

Sweet Pepper/Bell Pepper (*Capsicum annum*) is one of the most favored species of chilli and widely used universal spice, named as wonder spice. Different varieties of it are cultivated for varied uses like vegetable, pickles, spice and condiments. Sweet pepper, the gifted plant of nature is generally regarded as the king of cultivated crops has 80 per cent consumption in food purpose and others is using in industry. India has the largest area under sweet pepper with an average productivity of 13.2 tones / ha (APEDA 2010). However its production and yield are much lower as compared to those of the major sweet pepper growing countries of the world. In India, the farmers grow hybrid sweet pepper and deshi sweet pepper. At present an area of 98 thousand hectare is occupied by hybrid sweet pepper, which constitutes 86 per cent of total sweet pepper area. India contributes 17.9 per cent of the total production. Out of total pesticide usage, Sweet pepper crop alone consumes 2.6 per cent. Though, the Chhattisgarh is the major sweet pepper producing state in India, it's know main yielder state of sweet pepper but the average yield of sweet pepper is very poor because of non-adoption of the improved production technology. There exists tremendous scope to increase the sweet peeper yield provided the acceptance and implementation of recommended cultivation practices. With this background, the study is planned to underlying objectives know the extension participation of sweet pepper growers, adoption pattern of the recommended cultivation practices of the sweet pepper growers, to find out the reasons for no adoption or over adoption or partial adoption of recommended cultivation practices, and finally the constraints faced in cultivation of sweet pepper. Sharshar *et al.* (1998) in their study level of farmer's knowledge and implementation levels of technology for Sweet Pepper crop on reclaimed lands indicated low knowledge and implementation levels regarding new technical practices for Sweet Pepper crops. Farmers ranked field visits and demonstration visit as the most useful extension tools.

Sriram and Annamalai (2002) studied the effectiveness of different extension education strategies for converting non-Sweet Pepper growers into Sweet Pepper growers in Tamil Nadu, India. A sample of 72 non-Sweet Pepper growers from three taluks in Salem district were selected for the study. Three treatments, viz. lecture +field visit +discussion forum (T₁), lecture assisted with slide show+ demonstration +discussion forum (T₂), and lecture +video+ discussion forum (T₃), were developed and executed to assess respondents' knowledge gain and symbolic adoption behavior. It was found that T₁ and T₂ were effective among all the non-Sweet Pepper growers in terms of knowledge gain and symbolic adoption behavior in Sweet Pepper cultivation. Bhople, *et al.* (2001) on the basis of finding of the present study concluded that the Sweet Pepper growers possessed low level of knowledge about bio-control practices for pest management in Sweet Pepper crop. It is suggested that the extension workers of the state department of agriculture through their regular contacts with the farmers should try to provide detail information about bio control practices for pest management in Sweet

Pepper to the farmers. This will help in creating awareness and equipping the Sweet Pepper growers about the information on bio-control technology.

Significance of the study.

The introduction of new farm technology initiated the transformation of Indian agriculture and thereby created a large potential for increasing agricultural production. Agricultural production depends on the extent to which farmer adopt new agricultural innovations. It is felt that large parts of gains from new farm technology still remain to be realized. This is because of non-adoption of new innovations on the farm, since the adoption process is not simple and a number of social, economic, psychological factors influence it to a considerable extent. state in India but the average yield of Sweet Pepper is very poor because the farmers are not adopting the improved Sweet Pepper production technology. (socio-techno-economic & psychological) on the adoption of Sweet Pepper production technology, which will help the planners, policy makers, scientists and extension workers in understanding and devising appropriate measures to tackle the problems more efficiently. Though, the Chhattisgarh is the major Sweet Pepper producing state in India but the average yield of Sweet Pepper is very poor because the farmers are not adopting the improved Sweet Pepper production technology. Therefore, it is necessary to investigate the influence of various factors (socio-techno-economic & psychological) on the adoption of Sweet Pepper production technology, which will help the planners, policy makers, scientists and extension workers in understanding and devising appropriate measures to tackle the problems more efficiently.

Objective-

To determine the extent of adoption of the recommended Sweet Pepper production technology by the Sweet Pepper producers.

II. Material & Method

The Study has been conducted in Raipur district of Chhattisgarh Out of thirteen blocks the TILDA block has been selected randomly. The block has the maximum area 8864 (9.40%) under Sweet Pepper crop. TILDA block has 9 RAO circles out of which 10 villages had been selected randomly. The list of Sweet Pepper producers village-wise of the above selected villages was prepared and 10 farmers from each village were selected by random sampling method. Thus, the total sample consisted of 100 Sweet Pepper producers spread over 10 villages in the selected TILDA block. Data were collected with the help of pre-tested interview schedule, personally. The collected data was classified and tabulated and interpretations were made with the help of statistical tool.

III. Result & Discussion

Extent of adoption:

For the study of adoption behavior nineteen recommended practices of Sweet Pepper production technology viz, field preparation, improved varieties, time of sowing, seed rate, seed treatment of fungicides, seed treatment of culture, recommended row to row spacing, deep sowing, recommended dose of chemical fertilizers, use of bio-fertilizers, irrigation management, weed identification, method of weed control, weedicides insect control, disease control, Integrated Pest Management (IPM), and Integrated Disease Management (IDM), were selected. The weight age of 2 for complete adoption, 1 for partial adoption of each practice was assigned. The total score obtained by the respondent from all the nineteen practices was the adoption score of individual respondent. Finally this adoption score obtained by individual respondent was converted into adoption index.

Table - Distribution of respondents according to their level of
N=750

Adoption	Sweet Producer	
	No. of Respondents	Mean Score
Complete Adoption	42 %	15.49
Partial Adoption	58 %	16.49
Total	100	32.98

The data in above table show that out of the total 100 Sweet Pepper producers, 42 per cent had complete adoption, while 58 per cent had partial adoption. The mean of the complete adoption category was found to be 15.49 while that of the partial adoption category were 16.49. The overall mean was 32.98. Thus, it can be

concluded that majority of the Sweet Pepper growers had partial adoption. Hence, from the on-going discussion it can be concluded that majority of the respondents belonged to educated category having high socio-economic status, high attitude toward improved farm practices, high mass media exposure, high cosmopolitaness, high risk preference, high innovativeness, high economic motivation and high management orientation and high knowledge in case of Sweet Pepper crops. It was also found that majority of the Sweet Pepper growers were in young category of age group, small size of land holding, no social participation, seldom extension participation, low information seeking behavior, low exposure to demonstration, low exposure to training and low adoption.

Extent Of Adoption Of The Recommended Sweet Pepper Production Technology By The Sweet Pepper Producers

Table- Adoption behavior of Sweet Pepper growers regarding recommended Sweet Pepper production technology.

S.No.	Name of practices	Adoption percentage	
		Complete Adoption	Partial Adoption
1	Field preparation	71	29
2.	Improved varieties	48	52
3.	Time of sowing	76	24
4.	Seed rate	69	31
5.	Seed treatment with fungicides	32	68
6.	Seed treatment of culture	24	76
7.	Method of sowing	73	27
8.	Recommended row to row spacing	42	58
9.	Deep sowing	25	75
10.	Recommended dose of chemical fertilizers	21	79
11.	Use of bio-fertilizer	28	72
12.	Irrigation management	47	53
13.	Weed identification	37	63
14.	Method of weed control	49	51
15.	Weedicides	20	80
16.	Insect control	67	33
17.	Disease control	44	66
18.	Integrated pest management (IPM)	17	73
19.	Integrated disease management (IDM)	15	85

Regarding the adoption behavior of the Sweet Pepper growers about recommended Sweet Pepper production technology, complete adoption was found in the majority of the respondents in case of field preparation, time of sowing, seed rate, method of sowing, insect control, whereas, partial adoption was found in the majority of the respondents in case of practices like improved varieties, seed treatment with fungicides, seed treatment with culture, recommended row to row spacing, deep sowing, recommended dose of chemical fertilizers, use of bio- fertilizers, irrigation management, weedicides, method of weed control, disease control, integrated pest management (IPM) and integrated disease management (IDM).

Implication-

Sweet Pepper producers are not able to adopt the recommended practices in full due agro-climatic constraints, moisture stress during crop growth period, occurrence of insect pests & diseases, less fertility of soil, crop damage due to heavy rains during maturity period. Technological constraints such as lack of knowledge about I P M & I D M., lack of knowledge of bio-agent, poor seed germination due to low soil moisture at the time of sowing, improper use of insecticides, imbalanced used of fertilizer, lack of knowledge proper use of weedicides, lack of knowledge of scientific crop production. Infrastructure constraints such as lack of irrigation facilities. Inability to purchase modern agriculture implements, inability to purchase fertilizers and plant protection chemicals unavailability H Y V seed at the time of sowing. Economic constraints such as non-availability of credit facilities, high cost of chemical fertilizers, low price of Sweet Pepper, interference of middle man in marketing, high cost of cultivation, high cost of pesticides & weedicides. These constraints need to be highlighted and dealt with by the concerned authorities and departments so that the problems could be solved.

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Barriers Faced By Cassava Farmers in Adapting To Climate Change in Oron Agricultural Zone of Akwa Ibom State

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Abstract: This study examined barriers faced by cassava farmers in adapting to climate change in Oron agricultural zone of Akwalbom State. Multi-stage sampling was used to select eighty respondents for the study. Data was collected with the use of interview schedule. Barriers to adaptation were captured using a 4 point Likert-type scale, while the data was analyzed using descriptive statistics namely; mean, percentage, frequency count. Varimax rotated factor analysis was used to analyse the barriers faced by the cassava farmers in adapting to climate change. The findings show that 30% of the respondents were between the ages of 31 and 40 years. Majority of the respondents were male (67.5%), married (86.3%), literate (90%) with an average farming experience of 25 years. The result of the factor analysis identified eight major barriers faced by the cassava farmers in adapting to climate change namely; Land and labour constraints, non-accessibility/availability of farm inputs, non-availability/high cost of farm facilities, farming practices and traditional belief, information constraints, poor agricultural extension service delivery, income constraint and government non chalant attitude towards climate change issues. The study recommended that Agricultural development programme should make room for extension agents to visit farmer and disseminate proven measures to overcome barriers faced by these farmers in adapting to climate change.

Keywords: Climate change, cassava, cassava farmers, Barriers

I. Introduction

In the views of Intergovernmental panel on climate change (IPCC) (2007), climate change is a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period typically decades longer.

Climate change is a phenomenon induced by global warming. It is a topical issue affecting every facet of the world's economy. Developing countries such as Nigeria are vulnerable to the catastrophic effects of climate change. Climate change and agriculture have tremendous effects on each other. Agriculture affects climate change through the emission of Greenhouse Gas (GHG) from different farming practices while climate change in form of higher temperature, reduced rainfall and increased rainfall variability reduces crop yield and threatens food security in low income and agricultural-based economies. Therefore climate change is expected to have serious impacts on the environment, economy and social life of people, especially on the rural farmers whose livelihoods depend largely on agricultural activities. It was reported by Mahendra (2010) that climate change will result in ecological degradation and further threaten the fragility of dry soil and, with serious consequences for crop and livestock production and food security. Agriculture is the most assured engine of growth and development, and a reliable key to industrialization in Nigeria. This sector has been fallen short of expectations due to many factors in which climate-related disasters like drought and floods are one of the major ones.

Out of the major staple foods produce in Nigeria, cassava (*Manihot* spp) plays an important role in household food security. Cassava is a popular energy food in most of the tropics where its production and yield are prolific and has several advantages compared with other carbohydrate sources, especially other root crops; it has a high productivity under marginal climatic and soil fertility conditions, which result in a low cost raw material (Henry *et al.*, 2001). Nigeria is the largest producer of cassava in the world (Ogbe *et al.*, 1999; Ogbe & Olojede, 2003), but unfortunately the product is not readily available for consumption. In times of war, drought or low national incomes, cassava consumption increases relative to alternative food staples such as yam, maize, rice and wheat (Mendelsohn *et al.*, 2006).

Cassava in certain forms is a low income consumer's staple. Although an individual may not increase the quantity of cassava consumed. In a year, as national income declines, annual average cassava consumption per person increases because more people begin to substitute cassava for more expensive alternative food staples. (United State Department of Agriculture (USDA) 2001).

Cassava is affected by various diseases and insect pests. These pests and diseases include the African cassava mosaic disease, bacterial blight, and mealy bug. Green spider mite and larger grain borer also attack dry chips of cassava in storage. White ants sometimes have deleterious effects on cassava production by destroying

the stems that were planted before they sprout. Climate change and its associated temperature increase will increase the incidence of pest and diseases. Temperature increases has been said to encourage the evolvement of new diseases that will be able to thrive in specific temperature and humidity (Fatuase *et al.*, 2011).

Adaptation is one of the policy options for reducing the negative impact of climate change (Adger *et al.*, 2003; Kurukulasuriya & Mendelsohn, 2006). Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderate harm or exploits beneficial opportunities (IPCC, 2001). Common adaptation methods in agriculture include use of new crop varieties and livestock species that are better suited to drier conditions, irrigation, crop diversification, adoption of mixed crop and livestock farming systems, and changing planting dates (Bradshaw *et al.*, 2004; Kurukulasuriya & Mendelsohn, 2006; Nhemachera & Hassan 2007; Onyeneke, 2010).

It is evident that the climate is changing and at the same time exerting effect on man and his activities. Studies indicate that Africa's agriculture is negatively affected by climate change (Grigg, 1995; Pearce *et al.*, 1996; McCarthy *et al.*, 2001; Onyeneke, 2010; Ifeanyi-obi, *et al.*, 2011). This may be said to be mostly as a result of dependence on rain fed agriculture and poor infrastructure capacity. Unfortunately, the climate change phenomenon may not be stopped as a result of man's continuous involvement in activities that causes emission of Greenhouse gas (GHG). Eboh (2009) stated that even if efforts to reduce greenhouse gas (GHG) emissions are successful, it is no longer possible to avoid some degree of global warming and climate change. Bearing this in mind, adaptation to the effects of climate change becomes very important if the goal of staple food security and better life for rural people will be ever achieved. Many countries are already making appreciable efforts to adapt to climate change but unfortunately a lot of constraints have and are still militating against this effort thereby bringing all efforts to zero.

Research has also proved that cassava as a crop is not left out in the menace of climate change. Despite advances in agricultural technology, cassava production remains uncertain and average crop yield is still low (Henry and Westby, 2001). Climate is claimed to be a factor in yield variations (Hershey *et al.*, 2001).

Considering the above, there is need to examine the barriers faced by cassava farmers in adapting to climate change, as this will better equip the government and other agencies to tackle these hindrances thereby making adaptation to climate change more effective. It is against this background that this study seeks to identify the barriers faced by cassava farmers in adapting to climate change in Oron Agricultural Zone of Akwa Ibom State. Specifically the study described the socio-economic characteristics of cassava farmers in the study area and identified the barriers faced by cassava farmers in adapting to climate change in the study area.

II. Methodology

The study was carried out in Oron Agricultural Zone of Akwa Ibom State. It is one of the six Agricultural Zones in Akwa Ibom State. The zone is found in the flood plain of South Nigeria with the land mainly intersected by numerous streams and tributaries flowing into Cross River State. The study population consists of all registered cassava farmers with Agricultural Development Programme (ADP) in the Oron Zone.

Multi-stage sampling was used to select the sample for the study. In the first stage, out of the four blocks that made up the zone, two agricultural blocks were randomly selected namely Oron and Mbo blocks. Secondly, two circles were randomly selected from each of the selected blocks. These were Eyo-Abasi and Uya-Oro in Oron block; Udessi and Okobo in Mbo block. From the selected four circles 80 cassava famers were randomly selected based on equal proportion.

Data was collected with the aid of interview schedule. Descriptive statistics were employed in the analysis of data namely frequency, mean, percentage. Factor analysis was also used to analysis the barriers faced by cassava farmers in adapting to climate change.

III. Results And Discussion

Table 1 shows majority (30%) of the cassava farmers were between the ages of 41 and 50 years. . The mean age of the cassava farmers was 48years with the oldest being 72 years and the youngest being 29 years.

This could possibly imply that the cassava farmers used for the study were old enough to have been able to experience the change in climate and as such be able to give reasonable responses to the questions in this research.

The Table also shows that 67.5% were female. This reveals that majority of the respondents were females. In line with this finding, IFAD (1994) reported that women play a central role in cassava production, contributing about 58 percent of the total agricultural labour in the southwest, 67 percent in the southeast and 58 percent in the central zones, with involvement in virtually all activities, hoeing, weeding, harvesting, transporting, storing, processing, marketing and domestic chores.

The Table further shows that majority (about 89%) of the cassava farmers had above ten years of farming experience. On the average the cassava farmers had 25years farming experience. This could imply that the respondents had long time farming experience and could have over the years acquired wealth of knowledge

on climate change and corresponding adaptation measures for cushioning the effects of climate change as well as been able to identify barriers against effective adaptation. Mapuno *et al.*, (2008) earlier noted that farmers who have sufficient farming experience could be in better position to identify challenges and opportunities on climate change.

