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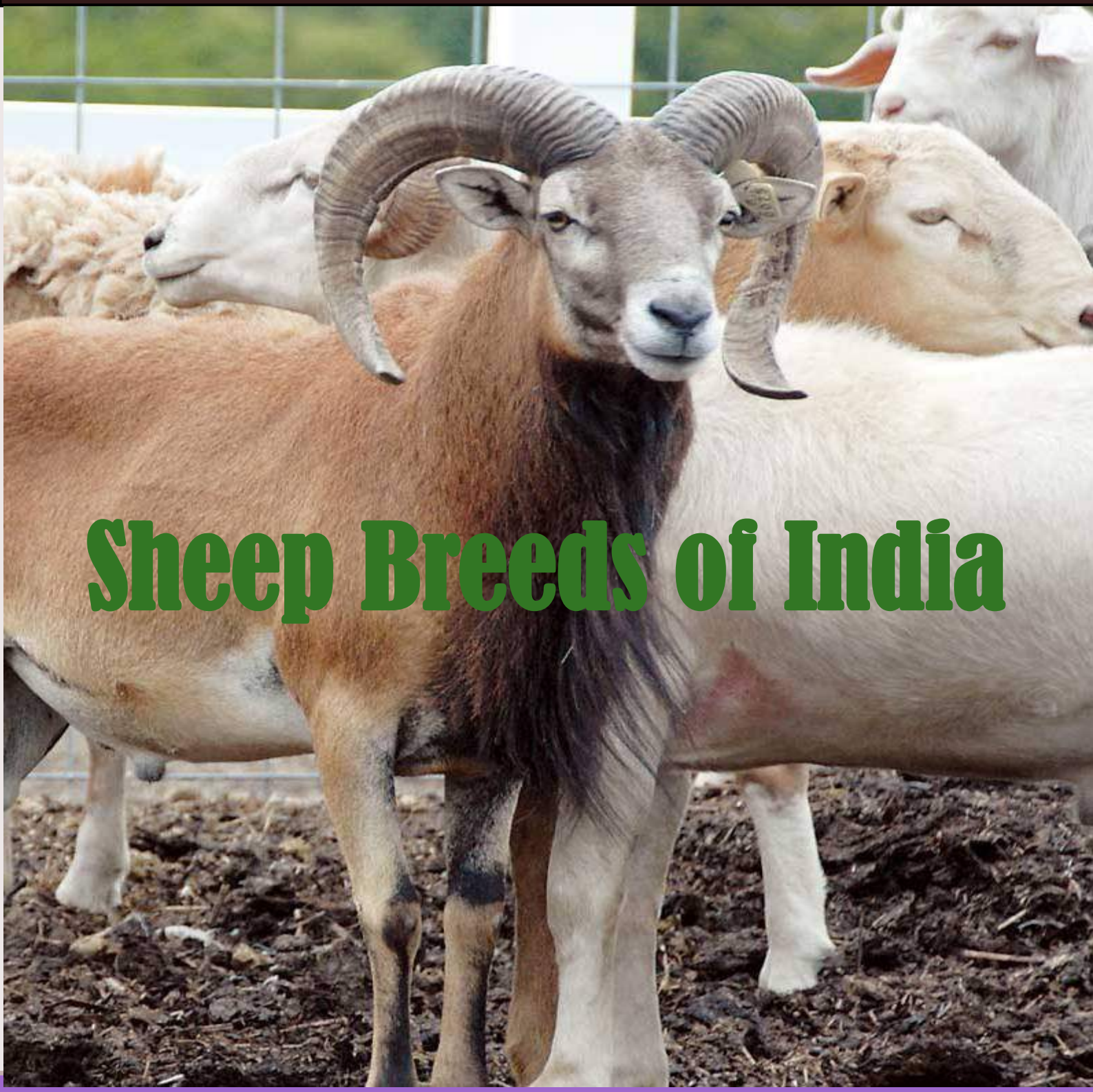

Sheep Breeds of India

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Registered indigenous Sheep breeds of India: An Overview

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Animals with distinct characters localized to a place and different from those of other places are termed as breeds and give some local name. There have been little efforts to conserve and improve the native breeds except for some Govt farms. Some important breeds of sheep are maintained for pure-breeding and producing stud rams for distribution to the farmers. Most of the breeds of sheep in India have evolved through natural adaptation to agro-ecological conditions, followed by some limited artificial selection for particular requirements. Most of the breeds have generally been named after their place of origin and on the basis of prominent characters. The country has about 40 registered breeds of sheep. They vary from the non-woolly breeds of sheep in the Southern Peninsular region mainly kept for mutton and manure to the reasonably fair apparel wool breeds of the Northern temperate region. Sheep with its multi facet utility (for meat, wool, skin, manure and to some extent milk and transport) play an important role in the Indian agrarian economy. They have an excellent ability to survive over a prolonged period of drought and semi starvation and are less prone to extreme weather conditions, ectoparasites as well as other diseases. They are unique for their fibre which allows ventilation and also protects the skin from the hot sun, rain and abrasions. Because of their hardiness and adaptability to dry conditions, the north-western and the Southern peninsular regions of the country have a large concentration of sheep. The sheep are mostly reared for wool and meat. Sheep skins and manure constitute important sources of earning, the latter particularly in southern India. Based on various agro-climatic conditions and type of sheep found in them, the following four distribution of type breeds in different agroclimatic region.

(I) Northern Temperate Region

This region comprises of Jammu & Kashmir, Himachal Pradesh and hilly parts of Uttat Pradesh. The important breeds of this region are Bhakarwal, Changthangi, Gaddi, Garole, Gurez, Karnah, Poonchi and Rampur Bushair.

1. Bhakarwal

The name of the Bakharwal breed is derived from the nomadic tribe which rears these sheep. The breed has no distinct home tract, and the sheep are entirely migratory. Bakharwal sheep flocks, winter in the Pir Panjal ranges of the Jammu division, and in the summer migrate to the Kashmir Valley, crossing the high mountain passes. They are medium-sized animals, with a typical Roman nose. The fleece which is coarse and open is generally white, although coloured fleeces are occasionally observed. They are a coarse carpet wool breed of sheep. All animals are spotted fawn or grey. The rams are horned and the ewes are polled. The ears are long and drooping, and the tail is small and thin. Adult ewes weigh between 29 and 36 kg; rams can weigh as much as 55 kg. Most of this breed has now been crossed with Merino for improving greasy-wool production and quality for apparel wool and only a small proportion of flocks still contain pure Bakharwal animals. The sheep are shorn three times a year. The total annual wool produced per animal ranges from 1 to 1.5 kg.

2. Changthangi

Predominantly white and the rest are brown, grey and black. Undercoat white/grey; yields warm delicate fibre - pashmina (cashmere, pashm). Body and

legs are small, have strong body and powerful legs. Ears are small, pricked and pointed outwards. Horns are large turning outward, upward and inward forming a semicircular ring. Average live weight of buck is 20 and doe is 20 kg; average birth weight is 2.1 kg. Kidding is once a year, normally single; Average age at first kidding is 20 months.

3. Gaddi

The Gaddi breed, also known as Bhadarwah, is native to the Kishtwar and Bhadarwah Tehsils in the Jammu region of Jammu and Kashmir and the breed is distributed in Kishtwar and Bhadarwah Tehsils in Jammu province of Jammu & Kashmir state, Hamirpur, Ramnagar, Udhampur and Kulu and Kangra valleys of Himachal Pradesh and Dehradun, Nainital, Tehri Garhwal and Chamoli districts of Uttar Pradesh. These are medium sized animals, usually white, although tan, brown and black and mixtures of these are also seen. Males are entirely horned but females to the extent of only 10 to 15% are horned. Fleece is generally white with brown coloured hair on the face. Wool is fine and lustrous; average annual yield is 1.13 kg per sheep, clipped thrice a year. A part of this clip is sent to Dhariwal mills and Amritsar markets. Undercoat is used for the manufacture of high quality Kulu shawls and blankets.

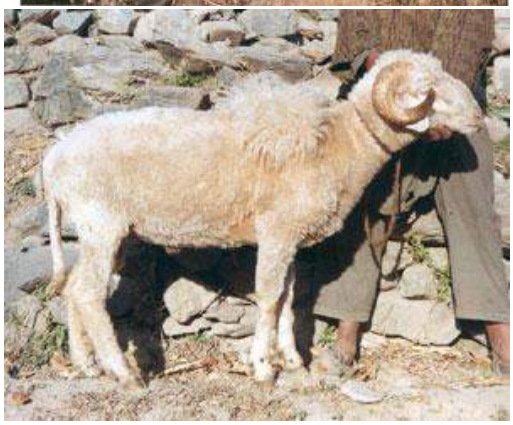
4. Garole

The Garole breed is native to the hot, humid and swampy Ganges delta of West Bengal. It is a small-sized animal, reared for meat, and plays a vital role in the economic subsistence of marginal farmers and landless households in the Sunderbans region of the South 24 Parganas district in West Bengal. It has a compact and square body with a small head, medium ears and a short thin tail. Grey and white are the predominant colours. Males are usually horned and females are polled. The fleece is open and very coarse and, though not dense, covers almost the whole body and a major part of the legs. The animals are usually not shorn, though some farmers shear the animal and use the wool for bedding material. Garole ewes breed around the year with two lambing peaks between December to February and August to September. Multiple births are common.