It was also shown that more than 90 percent of the cassava farmers were literate enough to read and write with at least primary education. This could serve as a facilitating factor in respondent's adoption of new adaptation measures. Agwu and Anyanwu (1996) in line with the above statement noted that increase in educational status of farmers positively influence adoption of improved technologies and practices

It further shows that majority (86.8%) of the cassava farmers were married and could be said to be responsible and matured enough to give reasonable answers to research questions.

The average household size was found to be 6 persons. The result reveals that their household size is fairly large and this strongly suggests the practice of the extended family system, which Ekong (2005) noted is common in rural areas. It could imply that more family labour will be readily available. Igben (1988) noted that relatively large household size is an obvious advantage in terms of farm labour supply.

The Table shows that 76.3% of the respondents had access to land below 5 hectares for their farming activities, while 2% had between 20 hectares of land and above. The result reveals that majority of respondents had access to land below 5 hectares for their farming activities. This could be a reflection of the increasing pressure on available land as more people depend on a fewer portion of land for farming. Also it was gathered from the respondents that land in these communities is also used for other activities like building of both residential and industrial houses rather than only farming activities. These land-use changes could add to the deforestation of the area which is one of the likely causes of climate change.

It was also shows that approximately 21% of the cassava farmers had sale of product as their major aim of production, 49% had consumption as their major aim production while only 30% had both sale and consumption as their major aim of production.

Furthermore, it shows that only 28.8% of the respondents had been visited by agricultural extension officer. It could be implied that poor coverage of extension agents is one of the factors contributing to reduced productivity of farmers especially now that climate change is adversely affecting farming activities.

TABLE 4.1: Socio Economic characteristics of cassava farmers in the study area (n=80)

Characteristics	Variables	Frequency	Percentage	Mean
Age (Years)	30 & below	6	7.5	48
	31 – 40	21	26.3	
	41 – 50	24	30	
	51 – 60	15	18.8	
	61 – 70	11	13.8	
	Above 70	3	3.8	
Gender	Male	26	32.5	
	Female	54	67.5	
Farming experience	10 & below	9	11.3	25
	11 – 20	24	30	
	21 – 30	20	25	
	31 – 40	14	17.5	
	41 – 50	9	11.4	
	Above 51	4	5	
Level of education	No formal education	6	7.5	7
	Primary education	13	16.3	
	Secondary education	43	53.8	
	Tertiary education	18	22.5	
Marital Status	Single	7	8.8	
	Married	69	86.3	
	Divorced	1	1.3	
	Widowed	3	3.8	
Household Size	5 & below	14	17.5	6 persons
	6 – 10	53	66.25	
	11 – 15	12	15	
	16 and above	1	1.25	

Farm Size (hectares)	5 & below	61	76.3
	6 – 10	10	12.5
	11 – 15	7	8.8
	16 – 20	2	2.5
	21 and above	-	-
Aim of Production	Sale	17	21.25
	Consumption	39	48.75
	Both	24	30
Contact with Agricultural Extension Officer	Yes	23	28.75
	No	57	71.25

Source; Field data survey, 2012

IV. Barriers to climate change adaptation

Table 2 shows the barriers to effective climate change adaptation by cassava farmers in the study area. The results of the factor analysis revealed that eight major factors amplified the constraint experienced by cassava farmers in adaptation to climate change. These factors include; Land and labour constraints (Factor 1), non-accessibility/availability of farm inputs (Factor 2), non-availability/high cost of farm facilities (Factor 3), farming practices and traditional belief (Factor 4), information constraints (Factor 5), poor agricultural extension service delivery (Factor 6), income constraint (Factor 7) and government nonchalant attitude towards climate change issues (Factor 8)

The specific issues that amplified land and labour constraints (factor 1) include Limited availability of farm land for farming (0.79), High cost of farm land (0.81), Inherited system of land ownership (0.64), Communal system of land ownership (0.87), Non availability of farm labour (0.76), and High cost of farm labour (0.65). In traditional societies, individual farmers do not usually have title to farmland but enjoy user rights, which could be withdrawn at any time by the custodian of the communal land. Benhin (2006) noted that farm size and land tenure status are some of the major determinants of speed of adoption of adaptation measures to climate change. Deressa (2008) noted that shortage of farm labour is one of the major constraints to climate change adaptation by farmers.

Under factor 2 (non- accessibility / availability of farm inputs) the factors that loaded high were; Poor access to improved varieties of cassava (0.81), Poor access to disease and pest resistant varieties of cassava (0.64), Lack of cassava varieties that are adaptable to low rainfall (0.76), Lack of cassava varieties that are resistant to drought (0.73), Untimely supply of essential inputs for farming. (e.g. fertilizers, cassava stem)(0.69) and inadequate organic manure for improving the soil fertilities (0.55). All these variables suggest scarcity of farm inputs particularly improved and resistant varieties, which raise their prices beyond the reach of the farmers. This could pose as a possible threat to the climate change adaptation by farmers. As noted by Reilly (1996), climate change might constitute significant addition to the stresses already borne by farmers such that adapting to it might be beyond their resource capabilities.

Regarding factor 3 (non- availability / high cost of farm facilities) the variables that loaded high under this factor include; Lack of access to weather forecast technologies (0.65), Non availability of processing facilities (0.58), Non availability of storage facilities (0.71), High cost of irrigation facilities (0.72), and Lack of functional irrigation scheme (0.63). Most African farmers are resource poor and cannot afford to invest on these facilities for climate change adaptation so as to sustain their livelihood during harsh climate extremes such as flooding and drought.

Factor 4 (farming practices and traditional belief) the variables that loaded include; Intense weed growth due to minimum tillage (0.66), Poor yield from crop due to minimum tillage operation (0.69), and Pest and disease infestation due to minimum tillage operation (0.79).

Under factor 5 (information constraint) the variables that loaded high under this factor include; Poor access to information sources (0.82), Inadequate knowledge of how to cope or build resilience to climate change (0.51), and Illiteracy of farmers and lack of knowledge on adaptation options (0.74). In the present information age, information problems could pose serious challenges to farmers' coping strategies as they may not be aware of recent developments regarding climate change adaptations and the necessary readjustments needed.

Under factor 6 (poor agricultural extension service delivery) the variables that loaded high under this factor include; Poor agricultural extension service delivery (0.58) and Inability of extension personnel to build resilience capacity of farmers on climate change (0.73).

In factor 7 (income constraint) only one variable loaded high under this factor and that is inadequate finance to cope with the changing climate (0.65). It could refer to lack of money by the farmers as a constraint to adaptation. Lack of money hinders farmers from getting the necessary resources and technologies which

facilitates adaptation to climate change. Adaptation to climate change is may be costly. In line with this Deressa (2008) reported that most of the problems or constraints encountered by farmers in adaptation to climate change are associated with poverty.

In Factor 8 (government non chalant attitude towards climate change issues) only one variable loaded high under this factor; Government non-chalant attitude towards climate change issues (0.68). Government institutions responsible for climate change issues in Nigeria, like every other government institutions in most developing countries are still weak and often irresponsible to the yearnings of the people.

TABLE 2: Factor analysis showing the barriers faced by cassava farmers in adaptation to climate change

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Communalities
Poor access to improved varieties of cassava.		0.815							.737
Poor access to disease and pest resistant varieties of cassava	0.378	0.644							.631
Lack of cassava varieties that are adaptable to low rainfall.		0.767	0.467						.824
Lack of cassava varieties that are resistant to drought.		0.735	0.335						.647
Intense weed growth due to minimum tillage.				0.667				0.367	.515
Poor yield due to minimum tillage operation.	0.347			0.697				0.349	.747
Pest and disease infestation due to minimum tillage operation.				0.796					.688
Limited availability of farm land for farming.	0.796						0.443		.646
High cost of farm land.	0.811	0.434							.531
Inherited system of land ownership.	0.648			0.386			0.327	0.322	.731
Communal system of land ownership.	0.876	0.343						0.472	.592
Poor access to information sources.	0.327	0.337			0.852		0.401		.545
Non availability of credit facilities.	0.476				0.335	0.332			.548
Lack of access to weather forecast technologies.	0.408		0.657			0.442	0.429		.681
Government non-chalant attitude towards climate change issues	0.462	0.328					0.346	0.689	.537

Barriers Faced By Cassava Farmers In Adapting To Climate Change In Oron Agricultural Zone Of

Non availability of processing facilities.	0.319		0.588							.595
Non availability of storage facilities.	0.419		0.711							.706
Inadequate finance to cope with the changing climate.	0.457	0.383				0.651				.628
High cost of irrigation facilities.	0.457		0.722	0.301		0.305				.504
Lack of functional irrigation scheme.			0.638			0.382		0.438		.646
Inadequate knowledge of how to cope or build resilience to climate change.					0.512		0.344			.586
Non availability of farm labour	0.761				0.436			0.383		.592
High cost of farm labour.	0.651	0.422				0.337	0.321			.697
Traditional belief/practices e.g. on commencement of farming season		0.379		0.679						.507
Poor agricultural extension service delivery.		0.416	0.360			0.581				.680
Inability of extension personnel to build resilience capacity of farmers on climate change.						0.731				.578
Illiteracy of farmers and lack of knowledge on adaptation options.				0.341	0.741	0.345				.526
Untimely supply of essential inputs for farming. (e.g. fertilizers, cassava stem)		0.698			0.441					.614
Poor water harvesting technology.						0.382				.681
Inadequate organic manure for improving the soil fertilities		0.553	0.353		0.356					.508
Eigen value	4.572	2.638	2.229	2.109	1.926	1.723	1.436	1.350		

Percentage variance	15.239	8.792	7.429	7.031	6.421	5.744	4.788	4.499
Cumulative percentage	15.239	24.031	31.491	38.491	44.913	50.657	55.445	59.944

Source: Field Survey Data, 2012

Factor 1 = Land and labour constraint, Factor 2 = Non accessibility / availability of farm inputs, Factor 3 = Non availability / High cost of farm facilities, Factor 4 = Farming practices and traditional belief, Factor 5 = information constraint, Factor 6 = Poor agricultural extension service delivery, Factor 7 = Income constraint, and Factor 8 = Government non chalant attitude towards climate change issues

V. Conclusion And Recommendation

Climate change is perhaps the most serious environmental threat to the fight against hunger, malnutrition, disease and poverty in Africa, essentially because of its impact on agricultural productivity. The study identified barriers faced by cassava farmers in adapting to climate change in Oron Agricultural zone of AkwaIbom State. Based on the results of the study, it was concluded that the cassava farmers are facing varieties of constrains in their effort to adapt to climate change with Land and labour difficulties being the major constraints.

Based on the findings of the study, it was recommended that the Agricultural development programme should make room for extension agents to visit farmers more regularly, create awareness, and disseminate proven measures to boost farmer's knowledge in adapting to climate change. The Government should also make more available information on climate change and possible ways to overcome barriers to adaptation. Also, this study calls for re-visitation of the land ownership system as well land policies by the government and agencies concerned in the study area in order to come out with better policies that can reduce the land constraint faced by the cassava farmers in trying to adapt to climate change

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Protein Annotation & Advanced Insilico Based Mutation Hotspot Identification in Temperature Sensitive CDPK3 Protein of *Oryza sativa*

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Abstract: In the process of development of cold and heat tolerant rice varieties was done in field conditions. The current work is the extension of the same. In the current paper an extensive Insilico based research was carried out on the Mutational analysis and hot spot prediction of the protein CDPK3, Calcium Dependent Protein Kinases of *Oryza Sativa*. The work involves the retrieval of the protein sequence from the NCBI primary data base and identification of the Functional domains. Several sequences of the same protein from the other related plant species were collected and the phylogenetic study and the conservation prediction were performed. Tools like ProtParam and SOPMA have been applied to analyze the Physico chemical parameters and the Structure prediction of the protein was carried out. The regions of disorder present in the protein sequence were identified using several tools including DISEMBL, GLOBPLOT, RONN etc. Based upon the results of RONN the major sites prone for mutations are identified. The effect of possible substitution mutations on the selected target site was analyzed. I mutant tool was employed to check the effect of all the substitution mutations on the stability of the protein sequence, PolyPhen was used to evaluate the effect of mutations on Functionality and the tolerance level is calculated using SIFT. The work concludes to provide the complete protein annotation of Cold tolerance protein CDPK with a focus on the mutation hot spot prediction.

Keywords: Protein Annotation, Insilico Characterization, Mutation hotspots, CDPK, Cold tolerance

I. Introduction:

Rice being the staple crop of Middle and south India extensive research on the development of rice cultivation is a topic of demand. The current environment of extreme heat or extreme cold is causing a lot of stress on all the plants and crops cultivate. Though plants have their inherent mechanism to tolerate the adverse climatic changes sometimes due to the mutations and damages caused to the genetic makeup of the plants they lack this property of stress tolerance finally resulting in a huge damage to the crop cultivation. Calcium-dependent protein kinases (CDPKs) play an important role in rice signal transduction, but the precise role of each individual CDPK is still largely unknown [1]. A study revealed that OsCDPK13 gene expression and protein accumulation were enhanced in response to cold, but suppressed under salt and drought stress which depict the importance of this protein in the cold tolerance of the plant. Several works also inferred that the Over-expression of a single Ca²⁺-dependent protein kinase CDPK confers both cold and salt/drought tolerance on rice plants [2]. One of the research papers also presented the use of CDPK protein insertions and over expressions in Sorghum in order to impart tolerance to cold and freezing so as to expand the acreage for production [3]. CDPK protein super family consists of six types of protein kinases that differ in the regulatory domains they contain [4].

In view of the importance of the CDPK protein in the crop development and induction of resistant to the plants the current work aims to characterize and annotate the protein using insilico tools and software. The work aims to identify the mutation prone regions present in the CDPK 3 protein sequence of *Oryza Sativa*.

II. Materials and Methods:

I. Sequence Retrieval:

The major step in any of the Protein annotation works is to retrieve the Sequence of the protein of interest. The protein sequence is generally taken from the most reliable public data base, the NCBI [5] data base. The Boolean Operator search has been used for specifying the organism and the protein whose sequence is to be retrieved.

II. BLAST Analysis for collection of the related protein sequence:

In order to collect the sequences of the proteins that share sequence similarity to the query protein BLAST [6] tool has been applied. The BLAST is a local alignment search tool that would show the sequences that share some percentage of similarity. It is available at NCBI.

III. Multiple Sequence Alignment and Phylogenetic Study:

All the sequences collected in the above step are subjected to alignment so as to analyze the sequence conservation and phylogenetic relation present in the collected sequences. CLUSTALW [7] is used to perform the multiple sequence alignment and design the dendrogram showing the evolutionary relation among the sequences. The CLUSTALW tool available at SDSC Biology Workbench.

IV. Conservation Analysis using BOXSHDE:

The similarity among the collected sequences along with the percentage of conservation has been studied using BOXSHDE [8] tool by performing Global alignment of multiple sequences. The BOXSHADE tool is also available at SDSC biology Workbench.

V. Functional Analysis for the identification of Domains using SMART:

To identify the total number of domains (Independent functional units) present in the sequence of CDPK and to identify the positions of these domains on the sequence SMART [9] has been used. The tool will also give the detailed annotation of the domain and other important elements present on the input sequence.

VI. Analysis of the Physico chemical properties of the protein:

To study the inherent properties of the protein that would be necessary for designing the experimental protocol PROTPARAM [10] was used. The tool is available at EXPASY SERVER. The Protparam tool would give an insight to the chemical and physiological properties of the protein

VII. Secondary and Tertiary structure prediction using SOPMA and CPH tools:

To detect the secondary structural confirmations within the protein SOPMA [11] can be used. It would assign the conformational pattern for each residue separately and also summarize to show the total percentage of different confirmations present in the sequence. This data can be used to predict the regions present on the surface and those in the interior of the protein. To get the three dimensional structure of the protein one has to use RCSB Protein Data BANK [12]. However each protein would have a unique identity in PDB which must be known to retrieve the structure of the protein. CPH tool has been employed to get the PDB ID of the study protein. Once the ID is obtained the structure can be downloaded from PDB and visualized using the RASMOL [13] software.

VIII. Prediction of the probable disorder regions present in the query sequence:

To identify the regions of disorder present in the user entered sequence several online tools are available each working on a different algorithm and principle. GLOB PLOT [14], DISEMBL [15] and RONN [16] were employed to predict the regions of possible disorder. The results of RONN would provide the additional information about the disorder probability for each amino acid residue displayed separately. These results can be summarized to identify the sites on the sequence that have maximum disorder probability.

IX. Analysis of the effect of Substitution mutations on Stability and Functionality of the protein:

Once the mutational hot spots are identified the next step is to check for the effect of all possible substitution mutations on the stability of the protein structure. Also it is necessary to analyze the effect of the same on the functionality and disease occurrence.

The I Mutant [17] tool is used for the above purpose. To evaluate the effect of substitution of the functional ability and disease occurrence PolyPhen [18] was used. SIFT was used to evaluate the tolerance of the protein to the possible substitutions.