5. Gurej

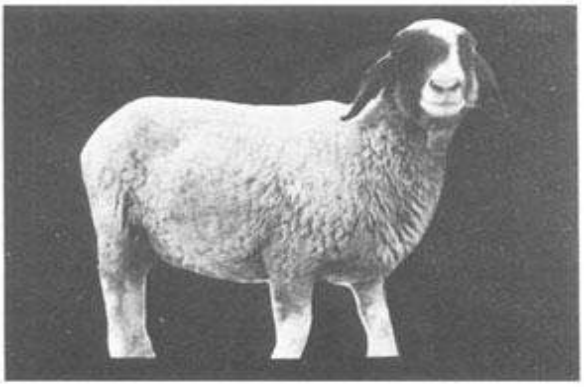
The Gurej breed is found in the Gurez block of Bandipore district in North Kashmir. They are the largest of the sheep breeds in the state. The skin colour pink. Both sexes are polled. Ears are large and leafy; tail is short to medium in length and thin. Fleece is white coarse, dense and long stapled. Forehead, belly and legs are covered with wool. The March and September clips are yellow but the September clip is golden yellow in colour.

6. Karnah



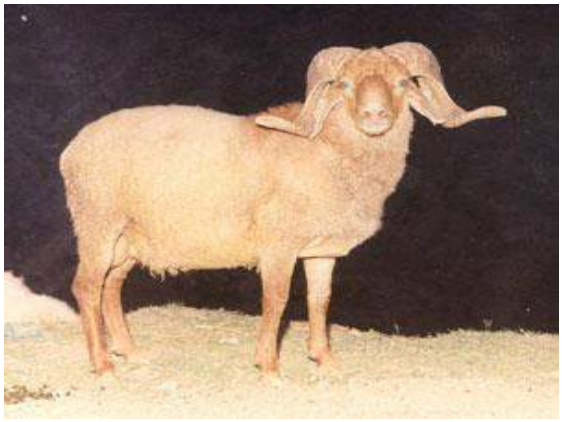
The Karnah breed is primarily found in Karnah, a mountainous tehsil of Kupwara district in North Kashmir. These are generally large animals. The rams have large curved horns and a prominant nose line. Wool is generally white in colour. The sheep are shorn twice a year, in spring and autumn which produce between 1 to 1.5 kg of wool per animal per year. Staple length ranges from 12 to 15 cm and the average fibre diameter between 29 and 32µ.

7. Poonchi



The Poonchi breed, as its name suggests, is native to the Poonch and Rajouri districts of the Jammu region of Jammu and Kashmir. The animals are similar in appearance to Gaddi except being lighter in weight. Animals are predominantly white in colour, including the face but spotted sheep varying from brown to light black are also seen. Ears are medium long. Tail is short and thin. Legs are also short, giving a low-set conformation. The weight of the adult ram ranges from 35 to 40 kg and that of a ewe from 25 to 30 kg. Wool is of medium to fine quality, mostly white in colour. Sheep are shorn three times a year which produce between 0.9 to 1.3 g greasy wool sheep per year. Fibre length ranges between 15 to 18 cm and the fibre diameter between 22 and 30µ.

8. Rampur Bushair



The Rampur Bushair breed is distributed in Simla, Kinnaur, Nahan, Bilaspur, Solan and Lahul and Spiti districts of Himachal Pradesh and Dehradun, Rishikaesh, Chakrota and Nainital districts of Uttar Pradesh. These are medium sized animals. The fleece colour is predominantly white, but brown, black and tan colour are also seen on the fleece in varying proportions. The ears are long and drooping. The face line is convex, giving a typical Roman nose. The males are horned but most of the females are polled. The fleece is of medium quality and dense. Legs, belly and face are devoid of wool.

(II) North Western region

This region comprises the states of Punjab, Haryana, Rajasthan and Gujarat and the planes of Uttar Pradesh and Madhya Pradesh. Important breeds of sheep found in this region are Chokla, Jaisalmeri, Jalauni, Magra, Malpura, Marwari, Muzaffarnagri, Nali, Patanwadi, Pugal and Sonadi. This region is the most important in the country for carpet wool production.

1. Chokla

Chokla also known as Chhappar and Shekhawati, is native to the districts of Churu, Jhunjhunu, Sikar, and the border areas of Bikaner, Jaipur and Nagaur districts of Rajasthan. It can be categerise as medium fine wool. Chokla are light to medium-sized animals. Their face is generally devoid of wool and is reddish brown or dark brown in colour which may extend up to the middle of the neck. The skin is pink. The ears are small to medium in length and tubular. Both the sexes are polled. The coat is dense and relatively ine, covering the entire body including the belly and the greater part of the legs.

2. Jaisalmeri

The name of the Jaisalmeri breed is derived from its home tract, Jaisalmer. They are

distributed across the Jaisalmer, Barmer and Jodhpur districts of Rajasthan.

The animals are tall and well built with black or dark brown face, the colour extending up to the neck, typical Roman nose, long drooping ears, generally with a cartilagenous appendage. Both sexes are polled. The tail is medium to long. The fleece colour is white, of medium carpet quality and not very dense. This is the largest breed in body size of Rajasthan which produce good quality carpet-wool. There is need for conserving this breed.

3. Jalauni

The Jalauni breed is distributed across the Jalaun, Jhansi and Lalitpur districts of Uttar Pradesh. The animals are medium sized with straight nose line. Both sexes are polled. Ears are large, flat and drooping. Tail is thin and medium in length. Fleece is coarse, short-stapled and open, generally white. Belly and legs are devoid of wool. The Uttar Pradesh Government is presently engaged in upgrading Jalauni with Nali to improve its wool yield and quality.