X. Analysis of the Tolerability of the mutations on the protein structure:

To check the tolerance range of the protein towards the substitutions specified SIFT [19] has been used. The tool enables to check the effect of substitutions on the proteins acceptability range.

III. Results and Discussion:

I. Sequence Retrieval of CDPK3 from NCBI:

The protein sequence of the query protein CDPK3 from *Oryza Sativa* has been retrieved from NCBI using Boolean operators to make the search specified. The length of the sequence was found to be 527 amino acids.

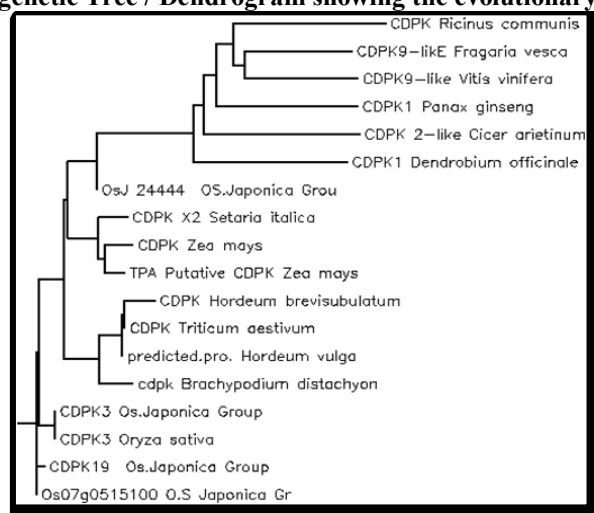
II. BLAST for the collection of similar sequences:

Using the BLAST tool a total of 17 sequences of different organism were collected and used for further analysis. All the sequences belong to the common CDPK protein.

III. Phylogenetic analysis using CLUSTALW Dendrogram:

To check the sequence similarity among the selected sequences MSA was performed using CLUSTALW and the phylogenetic tree was constructed.

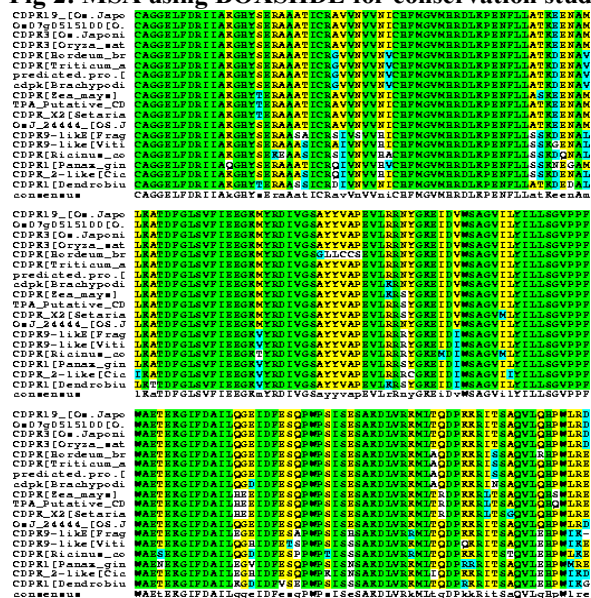
Fig1: Phylogenetic Tree / Dendrogram showing the evolutionary relationship:



The above dendrogram shows the evolutionary relation between the selected 17 organisms with the query. It can be inferred that all the selected organisms are evolving from the same common branch which indicates that the sequences are homologues.

IV. Conservation study based on Multiple sequence alignment:

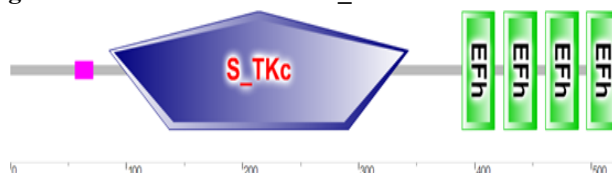
Fig 2: MSA using BOXSHDE for conservation study



Form the above fig 2 it can be inferred that the Sequences aligned in the given MSA show maximum conservation and are evolutionarily closely related.

Domain Identification using SMART:

Fig 3: The Picture showing total 5 domains one is the S_TKc domain and the other four are EFh domains.



From the above picture it can be inferred that there are a total number of 5 domains in the CDPK sequence. One of it would be the S_TKc domain and the other four being the EFh domains. The S_TKc domain ranges from 85 to 343 in the query sequence.

The EFh domains are present in the regions ranging from 389-417, 425-453, 461-489 and 496-524. These are the regions that are involved in the major functions of the protein. The function of the S_TKc domain is the Serine/Threonine protein kinases, It is the catalytic domain. The other domain EFh is involved in the binding of the protein to the calcium ion cofactors and thus is important in the normal functioning of the protein.

Protparam for Physico chemical properties of the protein:

To study the physico chemical properties of the protein PROTPARAM tool has been used which indicates that the protein is 527 amino acids in length with the isoelectric pH being 5.54 and the molecular weight is 58872.0. The protein is unstable with the instability index being 41.4. The hydropathicity of the protein was found to be -0.398 which indicates that the protein is polar and water soluble.

Secondary structure Prediction using SOPMA:

Fig 4: Showing the secondary structural confirmations of the sequence as shown by SOPMA

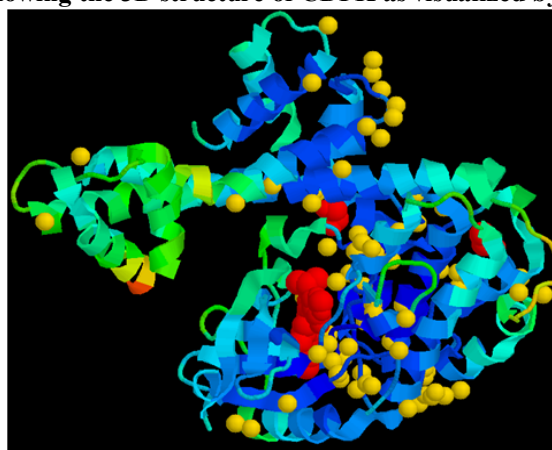
SOPMA result:			
Alpha helix	(Hh) :	228 is	43.26%
3 ₁₀ helix	(Gg) :	0 is	0.00%
Pi helix	(Ii) :	0 is	0.00%
Beta bridge	(Bb) :	0 is	0.00%
Extended strand	(Ee) :	57 is	10.82%
Beta turn	(Tt) :	41 is	7.78%
Bend region	(Ss) :	0 is	0.00%
Random coil	(Cc) :	201 is	38.14%
Ambiguous states (?)	:	0 is	0.00%
Other states	:	0 is	0.00%

From the above figure 4 the total number and types of confirmations present in the given sequence have been identified. It can be inferred that the sequence contains 43.26% of alpha helical conformations, 38.14% random coil, 10.82% extended strand and 7.78% beta turn conformations.

Tertiary Structure Prediction CPH and Visualization using RASMOL:

To get the 3D structure of the protein CPH tool has been employed and the ID 3SXF has been selected as the best id for the structure of the CDPK protein. The structure has been retrieved from the PDB data base and the visualization has been done in RASMOL software.

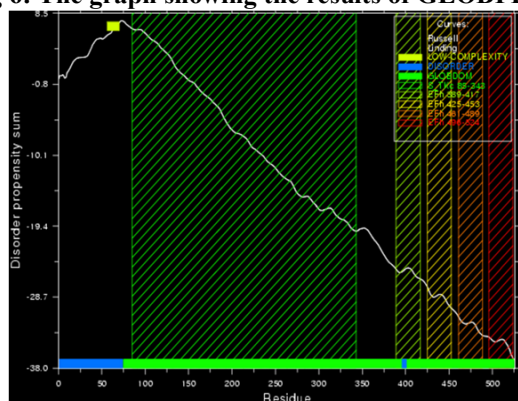
Fig 5: The picture showing the 3D structure of CDPK as visualized by RASMOL software:



Disorder site identification using Insilico tools:

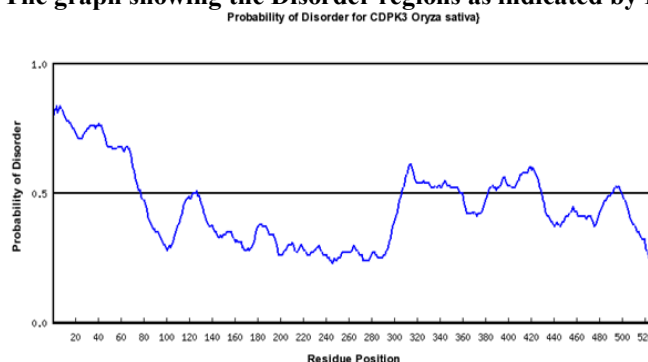
To identify the disorder regions present in the given sequence GLOBPLOT, DISEMBL and RONN have been used and the common regions are selected.

Fig 6: The graph showing the results of GLOBPLOT



The above fig 6 shows the disorder regions as indicated by the GLOBPLOT tool. From the results it can be explained that there are two regions of disorder in the given sequence which include: 1-74 and 396-401. To select the best site among the identified regions RONN can be used.

Fig 7: The graph showing the Disorder regions as indicated by RONN.



The above figure 7 shows the disorder regions as predicted by the RONN analysis. As per the results of RONN the disordered regions are 1 - 77, 127 - 127, 308 - 357, 383 - 429, and 493 – 499. Based on the common mutation sites and the highest mutation probability the sites selected are 1-11 amino acids.

Table 1: The table showing the summarized results of disorder prediction along with the evaluation of the hydropathicity index for each residue.

Amino Acid	Position	Disorder probability	Hydropathicity Index / Polarity
M	1	0.78	1.9
G	2	0.82	-0.4
S	3	0.82	-0.8
C	4	0.84	2.5
C	5	0.81	2.5
S	6	0.83	-0.8
R	7	0.84	-4.5
A	8	0.83	1.8
T	9	0.82	-0.7
S	10	0.81	-0.8
P	11	0.80	-1.6

From the above table it can be explained that from among the amino acids 1-11 the amino acids R7 and P11 are supposed to be exposed on the surface due to their less hydropathicity index. Thus the amino acid R7 is identified as the mutation hotspot for the CDPK3 sequence from Oryza Sativa.

Summarization of the effect of substitution mutations to the R7 position on the Stability of the structure:

In the position 7R there are a total of 19 substitution mutations that can be possible and thus the analysis was carried out to detect the effect of these 19 mutations on the Stability of the protein using I Mutant, The results are summarized in the Table 2.

Fig 8: The results of SIFT showing the Tolerance level for the mutations at R7.

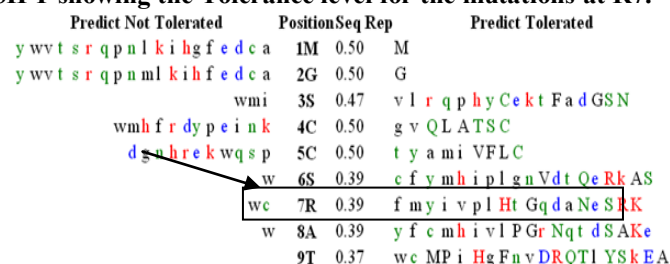


Table 2: The summarized results for the effect of substitutions:

Wild Type	Mutant Type	Effect on stability (I Mutant)	Effect on functions	Tolerance level (SIFT)
7R	A	Decrease	Benign	T
7R	V	Decrease	Benign	T
7R	N	Decrease	Benign	T
7R	D	Decrease	Benign	T
7R	C	Decrease	Possibly Damaging	NT
7R	E	Decrease	Benign	T
7R	Q	Decrease	Benign	T
7R	G	Decrease	Benign	T
7R	H	Decrease	Possibly Damaging	T
7R	I	Decrease	Benign	T
7R	L	Decrease	Benign	T
7R	K	Decrease		T
7R	M	Decrease	Possibly Damaging	T
7R	F	Decrease	Possibly Damaging	T
7R	P	Decrease	Benign	T
7R	S	Decrease	Benign	T
7R	T	Decrease	Benign	T
7R	W	Decrease	Possibly Damaging	NT
7R	Y	Decrease	Possibly Damaging	T

From the above results of I Mutant it can be inferred that any of the substitution at the position R would definitely result in the decrease in the stability of the protein thus resulting in the inactive form or defective form of the protein.

SIFT results based on damaging substitutions:

Substitution	Score
R7C	0.904
R7H	0.755
R7M	0.904
R7F	0.728
R7W	0.973
R7Y	0.728

IV. Conclusion:

The current work aims to analyze the complete protein sequence and functional parameters of CDPK which is a major protein involved in the stress mechanism and cold tolerance. The study aimed to identify the Disorder regions and the recognition of the mutational hotspot sites on the protein sequence.

The domain regions present within the sequence have been calculated using SMART tool. The work also included the evaluation of phylogenetic relationship among the selected plant species and designing of the Dendrogram for the same. The physicochemical parameters of the sequence were calculated using ProtParam. The PDB id that can depict the 3D structure of the protein was found to be 3SXF which was visualized using RASMOL. The major step of the research is to evaluate the effect of the substitution mutation at the hot spot site on the stability, functionality disease occurrence and tolerability of the protein. These parameters were calculated using various insilico tools. The final summary of the work is that the hotspot site located on the CDPK3 sequence of *Oryza sativa* is R7 position which when substituted with any of the other possible 19 amino acids would result in a decrease in the stability of the protein as shown by I Mutant tool. As per the results of SIFT it can also be inferred that though all the substitutions result in a decrease in the stability of the structure the mutations R7C and R7W are not tolerated whereas the other substitutions may be tolerated. According to the results of PolyPhen 6 substitutions among the total 19 were found to cause a possibly damaging effect. These include R7C, R7H, R7M, R7F, R7W, and R7Y whose scores were further evaluated and it was found that 3 of the 6 are having maximum damage than the other substitutions the three maximum damaging substitutions are R7C, R7M, R7W. From the complete analysis it can be clear that the amino acid substitutions of R7C and R7W are found to be damaging with respect to the results of all the three tool I Mutant, PolyPhen and SIFT. Thus the site R7 and the substitutions with C and W are found to be the most damaging mutations that could ultimately affect the cold tolerance of the plants.

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Diversity analysis of indica rice (*Oryza sativa* L.) genotypes against low and high temperature stress

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Abstract: Morphological characterization of 470 rice (*Oryza sativa* L.) accessions including five checks collected from different regions country were assessed using 19 quantitative characters traits. Accessions were evaluated in a field experiment in an augmented experimental design. The aim of the research was to study variations and to select lines that could be used as potential parents in future breeding programs. A principal components plot and distance between genotypes in different cluster groups were used to group the accessions. The rice genotypes grouped into divergent cluster 12 and 18 are expected to give promising and desirable recombinants in the segregating generations. Also, traits contributing maximum to genetic divergence viz. Seed vigor followed by Fertile Grains/ Panicle, Fertile Grains/ Panicle and panicle length may be utilized in selecting genetically diverse parents.

Key words: genetic divergence, cold tolerance, rice, inter cluster distance

I. Introduction:

Rice has become a commodity of strategic significance and the fastest growing food source in India, any reduction in the rice production will have large scale implications on food security. The recent studies have predicted a reduction of 4 % in rice production due to climate change. It is estimated that for every 1°C rise in temperature there is a reduction of 0.5 tons in rice yields (1). To meet the food demand of the growing population and to achieve food security in the country, the present production levels need to be increased by 2 million tonnes every year, which is possible through heterosis breeding and other innovative breeding approaches. To increase the present levels of heterosis for yield, there is a need to identify and utilize genetically divergent parents for inter and intra specific crosses in rice (2). A systematic evaluation and characterization of germplasm lines not only help in identification of superior and genetically divergent germplasm lines but also provide information on the utility of the genetic resources (3). Characterization of accessions provides the information on morphological and agronomic aspects of the material that is essential for the gene bank management (4). Therefore, the present investigation was undertaken to study the genetic variability for yield and its component characters in various rice germplasm lines. In the present study several germplasm accessions were evaluated for their cold tolerance during seedling stage and heat tolerance during reproductive phase.

II. Materials And Methods:

A set of 470 rice germplasm accessions collected from different parts of country were tested for their cold tolerance in a phytotron. Five checks AK Dhan, N-22, Prasanna, RP-Bio and Vikas were used. The seeds of the germplasm lines were allowed to germinate at 35°C in a growth chamber for 3 days. The germinated seeds were surface-sterilized with 1% sodium hypochlorite solution and washed with distilled water. 30 uniformly germinated seeds from each accession were sown in germination trays and cultured in growth cabinet where the temperature was maintained at 25°C with 70% relative humidity. At one-leaf stage the seedlings were subjected to cold stress at 6°C during night time and 80°C during day with a relative humidity of 70% for 7 days after which the temperature was adjusted gradually back to 25°C. The observations on the growth of seedlings were recorded from the 5th day of cold treatment. The survived lines at 20th day were transferred to field to evaluate their agronomic performance and tolerance to heat during reproductive phase. A field experiment was conducted by using augmented design during Rabi, 2012 at DRR farm, ICRISAT Campus Patancheru, Hyderabad. India. Situated at 17.53°N latitude, 78.27° E longitude and altitude of 545m above mean sea level. The augmented experimental design introduced (5) was used for the experiment. An Augmented Experimental Design (AED) is usually useful for testing a large number of genotypes in early generations when valid statistical analyses are needed particularly when seed supplies are too limited to permit replication. The basic concept of augmented design construction is to establish a standard replicated design using checks for which sufficient seeds are available. Each replicate forms a complete block, incomplete block, or cell, depending on the standard design. Additional unassigned plots are created within

each replicate and un-replicated entries for which there are insufficient seeds. Entries are then assigned to these plots in the form of an incomplete block design. Seedlings were transplanted at 21 day old with a spacing of 20X20 cm. The field experiment was carried out in summer with maximum temperatures crossing 40°C. One seedling was transplanted per hill and the inter-plot spacing was 40 cm. A plot size of 1.2x5 m with 6 rows was used for each accession in the field. Recommended cultural practices are followed. Morphological data were collected for nineteen quantitative characters at appropriate growth stage of rice plant following the descriptor for Rice *Oryza sativa* L. (6).

III. Results And Discussion:

The analysis of variance revealed significant differences among the 470 genotypes for all the nineteen characters studied (Table 1). The results indicated high variances for most of the characters, which may favour the selection and its further utilization in recombination-breeding programmes in the mere future. The quantum of genetic divergence was also assessed by cluster analysis using Mahalanobis's Euclidean squared distances which grouped the entire material into more precised clusters and estimates the average distance between them. The Euclidean squared distance grouped the material into 8 clusters.

Table. 1. Analysis of variance for different traits in rice germplasm

	Block (ignoring Treatments)	Treatment (eliminating Blocks)	Checks	Checks+Var vs. Var.	ERROR
d.F	4	474	4	470	16
Tillers/Plant	966.46 ***	23.59 ***	6.7	23.73***	4.9
Effective Tillers/ Plant	106.65 ***	14.46	3.34	14.56	8.91
Plant Height cm	2512.62***	219.40 *	1351.70 ***	209.77 *	99.85
Leaf Length cm	551.92 ***	139.06 ***	405.50***	136.79 ***	19.93
Leaf Width cm	0.35***	0.04	0.11*	0.04	0.03
Panicle Length cm	131.77***	12.01***	64.97***	11.56***	1.8
Sterility %	2882.25***	381.75*	5394.24***	339.09	169.07
Yield/ Plant	189.71**	32.67	564.93***	28.14	33.36
100-seed Wt	0.36**	0.18**	0.26**	0.18**	0.05
Seed Density	775.70***	141.36	357.46*	139.52	76.36
Grains/ Panicle	7676.18*	1215.72	2603.06	1203.91	1767.13
Fertile Grains/ Panicle	6675.63	1528.31	15504.14**	1409.36	2608.07
Pollen Viability	423.21 ***	71.98*	491.04***	68.41*	29.34
Days to 50% Flowering	123.06**	14.93	15.26	14.92	25.49
Germination %	1000.55***	908.5***	12.26	916.13***	15.97
Coleoptiles Length (cm)	12.57	31.72**	25.6	31.78**	10.74
Radical Length (cm)	17.36	22.66	15.97	22.72	22.71
Seed Growth (cm)	51.79	98.61	67.35	98.88	58.82
Seed vigor	399585.16	1053480.1	618118	1057185	586843

The 470 rice genotypes were grouped into 22 clusters (Table.2). Among the clusters, cluster III was the largest comprising of 46 genotypes followed by cluster VII (37), cluster XIII (34), cluster V (33), cluster 10,14 (30) and cluster 25 having twenty-four genotypes. Cluster 22,20,18 are having twenty genotypes. Cluster IV is comprising of four genotypes only. It is interesting to observe that most of the genotypes of one cluster were adapted to only one region. The clustering pattern reflects the closeness between the clusters and the geographical adaptation of the genotypes (7).

Table .2. Rice genotypes included in different clusters

Group	n	Cluster Members --->
1	13	38 48 64 86 121 162 222 229 277 325 435 441 473
2	14.	14 29 30 42 47 51 125 130 152 169 185 233 373 390
3	46	1 3 7 9 11 17 28 31 34 37 46 60 62 63 66 72 73 75 87 103 107 144 216 226 237 239 272 285 297 309 321 332 353 363 365 366 372 377 381 385 395 420 423 429 434 464
4	4	67 356 380 467
5	33	4 43 49 65 71 76 94 105 111 112 114 150 172 183 187 221 223 234 236 247 262 276 284 308 328 348 361 374 375 431 433 471 472
6	17	93 101 104 120 126 128 129 131 136 157 161 167 168 174 177 178 182
7	37	10 25 44 45 50 80 83 85 92 98 110 146 147 159 199 203 241 248 282 291 295 301 302 311 324 342 345 350 355 362 369 396 402 418 422 437 469
8	12	99 106 115 127 132 142 149 164 175 181 184 186
9	19	113 151 154 155 158 166 176 179 180 188 189 194 198 202 209 210 211 232 274
10	30	96 97 109 117 133 170 204 206 207 208 217 225 227 259 261 269 279 378 379 383 406 407 408 412 414 442 449 450 451 459
11	6	196 245 250 397 409 410
12	13	100 108 124 134 135 140 163 200 212 230 231 252 463
13	34	8 12 16 23 32 35 70 119 122 123 137 139 156 165 201 215 228 235 238 243 256 273 288 337 346 354 364 370 376 389 393 424 439 458
14	30	219 224 253 254 257 263 268 271 280 287 294 296 298 306 319 327 333 343 349 388 391 394 400 401 426 445 446 452 455 461
15	18	5 6 24 54 88 192 193 246 255 303 310 313 316 318 326 382 428 468
16	23	267 281 289 290 299 320 322 330 331 335 336 340 341 344 352 367 368 392 405 411 413 440 447
17	17	13 18 21 40 118 190 278 286 300 304 305 312 317 334 338 351 357
18	20	143 148 160 173 205 220 242 244 249 270 339 387 398 403 415 427 438 443 453 454
19	23	68 69 77 78 81 102 145 195 197 214 251 258 260 265 275 358 386 399 417 419 444 466 470
20	20	2 33 52 56 58 61 84 138 264 283 307 314 323 347 360 371 425 430 432 457
21	24	15 22 27 41 53 55 57 59 74 90 91 116 141 153 171 240 266 404 416 421 436 448 456 465
22	20	19 20 26 36 39 79 82 89 95 191 213 218 292 293 315 329 359 384 460 462

The average intra and inter cluster D2 values are presented in Table 3. Most of the intra clusters were closely related and cluster D2 values ranged from 45.4(cluster 22) to 10.6(cluster 9). The intra cluster distance analysis revealed that the maximum divergence was observed in cluster 22(45.4). It is reported that genotypes within the cluster with high degree of divergence would produce more desirable breeding materials for achieving maximum genetic advance. The other clusters showing high intra cluster values were cluster 3,17,10,12,7 and cluster 9 is having least intra cluster value(8).

Inter cluster D2 values ranged from 183(cluster 12) to 19.9(cluster 18). From the inter cluster D2 values of the twenty two clusters, it can be observed that the highest divergence was between cluster 12and 22while, lowest divergence was noticed between cluster 20and 18 (19.9). Highly divergent genotypes would produce a broad spectrum of variability in the subsequent generation enabling further selection and improvement, which would facilitate successful breeding of rice. Thus hybrids developed from the distant cross may produce high magnitude of heterosis or desirable transgressive segregants, which would facilitate successful breeding of rice (9).

The number of times that each yield component appeared in first rank and its respective percent contribution towards genetic divergence is presented in Table 4..The results showed that the contribution of Seed vigor towards genetic divergence was highest (96.47%) by taking 107693 times ranking first, followed by Fertile Grains/ Panicle (1.24%) by 1389 times, Grains/ Panicle (1.23%) by 1374 times, Germination % (0.61%) by 680 times. Seed density (0.13%) by 142 times, Sterility % (0.12%) by 138 times. Plant Height, Effective Tillers/ Plant, Leaf Width, Panicle Length, Yield/ Plant, 100-seed Wt, Days to 50% Flowering, Coleoptiles Length, Radical Length and Seed Growth did not contribute towards genetic divergence among the genotypes under investigation (10).

Table .3. Average intra and inter cluster distance values of rice genotypes

	1Cluster	2Cluster	3Cluster	4Cluster	5Cluster	6Cluster	7Cluster	8Cluster	9Cluster	10Cluster	11Cluster	12Cluster	13Cluster	14Cluster	15Cluster	16Cluster	17Cluster	18Cluster	19Cluster	20Cluster	21Cluster	22Cluster	
1 Cluster	17.6	25.3	55.5	71.8	28.7	24.5	26.3	27.2	38.3	42.0	34.4	54.5	51.7	26.4	38.5	36.5	27.5	30.5	41.7	29.8	45.4	112.6	
2 Cluster		18.9		60.6	65.0	36.9	25.8	32.3	37.6	44.4	40.3	33.7	61.2	46.4	27.3	41.6	43.3	30.9	41.2	42.1	33.6	46.3	106.3
3 Cluster			40.1	69.1	67.3	68.8	73.9	73.2	84.8	87.7	80.0	104.4	96.5	63.4	67.0	74.2	54.8	86.4	99.3	76.8	49.0	66.5	
4 Cluster				24.2	51.2	60.3	63.4	78.0	83.0	90.1	65.5	80.8	97.0	92.3	109.4	133.9	78.8	111.7	126.2	100.2	115.9	154.0	
5 Cluster					15.8	20.8	27.3	24.7	32.0	48.4	32.2	35.5	42.8	47.5	56.5	67.4	34.9	44.7	61.6	41.3	78.1	146.6	
6 Cluster						16.0	25.2	25.1	32.1	38.8	29.6	37.4	35.4	35.8	45.1	52.4	29.4	38.0	46.6	31.1	63.7	130.7	
7 Cluster							20.4	32.5	48.6	58.6	42.8	62.0	58.1	45.8	64.9	65.8	46.8	44.9	57.0	45.5	74.1	146.5	
8 Cluster								17.3	21.4	37.4	27.8	40.5	37.4	33.4	37.0	46.1	27.2	25.1	36.8	23.9	61.1	145.4	
9 Cluster									10.6	25.1	22.7	31.9	33.3	33.9	28.4	47.2	26.1	25.6	30.9	22.8	66.6	156.0	
10 Cluster										24.6	28.5	42.8	44.9	30.1	27.6	40.9	29.5	33.3	32.8	27.1	58.3	139.7	
11 Cluster											17.9	36.0	37.9	32.5	39.0	51.6	29.1	34.0	38.9	28.2	65.8	150.7	
12 Cluster												20.7		45.3	61.1	58.7	76.9	43.4	56.0	70.5	47.1	102.6	183.2
13 Cluster													26.5	50.5	47.3	62.2	38.0	48.5	49.2	36.5	77.0	149.0	
14 Cluster														16.9	21.9	23.3	23.0	25.5	26.1	21.2	32.4	104.9	
15 Cluster															13.1	21.3	21.5	27.5	26.4	20.9	31.0	99.0	
16 Cluster																16.5	29.3	29.3	31.4	26.6	29.8	99.3	
17 Cluster																		15.5	30.5	36.7	21.8	38.2	103.7
18 Cluster																			15.8	22.6	19.9	50.7	142.4
19 Cluster																				17.3	22.3	49.7	142.6
20 Cluster																					14.9	43.0	125.7
21 Cluster																						19.3	58.9
22 Cluster																							45.4

Table.4. Relative contribution of different traits to genetic diversity in rice

Source	Times Ranked	Contribution %
1 Tillers/Plant	7	0.01
2 Effective Tillers/ Plant	0	0.00
3 Plant Height cm	137	0.12
4 Leaf Length cm	58	0.05
5 Leaf Width cm	0	0.00
6 Panicle Length cm	0	0.00
7 Sterility %	138	0.12
8 Yield/ Plant	0	0.00
9 100-seed Wt	0	0.00
10 Seed Density	142	0.13
11 Grains/ Panicle	1374	1.23
12 Fertile Grains/ Panicle	1389	1.24
13 Pollen Viability	10	0.01
14 Days to 50% Flowering	0	0.00
15 Germination %	680	0.61
16 Coleoptiles Length (cm)	0	0.00
17 Radical Length (cm)	0	0.00
18 Seed Growth (cm)	0	0.00
19 Seed vigor	107693	96.47

IV. Conclusion:

In the present investigation, it is suggested that hybridisation programme within the divergent cluster 12 and 18 are expected to give promising and desirable recombinants in the segregating generations. Also, traits contributing maximum to genetic divergence viz. Seed vigor followed by Fertile Grains/ Panicle, Fertile Grains/ Panicle and panicle length may be utilized in selecting genetically diverse parents.

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Effect of lime on yield contributing characters of Wheat in Barind tract of Bangladesh

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Abstract : (11Bold) : There were six lime treatments viz. T1: Control, T2 : 0.5 t lime ha⁻¹, T3 : 1.0 t lime ha⁻¹, T4 : 1.5 t lime ha⁻¹, T5 : 2.0 t lime ha⁻¹, and T6 : 2.5 t lime ha⁻¹. Dolochun(CaCO₃) was used as the liming material. The design of the experiment was Randomized Complete Block Design (RCBD) with three replications. Every plot received 140.0 kg N, 25.0 kg P, 106.0 kg K, 3.06 kg S, 3.6 kg Zn and 0.6 kg B ha⁻¹ from urea, TSP, MoP, gypsum, zinc sulphate (monohydrate) and boric acid, respectively. Available K, P, Ca and Mg were significantly increased due to application of lime which was mainly associated with increased wheat yields. The different characters of wheat viz. plant height, tillers plant⁻¹, spike length, grains spike⁻¹ and grain yield were significantly increased by the application of lime. The application of 0.5 t lime ha⁻¹ significantly increased most of the growth parameters of wheat compared to that without any lime application. The application of lime had significant effect on the grain yield of wheat. The highest grain yield was found in T4 (4.73 t ha⁻¹), which was statistically identical with the grain yields obtained in T5 and T6 treatments but superior to those found in T1, T2, T3 treatments. Thus, the application of 1.50 t lime ha⁻¹ is enough for satisfactory yield wheat.

Keywords: Wheat, Lime, Yield, Spike, Panicle, Grain

I. INTRODUCTION

Nutrient availability in soil depends on the pH value of soils. On the basis of pH, soil are classified as alkaline, neutral and acidic having pH range 6.6 to 7.4. (Hausenbuiller, 1972). Most of the plant nutrients are highly available in neutral soil having pH 6.6 to 7.4. But soil acidity is a major growth-limiting factor for plants in many parts of the world (Adams, 1980).

The soils of North west part of Bangladesh are light textured, low in OM and strongly acidic to moderately acidic in nature, pH ranges from 4.5 to 5.5 (FRG, 2005). The status of available P, Ca and Mg of these soils are low. The sandy soil has low cation exchange capacity. These soils have high content of aluminum, iron and manganese and deficiencies of nitrogen, calcium, magnesium, potassium, phosphorus and boron are common. Aluminum toxicity is responsible for the poor yield of crops in acid soils.

Among the cereal crops, wheat is next to rice in Bangladesh. Although, rice is the staple food of Bangladesh but its total production is not sufficient enough to feed her population. Wheat can be a good supplement of rice and it can play a vital role to feed her population. From the nutritional point of view, wheat is preferable to rice for its higher protein content. In Bangladesh about 3.58 lac hectare of land is covered by wheat producing 9.95 lac metric ton with an average yield of 2.78 t ha⁻¹ during the year 2011-2012 (BBS, 2012). The cultivation of wheat needs only one or two supplementary irrigation while a boro rice crop needs about 15-20 irrigation during the growth period. It is a future challenge for Bangladesh to better exploit the potential of the production of wheat crop to meet the country's grain food requirement without endangering the environment.

The wheat yield in this country is low. There are several reasons that can explain the yield variation, which cover both biotic and abiotic factors. Among the biotic factors, unavailability of high yielding varieties (Rerkasem et al., 1993), incidence of diseases and pests (Hossain et al., 1995) and abiotic factors such as high temperature (Orakwue, 1984), moisture stress (Bingham, 1966) and nutrient deficiency (Rerkasem et al., 1991; Jahiruddin et al., 1992; Islam et al., 1999) are responsible for lower productivity of wheat in the tropics and sub-tropics. Among these factors, the most dominating factor that is a vital barrier for crop productivity is problem soil like acidic soil, saline soil etc. There are different types of problem soils in Bangladesh. These soils restrict the growth of plants and make crop production difficult and sometimes impossible. Special management practices need to be applied in such soils for economic crop production. Acid soil in Bangladesh is one of the problematic soils. The potential of acid soil for crop production is limited due to less availability of phosphorus and toxicity of aluminum. For example, the soils of Northwest part of Bangladesh are light textured, low in organic matter and strongly acidic to moderately acidic (pH ranges from 4.5 to 5.5) in nature (BARC, 2005). The status of available P, Ca and Mg of these soils are low. The sandy soil has low cation exchange capacity. These soils have high content of aluminum, iron, and manganese (Breemen, 1973), and deficiencies of nitrogen,

calcium, magnesium, potassium, phosphorus and boron are common. Aluminum toxicity is responsible for poor yields in acid soils (Lierop, 1984). There are some reclamation process for acid soils, for instance liming that increases the availability of P, Ca, Mg and Mo and renders iron, and manganese insoluble and harmless, increases fertilizer effectiveness and decreases plant diseases (Sahai, 1990). Thus, the crop plants may have a better nutrition and the crop may produce a good yield. Farmers in the Northern part of Bangladesh are applying a large amount of fertilizers for wheat production but they do not get good yields. Unless the soil pH is raised to around neutrality, the availability of nutrient elements will limit the growth of plants.