Nali crosses show improvement in fleece production as reflected by fleece weight, staple length and quality.

4. Magra

The Magra breed (formerly known as Bikaneri; and also known as Bikaneri Chokhla and Chakri) is distributed in the Bikaner, Nagaur, Jaisalmer and Churu districts of Rajasthan. Animals true to the breed type are found only in the eastern and southern parts of Bikaner districts. The animals are medium to large in size. White face with light brown patches

around the eyes are the characteristics of this breed. Skin colour is pink. Ears are small to medium and tubular. Both sexes are polled. Tail is medium in length and thin. Fleece is of medium carpet quality, extremely white and lustrous and not very dense. The most important strain of Magra (Bikaneri Chokla) has flocks with extremely white and lustrous fleeces and found only in a flocks with extremely white and lustrous fleeces and found only in a few villages around Bikaner. Their fleece is of good carpet quality. The breeding programme involves improving this breed through selection; however, there is much crossing with other breeds in the vicinity.

5. Malpura

The Malpura breed is native to the Tonk, Sawai Madhopur, Jaipur and Dausa districts and adjacent areas of Ajmer, Bhilwara, Chitaurgarh, Kota and Bundi districts in Rajasthan. They derive their name from the Malpura Taluk in Tonk district in Rajasthan. The animals are fairly well built with long legs with face light brown. Ears are short and tubular, with a small cartilagenous appendage on the upper side. Both sexes are polled. Tail is medium to long and thin. Fleece is white, extremely coarse and hairy. Belly and legs are devoid of wool. The milk production averaged 64.50 kg in a lactation period of 90 days. Tupping and lambing percentages in the spring and autumn seasons, are 61.54, 96.23% and 88.7, 32.7% respectively. The dressing percentage on the live weight basis at 6 months ranged from 40.90 to 49.49.

6. Marwari

The Marwari name originates from the home tract of the breed – the Marwar region of Western Rajasthan which encompasses Jodhpur, Jalore, Nagaur, Pali, Sirohi and Barmer districts. The animals migrate to distant places in Uttar Pradesh, remote districts of Madhya Pradesh and sometimes to the northern parts of Maharashtra. Sheep are hardy, yielding coarser carpet variety white wool of a mixed hairy composition. This sheep is characterized by long legs, black face and a prominent nose. Fleshy appendages under throat, known as wattles, are often present. Tail is short and pointed. They possess high resistance to disease and

worms. The yield of wool per year is 0.90-1.81 kg per animal.

7. Muzaffarnagri

The Muzaffarnagri, also known as Bulandshahri is native to the Muzaffarnagar, Bulandshaher, Saharanpur, Meerut and the Bijnor districts of Western Uttar Pradesh and parts of Delhi and Haryana. The animals are medium to large in size, face lines slightly convex. Face and body are white with occasional patches of brown or black, ears and face occasionally black. Both sexes are polled. Males sometimes contain rudimentary horns. Ears are long and drooping. Tail is extremely long and reaches fetlock. Fleece is white, coarse and open. Belly and legs are devoid of wool. As the breed is one of the heaviest, largest and very well adapted to irrigated areas, its gradual decline in number necessitates conservation.

8. Nali

The Nali breed is well adapted to the arid and semi-arid regions of Rajasthan and Haryana. It is also found in large numbers in Uttar Pradesh.

Nali sheep is of a large size. It has compact head, large and leafy ears, short legs with amber hooves. The forehead is covered with wool and the face is full of light brown hair. Body colour is yellow white. Both sexes are polled. The animals are clipped twice a year, in the month of March and September and weighs between 2.5 to 3.5 kg per year. Mature ram weighs between 35-40 kg while ewes are between 25-30 kg.

9. Patanwadi

The Patanwadi (also called Desi, Kutchi, Kathiawari, Vadhiyari and Charotari) is found in the coastal plains of the Saurashtra and Kutch regions of Gujarat, and the sandy loamy areas of Patan, Panch Mahals and Mehsana districts of Gujarat. The breed includes three distinct strains:

(i) non-migratory, red faced animals with small bodies, yielding relatively finer fleeces. These are typical Patanwadis and are located in north eastern Saurashtra; (ii) the migratory type, with larger body and long legs, typical Roman nose and long tubular ears. This variety, producing coarser fleeces, is found in western and northern Gujarat; (iii) the meat type, with big body, low stature ad coarser fleeces, found in south eastern areas around Palitana. It is distributed in coastal plain region of Saurashtra and Kutch districts and sandy loamy areas of Patan, Kadi Kalol, Sidhapur and Chanssama taluks of Mehsana district of Gujarat.