Liming also promotes the decomposition of organic matter by making condition more favorable for the growth of microorganisms. The bacteria that fixed nitrogen from the air both non-symbiotically and in the nodules of legumes are specially stimulated by the application of lime. The successful growth of most soil microorganisms depends upon lime that satisfactory biological activities cannot be expected if calcium and magnesium levels are low.

Infertility of Acid soil is a major limitation to crop production on highly weathered and leached soil throughout the world (Mokolobate and Haynes, 2004) and research project deal with soil management practices to sustain high yield through fertilization and liming to improve soil quality at a high level to meet plant requirements.

In respect of the northern part of Bangladesh, farmers are applying a large amount of fertilizer for wheat production but they do not get good yields. Unless the soil pH is raised to around neutrality, the availability of nutrient elements will limit the growth of plants. So it is urgent need to mitigate the shortage of wheat production, lime application is a crop sustainable production technology for better soil fertility management of acidic soil. In these regard a study in highly acidic soil using optimum level of lime is urgently needed. It is a future challenge for Bangladesh to better exploit the potential of the production of wheat crop to meet the country's grain food requirement without endangering the environment. Last of all through the application of lime, soil pH might be increased and yield gap of wheat grain can be minimized in North region. Therefore, an intensive study has been designed for the acidic soils of Northwest / 26 AEZ to evaluate the changes in chemical properties of soil due to lime in wheat field. Therefore, a study was undertaken in a highly acidic soil of Barind area, with the following objective:

- To evaluate the effect of lime on yield and yield contributing characters of wheat

II. MATERIALS AND METHODS

2.1. Study area

The experimental field is located at 25009'58.0" N latitude and 88o 28' 32.6"E longitude at a height of 28.0 m above the mean sea level. The experiment was conducted at Mouza Tiloni, Village Boikanthapur under Sapahar Upazila in Naogaon District during the period from October 2011 to April 2012.

2.2. Soil

Within total land surfaces of Bangladesh, terrace constitutes about 8% namely The Barind tract and The Madhupur Tract. The Barind tract has mainly level, poorly drained highland though it has a small area of dissected hilly lands at the western fringe and a small well drained highland area at the eastern fringe. The experimental field belongs to the AEZ No. 26, Barind Tract Soil. Amnura (Soil series of Bangladesh) soils are developed in deeply weathered Madhupur clay. The soils are mixed yellowish brown and grey to light grey silt loams to silty clay loams grading into grey, mottled yellowish brown, weathered Madhupur clay below about 2 feet, a member of hyperthermic Aeric Haplaquept under the order Inceptisol having only few horizons, developed under aquic moisture regime and variable temperature conditions, Agro ecological Appraisal of Bangladesh, (UNDP and FAO, 1988). According to BARC 'Fertilizer Recommendation Guide (2005) general characteristics of the soil and chemical characteristics of initial composite soil sample (0-15 cm depth) which were collected on October 2011 for initial status and tested, are presented in Table 1 and Table 2.

Table 1. Morphological, physical and chemical characteristics of the soil

AEZ	: High Barind Tract (AEZ 26)
General Soil Type	: Deep Grey Terrace soils and Grey Valley soil
Parent material	: Madhupur clay
Drainage	: Imperfectly drained
Topography	: High land
Flood level	: Above flood level

Table 2 Physical characteristics of soil

Sand (%)	: 42.0
Silt (%)	: 32.0
Clay (%)	: 26.0
Textural class	: Silt loam to Silty clay loam

2.3 Crop

The test crop was wheat. Certified seeds were collected from the Regional Wheat Research Centre, BARI, Shampur, Rajshahi. The variety used was Prodip.

2.4 Treatments

There were six different rates of lime application in wheat as follows-

- T₁ : Control
- T₂ : 0.5 t lime ha⁻¹
- T₃ : 1.0 t lime ha⁻¹
- T₄ : 1.5 t lime ha⁻¹
- T₅ : 2.0 t lime ha⁻¹
- T₆ : 2.5 t lime ha⁻¹

The liming material had 20% Ca and 10% Mg. The liming material was applied to the soil on 07 November 2011.

2.5 Land preparation

Repeated ploughing with power tiller and country plough was done on 07 November 2011 and the layout of the experiment was done as per statistical design. Liming was done and the liming material was incorporated to soil by spading. Final land was prepared on 27 November 2011. Ploughing was followed by laddering in order to break clods as well as level the land. All weeds, stubbles and crop residues were removed from the experimental field.

2.6 Experimental design

The experiment was laid out in a Randomized Complete Block Design. All the treatments were replicated three times. There were altogether 18 (6×3) unit plots, each plot measuring 2.5m × 4 m. Inter-block and Inter-plot spacing were 0.7m and 0.5m respectively.

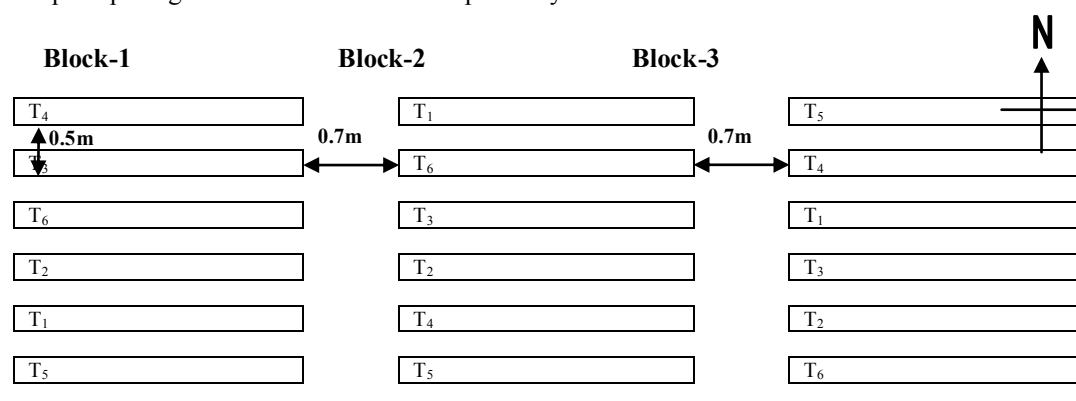


Figure 01. Layout of the experimental plot.

2.6 Treatment

T₁ : Control, T₂ : 0.5 t lime ha⁻¹, T₃ : 1.0 t lime ha⁻¹, T₄ : 1.5 t lime ha⁻¹, T₅ : 2.0 t lime ha⁻¹, T₆ : 2.5 t lime ha⁻¹

2.7 Fertilizer application

The total amount of urea, TSP, MOP, gypsum, zinc sulphate (monohydrate) and boric acid were applied on the basis of Soil Test value during final land preparation. Nitrogen was applied @ 140 kg ha⁻¹ from urea, P @ 5 kg ha⁻¹ from TSP, K @ 106 kg ha⁻¹ from MOP, S @ 3.06 kg ha⁻¹ from gypsum, Zn @ 3.6 kg ha⁻¹ from zinc sulphate (monohydrate) and B @ 0.6 kg ha⁻¹ from boric acid. Urea was applied in two splits, 2/3 was applied during final land preparation and rest 1/3 was applied 20 days after sowing. The fertilizers were incorporated to soil by spading one day before sowing.

2.8 Sowing of seeds

Seeds were sown in 28 November 2011, the seed rate being 125 kg/ha. Sowing was done continuously in 20 cm apart lines covered by soil manually.

2.9 Intercultural operations

Intercultural operations were done to ensure normal growth of the crop. The following intercultural operations were followed:

2.10 Irrigation

Three irrigations were applied, the first irrigation after 18 days of sowing, second irrigation after 29 days of sowing at crown root initiation stage and the third after 62 days of sowing at heading stage.

2.11 Weeding

Weeding was done twice during the whole growing period, the one after 19 days of sowing and the other after 38 days.

2.12 Insect and pest control

During maturation, four plots were slightly infested by field rat and the pest was controlled instantly by using mechanical control measures and application of zinc phosphide.

2.12 Harvesting

The crop was harvested at maturity after about four months of sowing (March 25, 2012). For data collection, ten plants from each plot were sampled randomly. The crop was cut at the ground level. Threshing, cleaning and drying of grain were done separately for every plot. Then plot-wise weights of grain and straw were recorded.

2.13 Data collection

Data were collected on the following yield and yield components.

2.14 Plant height

The plant height was measured from the ground level to top of the spike. From each plot, height of 10 plants were measured and averaged.

2.15 Number of tillers plant⁻¹

Ten plants were selected from each plot randomly. The number of effective and non-effective tillers plant⁻¹ was counted and averaged.

2.16 Spike length

Length of spike of ten plants per plot was recorded and averaged.

2.17 Grains spike⁻¹

Ten spikes were selected and the filled and unfilled grains spike⁻¹ were recorded and averaged.

2.18 Thousand grain weight

Thousand grains were randomly selected from each plot and the weight of grains was recorded after sun drying by an electrical balance.

2.19 Grain yield

Grains from each unit plot were dried and then weighed carefully. The results were expressed as kg ha⁻¹ on 14% moisture basis.

2.20 Shoot and Root weight

Like grain yield, biomass and dry weight of shoot and root for individual plot were recorded and expressed as kg ha⁻¹.

2.21 Harvest Index

- I. About 15 percent moisture in grain.
- II. Grains in hard dough stage.
- III. Yellowing of spikelets.

2.22 Statistical analysis

The data were analyzed statistically (Gomez and Gomez, 1984) by F-test to examine whether the treatment effects were significant. The mean comparisons of the treatments were evaluated by DMRT (Duncan's Multiple Range Test). The analysis of variance (ANOVA) for different parameters was done by a computer package programme "MSTATC".

III. RESULTS AND DISCUSSION

3.1 Effect of liming on growth and yield contributing characters of wheat

Table3. Effect of lime on growth and yield contributing characters of wheat.

Treatment	Plant height (m)	Tillers/ Plant (no.)	Spike length (m)	Grains/ Spike (No)	1000 grain wt. (g)	Yield (t/ha)
T ₁ : Control	0.88	1.88	6.35	28.33	29.00	2.71
T ₂ : 0.5 t lime ha ⁻¹	0.98	2.03	7.57	30.67	45.00	3.41
T ₃ : 1.0 t lime ha ⁻¹	1.10	2.99	9.15	33.00	57.00	3.89
T ₄ : 1.5 t lime ha ⁻¹	1.10	4.77	11.82	42.33	72.67	4.73
T ₅ : 2.0 t lime ha ⁻¹	1.08	3.86	10.08	36.00	53.00	4.49
T ₆ : 2.5 t lime ha ⁻¹	1.03	4.20	9.26	35.67	57.67	4.29
LSD	-	-	-	-	-	-
CV %	-	-	-	-	-	-

The figures having common letter(s) in a column are not significantly different by DMRT at 1% level.
LSD= Least Significant Difference, C. V. = Coefficient of variation.

3.1.1 Plant height

Liming effect on plant height of wheat was found statistically significantly different and the application of different rates of lime significantly increased the plant height of wheat (Table 3 and Fig. 02). Plant height of wheat progressively increased with increase in lime rates. The plant height ranged from 0.88 m in T₁ (control) treatment to 1.10 in T₄ treatment. The highest plant height recorded in T₄ was significantly comparable to those obtained in T₅ and T₆, but T₄ and T₅ treatments are statistically identical. All the treatments T₁, T₂, T₃ and T₆ differed statistically from each other in terms of plant height. On the otherhand, another observation of this result where plant height was highest in the treatment T₄ (1.1m) and grain yield also highest was found in same treatment T₄ (4.73 t/ha). The grain yield of wheat was positively correlated with number of tillers plant-1 character.

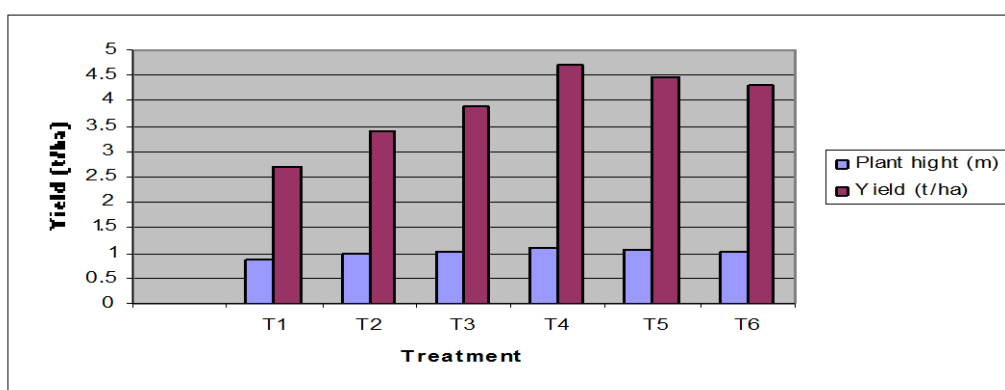


Figure 2. Relationship between plant height and yield with different lime rates.



Plate 01. Measurement of wheat plant height with scale after harvest.

3.1.2 Tillers plant-1

Liming effect on number of tillers plant-1 was found statistically highly significant (Table 3). The highest number of tillers plant-1 (4.77) was found in T₄. The lowest number of tillers plant-1 (1.88) was found in T₁. The number of tillers plant-1 in T₅ was identical to those found in T₆, and also identical was found in T₁ and T₂. The treatment was superior to T₄, T₅ and T₆ in recording the number of tillers plant-1. The number of tillers plant-1 in T₄ and T₆ was statistically superior to tillers plant-1 recorded in T₁, T₂, T₃ and T₅ treatments. The number of tillers plant-1 of wheat was affected due to changes in soil properties through liming. The grain yield of wheat was also found in highest in the treatment of T₄ (4.77 t/ha). The grain yield of wheat was positively correlated with number of tillers plant-1 characters.

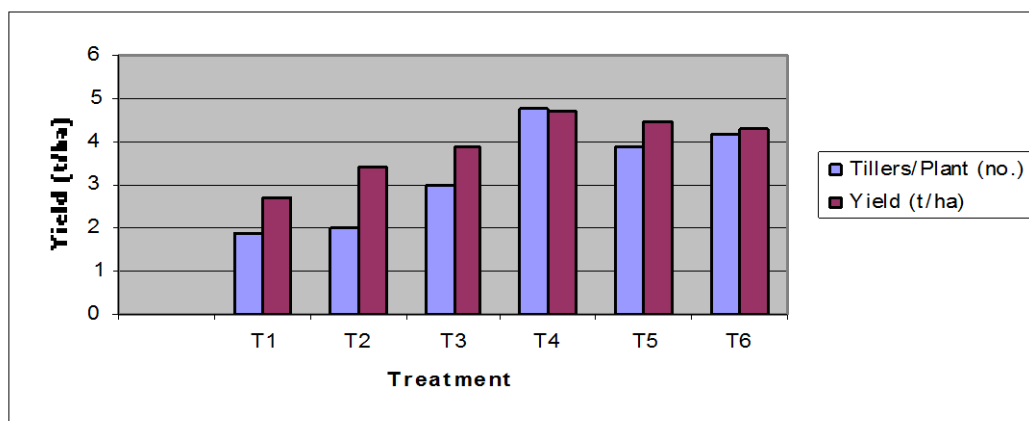


Figure 3. Relationship between tillers plant-1 and yield with lime rate.

The result is in agreement with Sharma et al. (2000), they reported that limes application significantly increased yield of mungbean. Samia(2007) also agreed with this result, she found that Liming effect on number of tillers plant-1 was significantly influenced by the different treatments of lime. The number of tillers per plant by different treatments varied from 2.09 to 4.03.

3.1.3 Spike length

Spike length of wheat was found significantly different due to the increasing amount of lime application (Table 3). Spike length of wheat ranged from 6.35 to 11.82 cm, tallest spike was found in T₄ treatment which is not statistically similar to others treatment. The treatment T₅ recorded the spike length of 10.08 cm which was comparable to those found in T₃ and T₆ treatments. The treatment T₄ was statistically superior to T₃, T₅ and T₆ treatments in terms of spike length. The grain yield of wheat was positively correlated with spike length characters.