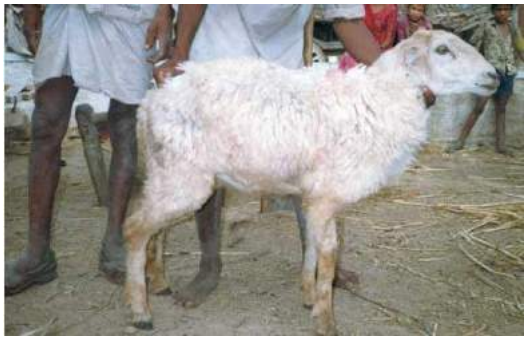
10. Pugal

The name of the Pugal breed originates from the Pugal tehsil of Bikaner district, which is the home tract of this breed. It is also distributed over Bikaner and Jaisalmer districts of Rajasthan, but pure specimens are available only in the north western border area of the two districts.

Fairly well built, animals have black face, with small light brown strips on either side above the eyes, lower jaws, of typically light brown colour. The black colour may extend to neck. Ears are short and tubular. Both sexes are polled. Tail is short to medium and thin. The fleece is of medium carpet quality but not very dense. Considering these small numbers, there is need for conservation of this breed. The breeding policy involves improving this carpet wool breed through selection for greasy fleece weight and carpet quality.

11. Sonadi

The Sonadi breed is found in the Mewar region of Rajasthan comprising Udaipur, Dungarpur, Chittaurgarh and Banswara districts, also extends to northern Gujarat. They are also locally known as Laapdi (long flat drooping ears) and Bhagli (of good fortune). The animals are fairly well built somewhat smaller to Malpura with long legs, light brown face with the colour



extending to the middle of the neck, ears large, flat and drooping and generally have a cartilagenous appendage. Tail is long and thin. Both sexes are polled. Udder is fairly well developed. Fleece is white, extremely coarse and hairy. Belly and legs are devoid of wool.

(III) Southern peninsular region

This region (semi-arid in central peninsular and hot humid region along the coast) comprises of Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu and Kerala. The important breeds of this region are Bellary, Coimbatore, Deccani, Hassan, Katchaikatty-Black, Kenguri, Kilakarsal, Madras-Red, Mandya, Macheri, Nellore, Nilgiri, Ramanadhapuram-white, Trichi black and Vembur

1. Bellary

The Bellary breed is native to the districts of Bellary and Davanagere and the adjoining areas of Haveri and Chitradurga districts of Karnataka. This breed is not very different from Deccani. Animals found to the north of the Tungabhadra River are called Deccani and those to the south of it Bellary. Mostly found in Bellary district of Karnataka.

The animals are medium sized with body colour ranging from white through various combinations of white and black to black. One third of the males are horned, females are generally polled. Ears are medium long, flat and drooping. Fleece is extremely coarse, hairy and open. Belly and legs are devoid of wool.

2. **Coimbatore**

It is distributed in Coimbatore district of Tamilnadu. It is wool purpose breed. The Coimbatore breed, also called Kurumbai. It is widely available in Coimbatore and Madurai districts of Tamil Nadu and bordering areas of Kerala and Karnataka. The animals are of medium size and white colour with black or brown spots. Ears are medium in size and directed outward and backward, Tail is small and thin. 38% of the males are horned but the females are polled. Fleece is white, coarse hairy and open. Adult male average body weight 25kg. Adult female average body weight 20kg.

3.Deccani

The Deccani breed is spread over the greater part of the central peninsular region, comprising the semi-arid areas of Maharashtra, Andhra Pradesh and Karnataka. Deccani breed is an admixture of the woolly types of Rajasthan and the hairy types of Andra Pradesh and Tamil Nadu. The sheep is small and hardy, and well adapted to poor pastoral conditions. It possesses a coloured fleece, black and gray colours being more dominant. The average annual yield of wool being 4.54 kg per sheep. The wool is of a low grade and is a mixture of hair and fine fibres, mostly consumed for the manufacture of rough blankets (Kambals). The flocks are maintained chiefly for mutton.

4. Hassan

The Hassan breed of sheep as the name suggests is traditional to the Hassan district of Karnataka. These are small sized animals with white body and light brown or black spots. Ears are medium-long and drooping. 39% of the males are horned, females are usually polled. Fleece is white, extremely coarse and open, legs and belly are generally devoid of wool.

5. Katchaikatty Black

Katchaikatty Black sheep are maintained in small flocks in Vedipatti taluka of Madurai district of Tamil Nadu. Animals are medium in size with compact body and are black in colour. Coat type is hairy. The breed is reared for meat and manure. Rams are well known for fighting.

6. Kenguri

The Kenguri breed, also known as Tenguri is native to the hilly tracts of the Koppal and Raichurs district (particularly Lingasagar, Sethanaur and Gangarti taluks) of Karnataka. These are medium sized animals. Their body colour is mostly dark brown, but colours ranging from white to black with spots of different shades are also not uncommon. Males are horned, while the females are generally polled. Although their exact number is not known but their population is too small.

7. Kilakarsal

The Kilakarsal, also known as Keezhakkaraisal, Karuvai, Keezha Karauvai, Ramnad Karuvi and Adikarasial, is mainly found in the Madurai, Virudhunagar, Tirunelveli and Thoothukudi districts of Tamil Nadu. Coat dark tan, with black spots on head, belly and legs. Ears medium sized. Tail small and thin. Males with thick twisted horns. Most animals have wattle.