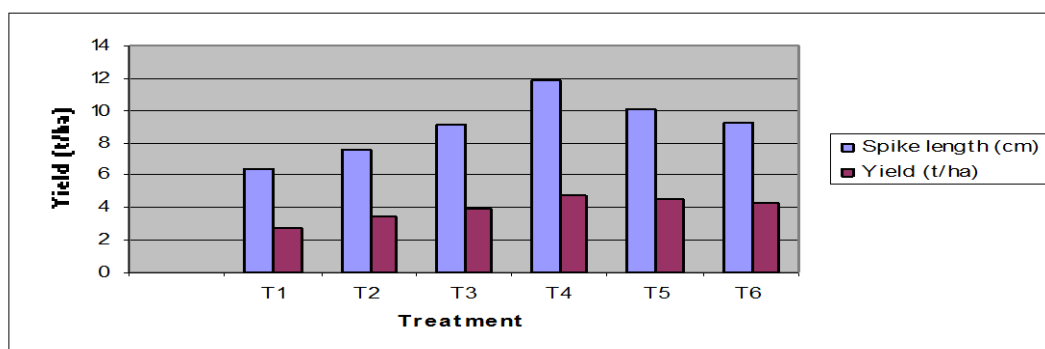


Figure 4. Relationship between spike length and yield with lime rate.



Plate 02. After harvesting of wheat plant spike length measured with scale. The result is in agreement with Sharma et al. (2000) and Samia(2007).

3.1.4 Grains spike-1

The number of grains spike-1 was also shown significantly variation due to different liming treatments (Table 3). The number of grains spike-1 of wheat ranged from 28.33 to 41.33. The highest number of grains was found in T₄ treatment which is not statistically similar to all the treatments. The treatments T₂ and T₃, and T₅ and T₆ recorded identical number of grain spike-1. Again the treatment T₃ recorded higher number grains spike-1 over T₂ treatment but they were statistically alike. The grain yield of wheat was positively correlated with the number of grains spike-1 characters Samia (2007) also agreed with this result, she found that liming effect of the number of grains spike-1 was significantly influenced by the different treatments of lime.

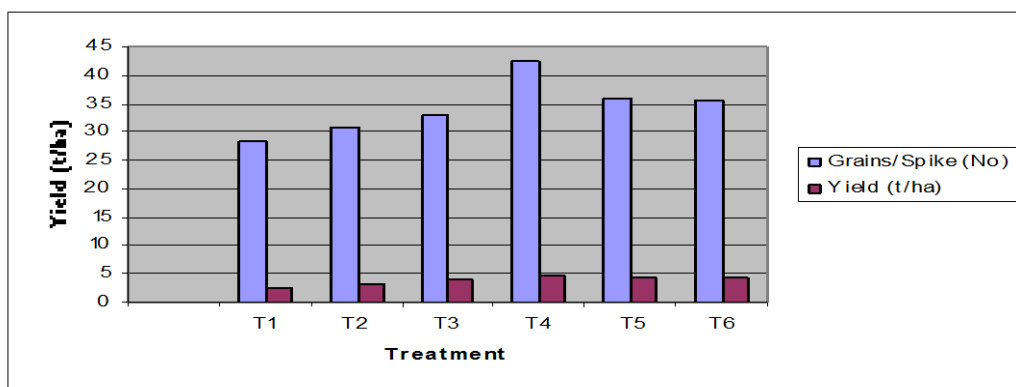


Figure 05. Relationship between grains spike-1 and yield with lime rate.

3.1.5 1000-grain weight

Liming had also shown significant effect on the 1000-grain weight of wheat (Table 3). The 1000-grain weight of wheat varied from 29.0 g to 72.67 g. The 1000-grain weight for T₄ was highest (72.67 g) and the lowest was in T₁ (29.0 g). The 1000-grain weight for T₆ was in 2nd highest (57.67 g). The 1000-seeds weight and grain yield of wheat was affected due to changes in soil properties due to liming. This result is agreed with Samia (2007) and Basak (2010), they reported that liming increased soil pH and availability of nutrients which increased the yield components of wheat and mungbean finally higher yields of wheat and mungbean.

3.1.6 Grain yield

Grain yield of wheat (var. Prodip) was significantly responded due to application of different rates of lime (Table 3). The highest grain yield was found in T₄ (4.73 t ha⁻¹) while the lowest was in T₁ treatment (2.71 t ha⁻¹). The rate of lime application 0.5 t ha⁻¹ (T₂) significantly increased the grain yield of wheat compared to control treatment. Application of lime increased grain yield of wheat to a considerable extent but application of lime at the rate of 1.5 t ha⁻¹ was optimum for desired yield of wheat in the study area. The application of 0.5, 1.0, 1.5, 2.0 and 2.5 t lime ha⁻¹ recorded 3.41, 3.89, 4.73, 4.49 and 4.30 t ha⁻¹ compared to lime control treatment (Table 3). The grain yield of wheat was positively correlated with different plant characters like plant height. The grain yield of wheat was affected by changes in soil properties due to liming. It appeared that liming increased soil pH and availability of nutrients which increased the yield components as well as yields of wheat. Caires et al. (2006) reported that surface liming caused increases up to 140% in the grain yield of wheat. Kisić et al. (2002) found that besides mineral and organic fertilization, liming also rendered significantly higher yields compared to the control and relatively higher yields than treatments involving mineral fertilizers. Jovanović et al. (2006) found that liming considerably influenced the yields of the field crops and single application of high rates was the better choice compared with repeated use of low rates. Similar observations were also reported by Miller (2000), Donahue (1981), Samia (2007) and Basak (2010).

IV. Conclusion

The different characters of wheat viz. plant height, tillers plant⁻¹, spike length, grains spike⁻¹ and grain yield were significantly increased by the application of lime. The application of 0.5 t lime ha⁻¹ significantly increased most of the growth parameters of wheat compared to that without any lime application. The application of lime had significant effect on the grain yield of wheat. The highest grain yield was found in T₄ (4.73 t ha⁻¹), which was statistically identical with the grain yields obtained in T₅ and T₆ treatments but superior to those found in T₁, T₂, T₃ treatments. Thus, the application of 1.50 t lime ha⁻¹ is enough for satisfactory yield wheat.

The results from this experiment showed that liming is necessary for wheat cultivation in the Amnura soil series of Sapahar Upazila of Naogaon District. The application of lime had positive impact on yield components resulted in higher yield of wheat. The application of 1.5 t lime ha⁻¹ appears to be optimum for wheat cultivation in the study area. However, further research may be carried out on the effects of lime on crops in different cropping patterns for a sustainable food production.

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Study Title: Economics of Mazri Making as Source of Livelihood in Nomadic Lifestyle of Balochistan, Pakistan

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Abstract: *The present study was conducted to chalk out socioeconomic characteristic, average per unit cost of production and average net return earned by the mazri producers. Mazri is a dwarf palm grows naturally in the dry tropical regions of Pakistan. Mates, ropes, bannns, ornamental products, different commodities for mosques, baskets, brooms, trays, hand fans, grain bins, cordage, cupboards and decoration pieces etc. are prepared from the foliage of this plant. Balochistan is the biggest producer of Mazri in Pakistan with an average annual production of 27,265 tonnes. About 65,000 people are directly are indirectly involved in the processing of mazri leaves, among which 78% of them are women. The involvement of women was quite active in mazri manufacturing. Most of the collection and harvesting task was performed by women. The results showed that Rs 118/- is the daily labor charges of a women working on mat making, which is far below than working anywhere else. There is no regular market of mazri, therefore the community is not availing its deserving amount of their produce.*

Key Words: *Mazri (dwarf palm), foliage, net return and cost of production, Balochistan*

I. Introduction

Mazri is the local name for dwarf palm (*Nannorrhops ritchiana*) and mazri, a small palm, is traditionally used for making various household and other utility articles, but is also very rich in fibres. It is a gregarious, tufted, and shrubby palm, growing naturally in dry tropical regions of Pakistan. Fibers of mazri are widely used for preparation of mates, ropes, bannns, ornamental products, different commodities for mosques, baskets, brooms, trays, hand fans, grain bins, cordage, cupboards and decoration pieces etc. Mazri palm is mostly found on either side of Suleiman range with the height ranging from 600-1100 m in sandy soil depressions [1], Jandia (Kalpani, District Mardan), Swat, Totakan, Anbar, Kohat, Bannu in NWFP, Qasoor, Gujrat, Kot Addu in Punjab, Khuzdar, Loralai, Harnai, Musa Khail etc. in Balochistan are the famous areas of Pakistan for their various decorating and fascinating mazri commodities.

Mazri is found in the wild in patches, while it is also cultivated in some areas of the country. About 65,000 people are directly are indirectly involved in the processing of mazri leaves, among which 78% of them are women [2], The women are doing most of the job starting from harvesting to finished product. Men and women with the help of sickle harvest the mazri foliage from the growing areas. Both fresh and dried leaves are used for product making. One leaf yield about 30 to 40 pieces and 5 kg of leaves produce about 4 kg of products with waste of 20% [3]. Average annual production of raw mazri leaves in the country is 37,315 tonnes in 1991-92 [4] and [5]). Balochistan is the biggest producer of mazri in Pakistan with an average annual production of 27,265 tonnes. It has been estimated that on an average a mazri worker can process more than 0.5 tones of raw mazri leaves per year [3]. Mazri leaves are distributed in various parts of the country through railways and trucks. About 3400 tons of mazri was produced in 1999-00 [6]. Mazri palm's production was reduced to 70% in 1999-00 compared to 1991-92. But according to [7], the production of Mazri increased to 95% as compared to that in 1999-00 i.e. 394,559 tons. The price of the mazri raw material (leaves) used in product preparation is Rs. 300-350 and 400-500 per 50 kg. in Khuzdar and Harnai districts of Balochistan, respectively. Average sale price of mazri leaves in the Kohat district is Rs. 100 per 40 kg [8] and Kalpani (Mardan) its price was Rs.200-220 per 50 kg [2]. There was a total export of mazri 126 million rupees in Middle East countries, etc. during 1991 from various products of mazri prepared by the rural people. There is more potential of exports than the Rs. 126 millions, if various products are properly marketed and supply is maintained through sustainable harvest [3], **Sources: EPB, 2001, ASP, 2001, Ziaul, 2001.**)

A segment of poor people from Balochistan are involved in this profession. Keeping in view the importance of the mazri products as a source of income for poor community, the present study was designed to assess the socioeconomic environment and mazri production system followed by the mazri producers, to estimate the average per unit cost of production incurred by mazri producers, and to chalk out the channels

involved in the production, marketing and product preparation of mazri and to compute average net return earned by the mazri producers.

II. Methodology

In order to achieve the study objectives, primary and secondary sources of information were used. The secondary data was collected from various sources such as libraries, Internet, NGOs etc. For primary information 50 mazri manufacturers were interviewed in Quetta district of Balochistan. Random sampling technique was used for the selection of respondents. Various steps involved in the manufacturing of mazri were analyzed. The economic analysis of the study was carried out. A team of agricultural economists from SSRI, Quetta conducted the survey in the month of September 2011. SPSS software was used for data analysis.

III. Results And Discussion

3.1 Socioeconomic Characteristics of Mazri Manufacturers

Socioeconomic information of mazri product producers revealed that an average age of respondents was found 40 years ranging from 25 to 60 years and 100% were found illiterate. Due to their mobility round the year, they cannot get their children enrolled in schools, which is one of the reasons that almost all of them were found illiterate. All professional/traditional people live in huts made of mazri in the suburb of the cities like nomads, without proper facilities of basic necessities of life. Joint family system was predominant among the sample respondents. It was revealed during the survey that 32 to 40 percent respondents were found much experienced in their field having an experience of less or more than 30 years. They narrated that their families are working in this profession since their forefathers and making mazri products as a customary work. The people move their dwelling round the year keeping in view season and market opportunities. In summer, they come to Quetta from the other cities of Balochistan, such as Lehri (22%), Jacobabad (36%), Nasirabad (2%), Dera Allah Yar (28%) and Sibi (12%). It was found common in almost all the nomadic families that they migrate in groups and it was found identical in this migrant group. Ninety percent of the farmers reported that they move in groups, which has certain advantages. Sharing the hiring cost of a truck for more than one family is economical and feels safe while traveling in groups. Some advancement in transportation mode has been recorded. Camels were used to be the source of migration in past, which was replaced by tractors trucks, buses etc. It is an indicator of their well being and change in life style. Most of the mazri farmers belong to "Jat" and some farmers were "Pashtoon" tribe found in the study area.

The involvement of women was quite active in mazri manufacturing within the community. Mostly prepared of mazri products task was performed by women. They were not only involved in home activities but were also found involved in supplementing household income for their families. Women belonging to low-income families make ropes, fans, baskets and mats and sell them to the traders.

3.2 Economic condition and level of income from the mazri business

The economic condition of mazri product maker peoples is lowering day by day. The source of income was found as primary source of income for livelihood, related with mazri business. The level of income from mazri products is decreasing day by day. The number of dependent persons per income is 8-10. Their monthly average income was ranging from Rs.8000 to 10000. Our result of related with mazri business people dependent persons and monthly average income comprises with results of [2]. They studied challenges faced to mazri palm: A case study of Jhandey, district Mardan" and found mazri product makers dependent persons and monthly average income almost similar in Jhandey areas.

3.3 Production of mazri

The production of mazri palm varies according to the favorability and suitability of climate, soil, and rainfall. The production of the foliage changes from season to season each year. The mazri palm production reduced to 70% in 1999-00 compared to 1991-92 [3], [4] and [5]). But according to [7], the production of mazri increased to 95% as compared to that in 1999-00 i.e. 394,559 tons. The domestication of different plants is increasing due to lesser availability of products extracted (explain) from the wild and some of the restrictions by government departments like "Mazri Control Act, 1953". In Balochistan, the mazri can be found in most of the hot climatic hilly areas. However Khuzdar, Barkhan, Musakhail, Loralai and Harnai are the areas where the plant is found in abundance. Mazri is a wild plant, which is not grown by the farmers like other agricultural crops. In past its foliage was harvested freely without paying any amount for it, but now it is not free of cost for the collectors, they have to pay for it in the Khuzdar district while Harnai district people was harvested free of cost.. Survey results revealed that mazri was mainly collected from Khuzdar and Harnai districts, However 12% of respondents who were collecting mazri leaves from Harnai district and 18%, 66% and 4% in Gaslati, Wadh Khuzdar and Quetta districts, respectively. Quetta is not a mazri producing area while the foliage is purchased

by the respondents in small quantity for manufacturing from the whole sale dealers. The whole sellers purchase the mazri foliage exported from other mazri growing districts.

3.4 Harvesting

The mazri respondents go for harvesting in groups of three to seven men and spend eight to ten days in the field to satisfy their demand of mazri foliage. There is no specific mazri harvesting date, but depends on the needs of people and magnitude of market value, but the mazri farmers normally harvest the foliage in the months of April to August. The plant of mazri is evergreen and can be harvested anytime of the year. Many professional mazri product makers reported that they stay in the Quetta maximum till five months, but a few respondents also reported four to six months stay in the Quetta. The Mazri harvesting and its enterprise are in transition stage. They carry the harvested foliage on camels to metallic road and load on trucks for further transportation. Because mazri plants are wildly grown in the hilly areas and there is no pave road to the fields of mazri. Due to these reason camels are mostly suitable for the transportation of raw mazri from the hills. The nearby market distances are also covered by camels by carrying their finish mats or other mazri products. But the far markets and distances are covered by relying on modern transportation network, as the extension of village roads to the major cities have made it possible.

3.5 Types of Product Prepared and main buyers of the product

Various types of product are prepared by the respondents i.e. mats, ropes, banns, decoration products, baskets and hand fans etc. But of all mat making is commonly practiced which is being operated hundred of years back. In ancient times, the nomads have developed their skill to convert mazri leaves into mats. These mats were initially used for tents. Later on this material was applied in constructing houses. Gradually this mate making became commercialized and a group of people adopted this profession as source of income. Mat making is a hard profession where one sits hours to work getting a reduced amount of reward. Some families are involved in this business since their childhood. Mat making is the sole responsibility of their female members and men can help hands to prepare other mazri products such as hand fans, sweeps, baskets, etc. The survey results revealed that a woman spend on at least six to eight hours daily for mat making despite of other household routine work such as cooking, washing clothes, cleaning etc. Men are responsible to provide the raw material and market the final products. Although mazri is almost free natural resource for earning income by applying skill into finish farm. Since then, no research work has been carried out to know the raw material source, its labor charges and return. Different sizes of mats were observed during the survey normal, medium and large. The size of 6x12 feet was considered the normal size 10x20ft medium and 15x25ft large. The normal size mat was prepared in one day by a woman; medium size took 1.12 days while large size could be completed by a woman in 3.16 days. They further replied that they can make any size of mats as per demand. The four dozen of sweeps was prepared in one day by a man.