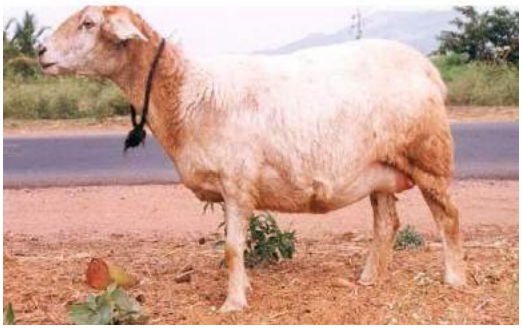
8. Madras Red

The Madras Red breed of sheep is native to the Kanchipuram and Chingalpet and Madras districts of Tamil Nadu. The animals are medium sized. Their body colour is predominantly brown whose intensity varies from light tan to dark brown. Some animals have white markings on the forehead, inside the thighs and on the lower abdomen. Ears are medium long and twisted horns and the ewes are polled. Their body is covered with short hairs which are not shorn.

9. Mandya

Mandya, also known as Bannur and Bandur, is distributed in the Mandya district and areas bordering the Mysore district of Karnataka. Relatively small animals are white in colour but in some

cases their face is light brown which may extend to the neck.



Possess a compact body with a typical reversed U-shape wedge from the rear. Ears are long, leaf-like and drooping. Tail is short and thin. A large percentage of animals carry wattles. Slightly Roman nose. Both sexes are polled. Coat is extremely coarse and hairy. There is high incidence of cryptorchidism in Mandya, possibly due to selection of animals for meaty conformation. Adult male weighs 35 kg and female weighs 23 kg. Best mutton type conformation among the Indian breeds.

10. Mecheri

It is distributed in Salem, Erode, Karur, Namakkal, and fewer parts of Dharmapuri districts of Tamilnadu.

Also known as Mainlambadi and Thuvaramchambali in Coimbatore district. Mostly found in Macheri, Kolathoor, Nangavalli, Omalur and Tarmangalam Panchayat Union areas of Salem district and Bhavani taluk of Coimbatore district of Tamil Nadu. It is a meat purpose breed. It has medium sized body with pale purplish skin color. There are no horns for both the sexes. Ears are medium sized. Tail is short and thin. Body is covered with very short hair which are not shorn. Adult male average body weight 36kg. Adult female average body weight 22kg.

11. Nellore

It is distributed in Nellore, Prakasam and Ongole districts of Andhra Pradesh. They are tall animals with little hair except at brisket, withers and breech. Rams are

homed ewes are polled. Long and drooping ears; Majority of animals carry wattles. Males have average body weight of 36 kg and female have 28 kg. Nellore is the tallest breed of sheep in India, resembling goats in appearance. It has a long face and long ears with the body densely covered with short hair. The majority of the flocks are of fawn or deep red fawn colour. Based on coat colour, three varieties of this breed are: Palla' completely white or white with light brown spots on head, neck, back and legs. Jodipi'(also called Jodimpu) are white with black spots particularly around the lips, eyes and lower Jaw but also on belly and legs, and Dora are completely brown. The animals are relatively tall with little hair except at brisket, withers and breech. The rams are horned but the ewes are almost always polled. The ears are long and drooping. The tail is short and thin. 86% of the animals carry wattles. nellore district and neighbouring areas of Prakasam and Ongole districts of Andhra Pradesh predominantly contain this breed population.

12. Nilgiri

The Nilgiri breed is said to have evolved during the 19th century, originating from a cross-breed base and contains an unknown level of inheritance of Coimbatore, the local hairy breed, Tasmanian Merino, Cheviot and Southdown.

These are distributed in Neelagiri district of Tamilnadu. It is wool purpose breed. They are medium weighed animal. Majority are found in white colors. Certain goats are found with purple spots on their body and face. Ears are broad and drooped out. Females are without horns. Adult male average body weight 31kg. Adult female average body weight 31kg.

13. Ramanadhapuram white

This is distributed in Ramanadhapuram, Sivagangai, Virudhunagar districts and and adjoining areas of Tiruneveli district of Tamil Nadu. It is meat purpose breed. It has medium sized body. Majority of them are white in color. Certain goats hold

black colored stripes all over their body. The ears are medium sized and directed outward and downward. Males have twisted horns but females are polled. Tail is short and thin. Legs are smaller and slender. Adult male average body weight 31kg. Adult female average body weight 23kg.

14. Trichy black

These are distributed in Trichy, Perambalur, Dharmapuri and Salem districts of Tamilnadu. Also known as Tiruchy Karungurmbai, the breed is largely found in Perambalur and Ariyalur taluks of Tiruchy districts, kallakurichy taluk of South Arcot district, Tirupathur and Tiruvannamalai taluks of North Arcot district and Dharampuri and a portion of Krishnagiri taluk of Dharampuri district of Tamil Nadu. It is wool purpose breed. These are smaller breeds. Black coloured all over the body. Adult males are found with horns and females without horns. Ears are smaller, facing forward and downwards. Tail is short and thin. Adult male average body weight 26kg. Adult female average body weight 19kg. Their fleece is extremely coarse, hairy and open.