During the survey, mostly buyers of the products are local and other districts of Balochistan people as most of the products are used for tent, ceiling, side of fruit trucks cleaning and other domestic problems. Summer season is always good for this business according to one of the respondents. Further; results show that daily mat sale was 1-3, 1-5 and 1-7 large, medium and normal size, respectively in the study area in the huge season. The normally soling of products good season was June to August.

3.6 Economic Analysis

The economical analysis describes the methods used in analyzing economic, behavior and the application of the result obtained to solve economic problem (David, 1979)

3.6.1 Capital Investment

Capital investment is the amount of money invested in some business. It provides the means of production like; raw material, tools and building etc. in the present study, Economics of Mazri Making as Source of Livelihood, initial investment has taken in to account (table 1). Average cost of mat making was obtained from the sample respondents and the estimated costs and earning benefits were analyzed. The respondents divided the mats into three different categories as per its sizes. The average expenditure for large mat was Rs.308; medium mat costs Rs. 154 and Rs. 67 for small size (normal) mat was calculated. This expenditure shows the mazri price that includes cost of mazri leaves, camel charges, treatment cost, rope cost and transportation cost.

Table No.1. Average cost of mat making

Size of mat	Rs/ mat	Total mats in per season (#)	Amount (Rs)
Large (15x25 ft)	308	61	18788
Medium (10x20 ft)	154	156	24024
Small (6x12 ft)	67	219	14673
Total Amount (Rs.)			57485

Source: Survey data, 2011-12

3.6.2 Costs of mazri products and migration.

The table below reveals a cost that is paid by the respondents regarding cost of mazri leaves, transportation, camel charges, treatment, ropes and the amount paid for migration. The average estimated cost of mazri products was Rs. 57485 and migration cost was Rs.11000. The total cost of mazri farmers incurred was Rs. 68485 in the study area table 2.

Table No.2. Cost of mazri leaves/89 bundles

Component Costs	Amount (Rs)
Cost of mazri leaves	21327
Cost of camel from field to main road	15232
Cost of transportation	18279
Treatment cost	1803
Rope cost	844
Migration cost	11000
Total Amount (Rs.)	68485

Source: Survey data, 2011-12,

Note: 80kgs/bundle weight of mazri leaves

3.6.3 The prices received by the mazri producers were analyzed and it was found that average price received for large size mat was Rs.963.75/-, medium size Rs. 514/mat and small (normal) size of Rs. 185.04/mat. The margin is equal to the labor charges. If we further analyze, the expenditure spent on small mat is Rs. 67 and is sold at Rs. 198 so the price margin is Rs 118. The small mat takes a single day for completion. The result showed that Rs 118 is the daily labor charges of a women working on mat making. These daily wages are far below than working anywhere else, but still they are going on with this mat making profession. However, presently the government has notified Rs 233/- daily wage for unskilled labor whereas mazri mat making is not a job of unskilled labor table 3.

Table No.3. Average prices received by the mazri producers

Size of mat	Rs/ mat/sweeps	Total mat/sweeps	Amount
Large (15x25 ft)	963.75	61	58789
Medium (10x20 ft)	514	156	80184
Small (6x12 ft)	185.04	219	40524
Sweeps made by wastage leaves	4	960	3840
Total Amount (Rs.)			183337

Source: Survey data, 2011-12

3.6.4 Costs, Revenues and Returns of mazri product

The gross value of output was composed of the value of mazri product estimated at farm gate price and the imputed value of the wastage leaves. The expenses incurred on mazri foliage and other costs were estimated in terms of imputed and purchased costs. Net income was estimated by deducting total cost from the gross value of output. It was found that the sample mazri producers had produced mazri product of average gross value amounting Rs. 183337/five months. The average mazri leaves, migration and other costs were estimated as Rs. 21327, Rs.11000 and Rs.36158, respectively, making total cost as Rs. 68485.

The overall net income per mazri producers was computed as Rs. 114852/season, during the five months. The returns to per rupee investment and returns to per rupee spent on mazri leaves costs were estimated as almost 167.70% and 759.65%, respectively. The further result shows that the revenue per day (rupees) was Rs.1222 (table 4). The percentage shares of cost on different groups of mazri leaves operations shows that mazri leaves and transportation costs constitute the highest share 57.83 percentage followed by a decreasing order of groups of mazri leaves practices as camel, migration, treatment and rope.

**Table No.4. Cost, revenue and return of mazri products in the study area of Balochistan.
(Per season)**

Component Costs	Amount (Rs)
Cost of mazri leaves	21327(31.14%)
Cost of transportation	18279(26.69%)
Cost of camel from field to main road	15232(22.24%)
Treatment cost	1803(2.64%)
Rope cost	844(1.23%)
Migration cost	11000(16.06%)
Total cost (Rs.)	68485
Gross revenue	183337
Net-income/season	114852
Net-income against mazri leaves costs (Rs./season)	162010
Returns/Rs investment (%)	167.70
Returns/Rs of variable cost (%)	759.65
Stay period of duration (days)	150
Revenue per day (rupees)	1222
Benefit Cost Ratio	1:2.6

Source: Survey data, 2011-12

IV. Conclusion:

In Pakistan, especially Balochistan has the potential for mazri and its products and can be increased manifold if major constraints are removed. The mazri working groups need to have some alternative sources for better livelihood. They have taken over this profession through inheritance from their forefathers. The people are hard working and they know the only skill of preparing mazri products. Mazri is an important plant and can play a vital role in the socioeconomic conditions of poor people of the rural areas. Many poor people of Balochistan are involved in this profession. It was reported by the farmers that several other products are made despite than mat from the mazri plant leaves, such as baskets, hand fans, sweeps, ropes, decoration item etc. Its leaves are used for the making of huts, shelters and roof construction. The plant parts are used as fuel wood. Dry leaves of mazri (*peesh*) are highly inflammable which are used for quick fire burning.

Mazri farmers were totally uneducated, because they migrate on traditional routes round the year. They come to Quetta from the other cities of the province like Lehri, Nasirabad (Teepul), Dera Allah Yar (Jhatpat), Harnai and Sibi. Mazri farmers reported that during the time of harvesting they face many problems such as mazri cutting and living in the mazri growing areas which is mostly in the hilly regions and there is no facility. The mazri framers go for cutting of mazri foliage in groups and they live 8-10 days in the mazri growing areas. Majority of the mazri farmers store mazri in the open fields which takes 4-10 days for drying up and further treatment. Women are responsible for mat making and men can help hands to prepare other mazri products such as hand fans, sweeps, baskets, etc. Marketing is very important for mazri products and they are not satisfied from the market prices. It has been reported that some mazri farmers have transformed their profession to agriculture farming/harvesting in their native places. The economic analysis of mazri products has been carried out based on primary data collected from the Quetta. The main problems in mazri products was identified are, self-cutting, loading/un-loading, high prices of mazri leaves, high price of transportation, fluctuating and lower prices, availability of good market for products and proper research on market development for mazri products. and poor financial problems.

V. Recommendations:

On the basis of study findings following recommendation are suggested for the improvement of this negated business of poor people.

- To set up an information and database.
- To arrange seminar for the betterment of this industry with the involvement of mazri community.
- Government/ NGOs should arrange better marketing facilities for mazri products within and out of country in order to maximize the income of the product makers.
- PARC with the involvement of provincial research institute should take initiatives for the plantation of mazri as a field crop, in order to save the natural vegetation and to lessen down the problem faced by the mazri manufacturers.
- In this modern age of technology, mazri farmers were using traditional methods. It may be due to illiteracy and unawareness; there for extension services may be made more effective for mazri farmers.
- Proper advertisement and exhibition for the promotion of products as well as local people should be intercede.
- There is need to promote the products both at national and international level, which will ultimately increase the income of the people and conservation of Mazri palm.

- Training on sustainable production should be imparted to the local people for improved quality of produce
- There is pressing need of credit facilities. Government should provide loan to the mazri producers without any interest for the purchase of mazri.
- Excess to schools and hospitals must be provided to the mazri producers in their premises. Mobile schools can bring their children educated if such facility is extended to mazri makers

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Comparative Analysis of Organic and Inorganic Food

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Abstract: Increased use of chemicals, under intensive cultivation has disturbed the harmony existing among soil, plants and animals and human health. The extensive use of chemicals and antibiotics in inorganic food production technology has compelled the health conscious people to explore and support organic farming. The study reveals the fact that the food produced using organic methods taste better and contains a better balance of vitamins and minerals than inorganically grown food. The eating of organic food considerably reduces the heart attacks, strokes, cancer, bowel cancer, and many other diseases. Hence, importance of organic farming has increased due to its environmental friendly methods and growing consumer awareness of food safety. The role of the Government is critical in motivating the farmers switching over from inorganic farming system to organic farming system where organic farming is economically viable in the country. Besides, the government has to take appropriate measures like the separate market for organic products; announcement of support price, creation of demand by more awareness programmes, subsidy for organic inputs producers, subsidies for encouraging organic farmers; certification of farms and increase in investment on research and development activities in organic farming practices.

Key words: Organic Farming System, Inorganic Farming System, eco system, sustainability, food security, certification

I. Background

Agriculture sector in India has undergone significant structural changes. Inorganic farming has made the farmers of today searching for something better, in addition, farmers are pursuing chemical supplements to push crop yield, which is only harming the earth. Farmers and communities faced many socio-economic problems, particularly small farmers who found themselves increasingly marginalized due to lack of access to external inputs (Yasin 2007). Their soil is depleted from the constant application of harsh and harmful chemicals. This is particularly true in its heavy reliance on chemical fertilizers and pesticides, it depends upon subsidies and price support and external costs such as threat to other species, environmental pollution, habitat destruction and risks to human health and welfare. Besides, increase incidence of miscarriage, birth malfunctions, still births and delayed pregnancy have been documented among women agricultural workers and wives of men employed in pesticide mixing and spraying (Ranson, 2002). In this background, the solution for this problem and ills of IFS now lies in Organic Farming System (OFS) a strong feeling world-over.

Organic agriculture in general is a system of crop and livestock production that promotes and enhances the health of agricultural ecosystem while providing healthy food and reflects the profound inter relationship that exists between farm biota, its production and the overall environment. Therefore, the extensive use of chemicals and anti-biotic in inorganic food production technology has compelled the health conscious people to explore and support organic farming methods in agriculture. It is generally believed that organic farming with its central focus on maintaining and improving soil health, its avoidance of pollutants, and its reliance on local inputs and labour could materially advance the economic and ecological health. Organic farming can contribute to sustainable food security by improving nutrition intake, supporting livelihoods in rural areas and enhancing biodiversity while simultaneously reducing vulnerability to climate change. In this context, the study has been undertaken to compare the quality of food produced under organic farming and Inorganic Farming Practices.

II. Objectives of the Study

The study is based on the following specific objectives

- To know the concepts of organic and inorganic farming.
- To study the quality of organic and inorganic food.

III. Methodology of the study

The study is based on secondary data which have been collected from the Government reports, national and international journals etc. In this study, the use of inorganic inputs in production of crops and rearing animals in agriculture is called conventional or modern or chemical, or inorganic agriculture, but from here onwards, it is termed as inorganic farming. On the other hand, the application of organic or natural inputs

in the farm operations is known as organic or biodynamic or natural or biodynamic organic agriculture but it is termed as organic farming. Some of the important studies related to this area of the study have, therefore, been summarized under the following headings.

IV. Organic versus Inorganic Farming

Organic farming though is not a 'new' concept; it was marginalized against the large-scale inorganic based farming practices that have steadily dominated food production over the years (50 years). The difference between organic and inorganic farming accounts for the most of the controversy with claims and counter claims surrounding organic agriculture methods and organic food. They are as follows;

Terry Cacek and Lind, L Langer (1986) have distinguished the organic farming from inorganic farming in the following ways. The term inorganic farming refers to a production system which employs a full range of pre and post-plant tillage practices (eg. plow, disk, plant, cultivate), synthetic fertilizers and pesticides. Therefore, inorganic farming is characterized by a high degree of crops specialization. By contrast, organic farming is characterized by a diversity of crops. Organic farmers need to borrow less money than inorganic farmers do because organic farmers buy fewer inputs such as fertilizers and pesticides. Moreover, costs and income are more evenly distributed throughout the year on diversified organic farms. The technology used in organic farming is nature based, environment friendly and sustainable. However, inorganic farming is based on synthetic fertilizer which is harmful to environment.

Subhash Chand and Sunil Pabbi (2005) made difference between organic and inorganic farming in the following ways. Products produced by organic farming are good in taste, flavor, nutritional and free from chemicals whereas products produced under inorganic farming are tasteless, less nutritious, may contain toxic residues of chemicals. Organic farming may not lead to higher production and income in the short-run as its returns are of a long-term nature. However, inorganic farming leads to higher production and income in the short-run and returns are declining in the long run. Therefore, returns from organic farming are of a long-term nature whereas returns are of short-run nature under inorganic farming.

It is increasingly felt that inorganic farming is becoming unsustainable as evidenced by declining crop productivities, damage to environment, chemical contaminations. The necessity of having an alternate agriculture method which can function in a friendly eco-system and could sustain the crop productivity is widely spread. Hence, organic farming is recognized as the best know alternative to the inorganic agriculture.

V. Quality of Organic and Inorganic Food

The quality and superiority of organic food production over inorganic food production has been reviewed as under.

Organic farming is becoming increasingly popular not only in India, all over the world. Many consumers are feeling disillusioned from chemically produced foods and are started to make the effort to buy organic food. The reasons are; their concern for the family members as well as the health of the environment. The good taste and nutritional value of organic food also attract the consumers. Inorganic agriculture uses a wide range of synthetic chemicals that inevitably leave residue in the produce: There are more than 130 different classes of pesticides containing some 800 entries (Plimmer, 2001). Pesticides residues enter the food chain via four main routes; on-farm pesticide use, post-harvest pesticides use, pesticide use on imported food and cancelled pesticides that persist in the environment (Kuchler et al., 1996). According to WHO estimate approximately one million people are taken ill every year with pesticides poisoning and up to 20,000 of them die in agony and a variety of reproductive health impacts on women. Increased incidence of miscarriage, birth malfunctions, still births and delayed pregnancy have been documented among women agricultural workers and wives of men employed in pesticide mixing and spraying (Ranson, 2002). This is mainly due to overuse or misuse of chemicals, particularly synthetic insecticides, fungicides, herbicides, fertilizers, plant growth regulators etc that resulted in undesirable side effects not only in the agro-ecosystems, but also on human health and life systems of beneficial fauna and microorganisms. Further, the Inorganic farming's benefits have come at the cost of extensive environmental degradation and considerable health problems due to exposure to agro-chemicals. The toxic residues poison the body slowly causing intensive damage to human body; the food products containing toxic pesticides residues cause heart disease, brain, kidney and liver damage and even cancer, limb deformities and poor eyesight. Thus, the extensive use of chemicals and antibiotics in inorganic food production technology has compelled the health conscious people to explore and support organic farming.

Now a day's all over the world, food safety is receiving more attention than ever before by governments and policy makers, health professionals, the food industry, the biomedical community and last but not least, the public (Crutch field and Roberts, 2000). The multiple factors have been associated with the preference for organic food that, in general, reflect an increased interest towards personal health, animal welfare and environmental protection (Makatouni, 2002). Health-related issues seem to assume greater importance than other concerns and notions about food safety are fundamental for purchasing organics (Magnusson et al., 2003;

The United Kingdom Parliament, 1999; Lohr, 2001; Harper and Makatouni, 2002; Beharrell and Mac Fie, 1991).

A study based on data collected by the US government found pesticide residues on 23 percent of organic fruits and vegetables and nearly 75 percent of conventionally grown produce, though the residues in all the samples well below statutory limits (Baker et al., 2002). A study of three apple production system (organic integrated and conventional) in Washington state assessed their impact on some factors in all three dimensions of sustainability. They concluded that organic production systems were more profitable, had a lower environmental impact and produced sweeter and less tart apples (Reganold et al., 2001).

There is a widespread belief that organic food is significantly healthier and safer than inorganic food and consumers are willing to pay significant price premium to obtain it (Beharrell and Mac Fie, 1991). Organic farming uses almost exclusively biological and natural materials and processes to produce food. The practice aims to protect human health and conserve or enhance natural resources, with the goal to presume the quality of the environment for future generations while being economically sustainable. Hence, farmers are converting to organic methods for a variety of reasons but the most important have to do with a general unease with the health and environmental impacts of conventional practice, increasing disease and pest problems and the expectation that organic methods might be more profitable (Blobsaum, 1983; Kramer, 1984; United states GAO, 1990; MacRae et al. 1990).

Singh and Dinesh Kumar (2007) have explained organic farming vis-à-vis human health and environment. The study revealed that organic farming was superior to conventional farming or chemical farming in terms of pollution free environment, good quality of food and health: conventional farming was produced food and fodder by using chemical fertilizers and pesticides, which contaminated the food, health hazardous and environment pollution. Besides, organic farming produces good quality of food, by using different plant nutrition, weed management, pest and disease management so that eating of organic food considerably reduces the heart attacks, strokes, cancer, bowel cancer and many other diseases.