15. Vembur

The Vembur, also called Karandhai, It is distributed in Vembur, melakarandhai, keezha karandhai, nagalapuram regions, Tuticorin and Virudhunagar districts of Tamilnadu. These are taller breeds. Their colour is white with irregular red and fawn patches all over the body. It is meat purpose breed. Ears are drooped out. Tail is smaller and slender. Adult males are found with horns and absence of horns in case of females. Adult males average body weight 35kgs. Adult females average body weight 28kgs. The body is covered with short hair which are not shorn.

(IV) Eastern Region

This region (hot and humid) includes Bihar, West Bengal, Orissa, Assam and other eastern states. This region has no distinguished breeds of its own except in the case of Bihar where Shahabadi and Chottanagpuri breeds are found. Other important breeds of this region are Balangir, Bonpala, Ganjam, Tibetan. The sheep in this region are primarily of meat

type but for Arunachal Pradesh which has a small number of better wool sheep. The quality of wool produced by the sheep of this region in general is small and extremely coarse, coloured and of hairy quality.

1. Balangir

The Balangir breed of sheep is native to the north western districts of Balangir, Sambalpur, and Sundargarh in Odisha. These are medium sized animals of white or light brown or of mixed colours. A few animals are black also. The ears are small and stumpy. Males are horned and females polled. Tail is medium long and thin. Fleece is extremely coarse, hairy and open. Legs and belly are devoid of wool.

2. Bonpala

The Bonpala breed is native to southern Sikkim. The animals are tall, leggy and well-built. This is found in southern Sikkim. The animals are tall, leggy and well-built. Fleece colour ranges from complete

white to complete black with a number of intermediary tones. Ears are small and tubular. Both sexes are horned. Tail is thin and short. Fleece is coarse hairy and open. Belly and legs are devoid of wool.

3. Chhotanagpuri

The Chhotanagpuri breed is mainly found in Jharkhand, Chottanagpur, Ranchi, Palamau, Hazaribagh, Singhbhum, Dhanbad and Santhal Parganas of Bihar and Bankura district of West Bengal. These are small light weight animals, light grey and brown in colour which possess

small ears parallel to the head. Tail is thin and short. Both sexes are polled. Fleece is coarse, hairy and open which is generally not clipped.

4. Ganjam

The Ganjam breed of sheep is native to the Ganjam, Koraput, Phulbani and parts of the Puri districts of Odisha. These are medium sized animals with coat colour ranging from brown to dark tan, some have white spots on the face and body. Ears are of medium size and drooping. Nose line is lightly convex. Tail is medium long and thin. Males are horned but females polled. Fleece is hairy and short which is not shorn.

5. Shahabadi

The Shahabadi, is native to the Shahabad (subsequently bifurcated into the Bhojpur, Rohtas and Buxar districts), Patna and Gaya districts of Bihar. This is also known as plain type sheep. These are medium sized leggy animals. The fleece colour is mostly grey, sometimes with black spots.

Ears are medium sized and drooping. Tail is extremely long and thin. Both sexes are polled. Fleece is extremely coarse, hairy and open; legs and belly are devoid of wool.

6. Tibetan

This Tibetan sheep breed is distributed in Northern Sikkim and Kameng districts of Arunachal Pradesh. These are medium-sized animals, mostly white with black or brown face and brown and white spots on

the body. Both sexes are horned. The nose line is convex, giving a typical Roman nose. The ears are small, broad and drooping. The fleece is relatively fine and dense. The belly, legs and face are devoid of wool. Tibetan sheep produce an excellent, lustrous carpet-quality wool, which was available in plenty to the Indian States bordering Tibet when the Indo-Tibetan border was open. However, after its closer in 1962, little Tibetan wool is available from Tibet.

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Effect Of Abiotic Stress On Plant Metabolome

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Abstract

Plant responses to abiotic stresses are very complex phenomena with individual characteristics for various species. Abiotic stresses (e.g. drought, salinity, flooding, cold, heat, UV radiation, heavy metals, etc.) strongly affect plant growth and development. It is estimated that they are the cause of more than 50% of crop yield losses. Abiotic stresses are known to activate a multigene response resulting in the changes in various primary and secondary metabolite accumulation. Therefore, metabolomic approaches are becoming very important and powerful tools used in studying plants' reaction to various stimuli. Precise analysis of metabolome is essential for understanding the fundamentals of stress physiology and biochemistry.