Faido Magkos et. al., (2006) reported the critical and transparent overview of organic food safety to identify potential drawbacks in organic food production. The results revealed that food safety of organic verses conventional produce is difficult because of divergent conditions prevailing in terms of soil, water, climatic conditions. Organic food is not free from pesticides. However, fruits and vegetables are grown under organic farming can be found much less agrochemical residues than their conventional alternatives. Further, the health risk associated with dietary exposure to agrochemicals remains to be evaluated. Organically cultivated nitrophillic vegetables viz. leafy root and tuber were found lower content than the respective conventional ones.

Pragya Agarawal et. al., (2007) compared the quality characteristics and sensory quality in fresh green peas grown by organic, inorganic and integrated methods at Govind Ballabh Pant University of Agriculture and Technology, Pantnagar. The study found that no significant difference was observed in terms of pod length but significant difference was observed in number of seed per pod that was higher in pea grown by integrated method of cultivation. The organically grown peas scored higher total sugar, sweetness, colour, flavor and taste, besides in terms of minerals; organically grown peas had higher copper and zinc levels as compared to inorganically grown peas and peas grown by integrated method of cultivation.

Thakur et. al., (2003) examined the comparative economics of organic produce (OFS) vis-à-vis inorganic produce (IFS) in the backward and tribal hilly area of Himachal Pradesh, India. The study revealed that the poisonous and toxic inorganic chemical inputs used under IFS have turned out to be highly destructive, injurious and harmful causing large scale polluting and poisoning of soil, water, air ecosystem, agro-ecosystem, environment, plants and crop produce which in turn, induce many deadly diseases including cancer. The organic produce or organic food is best for health; more nutritious of better quality, free and safe from toxic inorganic chemical residues, looks fresh and good and tastes delicious. Hence, the health conscious buyers and consumers are buying organic produce at very high premium prices which are generally 3-4 times higher depending upon products.

In Japan, similar study was conducted by Yukio Yokoi (2002) on the policy development of organic agriculture and future perspectives. The study revealed that the public greatly concern about food safety issues owing to the recent incidents of mad cow disease (Bovine Spongiform Encephalopathy) and the detection of excess pesticide residues and the use of prohibited pesticides. Hence, policies on organic agriculture and organic food have been developed in terms of the "JAS Organic" (Japanese Agricultural Standards) accreditation system and technological support of organic farming.

Wiebel et. al., (1999) assessed fruit quality in golden delicious apple from five organic farms and five farms using integrated production methods. They found that in terms of taste, firmness, dietary fiber and phenolic compound contents, fruits from organic farms outperformed the others. Hogstad et al., (1997) examined sensory quality and chemical composition of carrots from designed trials and from organic and conventional farms. The data were analyzed using principal components and partial least squares regression to identify the main factors responsible for variation in quality. One of the most important factors was fertilizers

application. Carrots grown with fertilizer, low levels of mineral fertilizer or with organic fertilizer, had more total sugars, stronger flavor but less crispness, protein and carotene than carrots grown with high levels of mineral fertilizer.

VI. Conclusion

Agriculture is a critical sector of the Indian economy. Increased use of chemicals, under intensive cultivation has disturbed the harmony existing among soil, plant and animal and human health. The extensive use of chemicals and antibiotics in inorganic food production technology has compelled the health conscious people to explore and support organic farming. World organic food consumption has grown at a rate of 25 percent per annum in the last decade and it is expected to grow more than 15 percent of total food consumption in future. Moreover, the findings of the literature-reviewed reveals the fact that food produced using organic methods are taste better and contain a better balance of vitamins and minerals than inorganically grown food. The eating of organic food considerably reduces the heart attacks, strokes, cancer, bowel cancer and many other diseases. Hence, importance of organic farming has increased due to its environmental friendly methods and growing consumer awareness of food safety. The role of the Government is critical in motivating the farmers switching over from inorganic farming system to organic farming system where organic farming is economically viable in the country. Besides, the government has to take appropriate measures like the separate market for organic products; announcement of support price, creation of demand by more awareness programmes, organic inputs/subsidies for encouraging organic farmers; certification of farms and increase in investment on research and development activities in organic farming practices.

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Effect of different levels of sucrose on microtuberization and different substrates on minituber production resulted from potato meristem culture

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Abstract: The present research work was undertaken to choose the most effective sugar concentration in *in vitro* microtuberization from cultured shoot tips and to select the best substrates for minituber production from *ex vitro* transferred plantlets. Percentage of survivability of microtuber producing plants increased with the increase of sucrose concentration. Best survival rate and average diameter of tuber per plant was found at 10% sucrose. Minituber production on direct field showed best performance. It was observed that after 30 days, maximum shoot length per plant (188.87 mm) was found on the direct field whereas the lowest shoot length per plant (66.81 mm) was on coconut dust. Lowest weight of tuber per plant was also recorded on the substrates containing coconut dust. The highest weight of tuber was found in direct field. In case of, average diameter of tuber per plant, 25% soil + 75% coconut dust showed minimum result and on the other hand, in direct field, large size of tubers were found.

Key words: Microtuberization, Minituber, *In vitro*, *Ex vitro*, Potato

I. Introduction

Microtubers ("in vitro" developed tubers) are miniature seed potatoes and they represent an intermediary phase between "in vitro" plantlets and minitubers. Microtubers are the first generation of potato seed from tissue culture, being used to solve the problems of transplanting the plantlets from "in vitro" to "in vivo" conditions. The microtubers offer a lot of advantages to storage, transport and mechanization due to their little size and reduced weight. They can be planted directly in the soil and they can be produced in any period of the year. Microtuber production "in vitro" is very important for producing and storage of valuable seed potato stocks.

Potato microtubers obtained by "in vitro" culture from single-node cuttings are convenient for handling, storage and exchange of a healthy germplasm, representing an important component, along with plantlets and minitubers, for seed potato production programs (Roşu R., 2004). Microtuber production represents in the same time an efficient method for obtaining a healthy material, by which the process of production is reduced with 3-4 years. The sucrose is the most critical stimulus for tuber induction (Wang, 1982 and Abbott, 1986), as results from the review of Struik (1999), regarding induction, initiation and growth of potato tubers. The high sucrose concentrations are essential for "in vitro" microtuber induction, influencing this process through the osmotic effect and by serving as energy source (Simko I. 1994, Perl A. 1991, Struik PC.1999)

Minitubers are generally produced in the greenhouse in many countries around the world. The source of material is either the plantlets developed inside the growth chamber of tissue culture laboratory or the already produced mini or micro tubers in the greenhouse and in the laboratory, respectively. Greenhouse should be facilitated with temperature, light, humidity and air circulation for the production of minitubers.

In *in vivo* condition average tuber weight and tuber number were determined as different depending on the production technique (Struik, 1999). Khuri *et al.*, (1995) found that the tuber numbers of various potato cultivars were between 6.2 to 7.9 in plantlets grown in polyethylene bags. Present research work has been undertaken to fulfill the following specific objectives to choose the most effective sugar concentration in *in vitro* microtuberization from cultured shoot tips and to select the best substrates for minituber production from *ex vitro* transferred plantlets.

II. Materials and Methods

2.1 Experimental site:

The experiment was carried out at the Plant Tissue Culture Laboratory of Agrotechnology Discipline, Khulna University, Khulna-9208, Bangladesh, during April 2010 to January 2011.

2.2 Type of explants:

In vitro grown potato explants were used as source materials for microtuberization and minituber production.

2.3 Constituents of media for microtuberization of potato:

For microtuber formation, MS medium supplemented with BAP-5.0 mg l⁻¹, Chloro Choline Chloride (CCC)-500 mg l⁻¹ and different concentrations of sucrose-5%, 6%, 7%, 8%, 9%, 10% is used.

2.4 Substrates used in pots for minituber formation:

Following substrates were employed for minituber production:

- | | |
|----------------------------|-----------|
| 1. Soil | 100% |
| 2. Sand | 100% |
| 3. Coconut dust | 100% |
| 4. Soil : Sand | 50% : 50% |
| 5. Soil : Coconut dust | 25% : 75% |
| 6. Soil : Coconut dust | 50% : 50% |
| 7. Soil : Coconut dust | 75% : 25% |
| 8. Directly into the field | |

2.5 Experimental design

All the experiments were laid out in a Completely Randomized Design (CRD) with five replications for each treatment. In that case, a plastic pot containing different substrates with a single healthy plant was considered as a replication.

2.6 Procedure for microtuberization

After taking all the precautions to ensure aseptic condition, *in vitro* grown healthy plantlets were selected for further inoculation. All inoculation and aseptic manipulations were carried out under a laminar airflow cabinet. plantlets were removed carefully and cut the shoot tips measuring 2 cm in length. Then they were placed onto nutrient media containing test tubes for microtuberization.

After inoculation of the explants, the microtuber induction cultures were incubated in the dark at 24°C and relative humidity 65%, maintaining a temperature of 18° C. Microtuber was first observed at 35 days after inoculation.

The experiment was laid out in a Completely Randomized Design (CRD) with ten replications. A test tube (15 cm length) containing 15 ml medium with a single shoot tip of potato was considered as a replication.

2.6 Procedure for minituber production

For minituber production of potato, *in vitro* cultured plants were transplanted into plastic pots (4 inch size) with different substrates (soil, sand, coconut dust and their different combination) and some were directly into the field. Soil, sand and coconut dust were autoclaved at 121° C for 15 minutes before transplantation. After proper mixing of different substrates according to each treatment, they were kept in plastic pots. Few minutes later after watering, plants were transferred into pots. Transferred plants were placed into growth chamber with 85% humidity for 24 hours. After that, they were kept in net house.

2.7 Parameters studied and data collection

To study the effect of different sugar concentrations on *in vitro* microtuberization,

- survivability of plant,
- percentage of plant producing microtuber,
- no. of microtuber per plant and
- average diameter of tuber per plant were measured.

After 20 days interval, data were collected.

For experiment of *ex vitro* minituber production, data were collected by measuring

- percentage of survivability of plants up to 30 days,
- leaf color,
- shoot length per plant,
- no. of tuber per plant,
- average diameter of tuber per plant and
- average weight of tuber per plant.

Leaf color of every plant was observed visually.

2.8 Analysis of data

Recorded data for all of the experiments were analyzed for ANOVA (Analysis of Variance) with the help of computer using MSTAT-C program and the means were compared according to Duncan's Multiple Range Test (DMRT) and Least significance Differences (LSD).

III. Results and Discussion

The results of the experiments (Table 1) revealed that the percentage of plants producing microtuber increased with the increase of sucrose concentrations. Percentage of survivability also increased with the increase of sucrose concentration. The highest survival rate (80%) was found at 10% sucrose. The highest number of microtuber was 2.17 observed on 10% sucrose where as the lowest number was 1.33 at 6% sucrose. In case of average diameter of tuber plant⁻¹, it was observed that 10% sucrose showed best result. Average diameter of tubers varied from 3.12 mm to 5.11 mm irrespective of sucrose concentrations.

Table 1. Effect of different sucrose concentration in presence of BAP (5 mgL⁻¹) and CCC (500 mg L⁻¹) on *in vitro* microtuberization from cultured shoot tips.

Sucrose concentration (%)	Survivability (%)	Plants producing microtuber (%)	No. of microtuber plant ⁻¹	Average diameter of tuber plant ⁻¹ (mm)
5	50	40	2	3.12
6	50	40	1.33	3.91
7	50	50	1.5	4.44
8	60	60	2	4.50
9	70	60	2	4.62
10	80	70	2.17	5.11
Level of significance	NS	NS	0.01	0.01
LSD	-	-	1.363	2.285

Sucrose has been established as prime component for potato micropropagation (Khuri and Moorby, 1995). There have been several reports comparing the effects on micropropagation of a range of sucrose concentrations and established that 3% sucrose was the optimum level for *in vitro* potato micropropagation (Pruski *et al.*, 2003). For optimal plantlet growth, sucrose level sustainability are necessary and if it is rapidly hydrolyzed into glucose and fructose making the long term maintenance of desirable sucrose level is difficult. The present investigation was tended to find out the effect of sugar level on microtuberization and found that microtuberization increased with the increasing sugar level and the optimum concentration was 10% sucrose which was dissimilar to Pruski *et al.*, (2003).

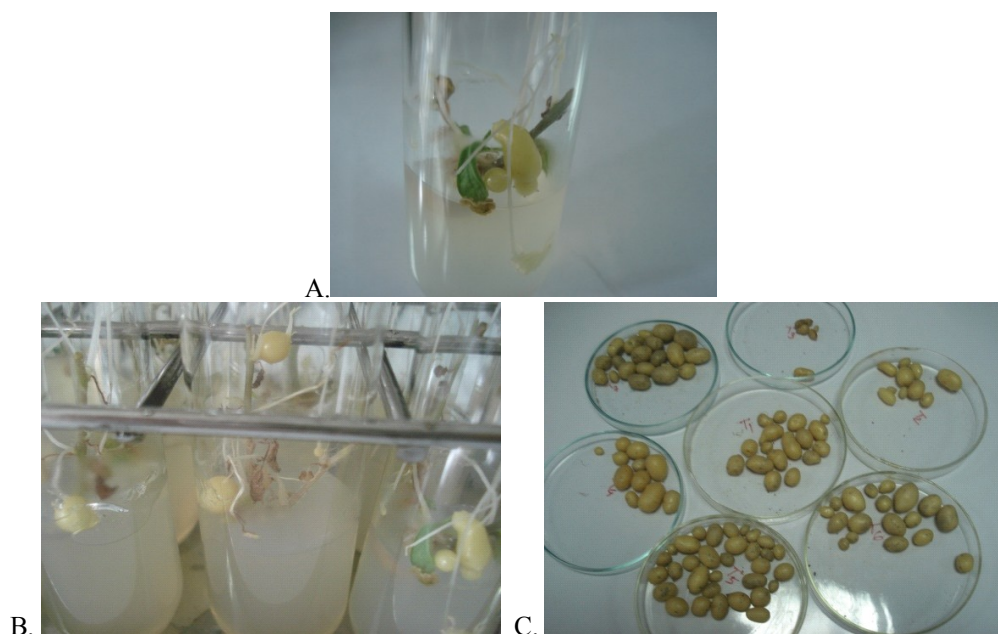


Plate 1. Effect of sucrose on *In vitro* microtuberization. A. Microtuber formation at 5% sucrose. B. Microtuber formation at 10% sucrose. C. Harvested Microtubers from *in vitro* grown plantlets.

In vitro grown potato plantlets were carefully removed, washed and planted into different substrates to investigate *ex vitro* performance of plants and performance of minituber production. Survival rate of plants after 30 days was found similar for all substrates whereas, leaf colors of plants vary from substrates to substrates.

Minituber production on direct field showed best performance. It was observed that after 30 days, maximum shoot length plant⁻¹ (188.87 mm) was found on the direct field whereas the lowest shoot length plant⁻¹ (66.81 mm) was on coconut dust. Average weight of tuber plant⁻¹ varied from 0.77 gm to 6.17 gm irrespective of different substrates. Lowest weight of tuber plant⁻¹ was recorded on the substrates containing coconut dust; although soil, sand, coconut dust, 50% soil + 50% sand, 25% soil+ 75% coconut dust, 50% soil + 50% coconut dust and 75% soil + 25% coconut dust were found statistically similar effective for weight of tuber. The highest weight of tuber was found in direct field. In case of, Average diameter of tuber plant⁻¹, 25% soil+ 75% coconut dust showed minimum result and on the other hand, in direct field, large size of tubers were found (Table 2).

Table 2. Ex vitro minituber production using different substrates.

Substrates	Survivability (%)	Leaf color	Shoot length(mm)	No. of tuber plant ⁻¹	Average diameter of tuber plant ⁻¹ (mm)	Average weight of tuber plant ⁻¹ (gm)
Soil	100	Green	131.76b	3.4bc	15.20	2.47b
Sand	100	Yellowish	69.32c	2.0bc	15.09	1.23b
Coconut dust	100	Yellowish	66.81c	1.0c	12.94	0.77b
50% soil + 50% sand	100	Light green	95.85bc	2.75bc	14.85	1.5b
25% soil + 75% coconut dust	100	Yellowish	92.14bc	4.6bc	12.49	1.36b
50% soil + 50% coconut dust	100	Light green	117.4b	4.5bc	12.53	1.63b
75% soil + 25% coconut dust	100	Green	135.34b	5.6b	14.37	2.6b
Direct on field	100	Dark green	188.87a	9.4a	15.5	6.17a
Level of significance	NS		0.01	0.01	NS	0.01

Data in a column followed by same letters are not significantly different according to DMRT.

In *in vivo* condition average tuber weight and tuber number were determined as different depending on the production technique (Leifert and Struik, 1992; 1999). Keller *et al.*, (2006) found that the tuber numbers of various potato cultivars were between 6.2 to 7.9 in plantlets grown in polyethylene bags. In the study of minituber production, result showed that plants which were directly transplanted into field represented best result than other substrates.





Plate. 2. Minituber formation from different substrates in *ex vitro* condition.

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