INTRODUCTION

Abiotic stresses are the major factors which negatively influence plant development and productivity. They are the main cause of extensive agricultural production losses worldwide. Among abiotic stresses, drought, salinity and extreme temperatures are the major environmental constraints that modern agriculture has to cope with. It has been estimated that they may be responsible for over 50% yield reduction in major crop plants. However, severity of losses depends on the plant development stage at which the stress occurs, its intensity and duration. Thus, as the climatic conditions are getting worse, new resistant crop varieties are needed. It is possible to obtain them through the selection of cross-bred lines or by the means of genetic engineering. However, better understanding of the mechanisms involved in plant stress responses is necessary to reach that goal.

Metabolome analyses have become powerful tools to monitor changes in response to various environmental stimuli. The results of such studies give insight into the functioning of plants under specified conditions and are an indispensable part in revealing the molecular mechanisms underlying responses to abiotic stresses. Nowadays mass spectrometry combined with various chromatographic or electrophoretic techniques plays a central role in metabolome analysis. In this article we have reviewed main metabolite classes, which were identified concerning metabolomic analyses of plants subjected to various abiotic stresses.

Metabolomics:

Metabolomics is currently an important tool involved in the selection process of plants resistant to changing climatic conditions. The most important abiotic

stress factors, such drought, salinity, soil flooding and extreme temperatures, cause significant changes in the composition of the plant metabolome. The knowledge about the role played by low molecular-weight primary and secondary metabolites in the stress tolerance process is essential for crop species improvement. However, the function of secondary metabolites in the abiotic stress tolerance is relatively understood.

Role of primary metabolites in response to abiotic stress:

Plants developed various adaptive strategies to withstand abiotic stresses, including alterations of metabolism in different directions, to ensure their survival under adverse environmental conditions. One of the widely described plant responses to water deficit is osmotic adjustment, which requires accumulation of compatible solutes, such as amino acids, carbohydrates, polyols, tertiary sulfonium and quaternary ammonium compounds (especially Glycine betaine). These molecules play an important role in maintaining cell turgor, as well as stabilizing proteins and cell membranes. Other hypothesis indicates their contribution in re-establishing the redox balance by scavenging reactive oxygen species, which could negatively affect cellular structures and metabolism. In cold stress, the content of cryoprotective molecules, such as soluble sugars, sugar alcohols and nitrogen-containing compounds is increased. This helps plant to cope with low temperatures by preventing ice adhesion to plasma membrane, which can be followed by cell disruption.

Amino acids:

It has been documented that many amino acids accumulate in plants exposed to various abiotic stresses. Proline is one of the most widely distributed osmolyte, the level of which is elevated in different environmental stresses including drought, salinity and cold stress. The important role of proline in osmotic stress was confirmed in transgenic plants, e.g. by P5CS overexpression in tobacco, which led to an increased proline content and a smaller decrease in osmotic potentials in the leaf of transgenic plants, compared with control plants after drought treatment. Therefore, the increased levels of proline in plants in response to abiotic stresses were for many years regarded to be the stress tolerance trait.

Glycine betaine:

Another extensively studied osmoprotectant is Glycine betaine (N,N,N-trimethylglycine). Glycine betaine is a quarternary ammonium compound, which is involved in maintaining water balance, stabilizing macromolecules, protecting photosynthesis and detoxificating reactive oxygen radicals.

Polyamines:

Polyamines are low-molecular-weight nitrogen compounds with a positive charge at the cellular pH, which enables them to interact with negatively charged molecules like nucleic acids, proteins and phospholipids. The most common polyamines are triamine spermidine (Spd), tetraamine spermine (Spm) and their diamine precursor putrescine (Put). Due to their cationic nature, these commonly occurring

compounds have been frequently related with environmental stresses, including drought, salinity and chilling stress, as well as UV-B and heavy metals and may act as a cellular signaling compound during stress response. Polyamines have been ascribed to be involved in the stabilization of membranes protecting them from denaturation under stress condition scavenging free radicals, modulating nucleic acid structures and also enzyme activities or function.

Carbohydrates:

It was widely reported that abiotic stresses lead to accumulation of nonstructural carbohydrates like sucrose, hexoses and polyhydric alcohols among many plant species. Especially, there is a strong correlation between the carbohydrate accumulation and tolerance to osmotic stresses, such as water deficit or salinity stress. Soluble carbohydrates play an important role in plant metabolism as a source of carbon and energy within a cell. Their level might be affected by different stresses, as the carbohydrate content is related to photosynthesis. Soluble sugars function as osmoprotectants during water deficit, reducing the detrimental effects of osmotic stress, helping in maintaining turgor, stabilizing cell membranes and protecting plants from degradation. The increase in sugar content is mostly the effect of starch hydrolysis, which requires enzymes with a hydrolytic activity. Furthermore, soluble sugars like sucrose, raffinose, stachyose, trehalose and sugar alcohols, like sorbitol, ribitol and inositol, act as cryoprotectants during cold stress, protecting cell membranes against ice adhesion. In addition, carbohydrates may act as signaling molecules and play a role in adaptive mechanisms to stress.

Role of secondary metabolite:

Secondary metabolites create a diverse group of compounds, which are regarded to play an important role in many biochemical and biophysical processes occurring in plant cells and tissues. These natural products are synthesized by the specified plant species and their concentration level is precisely regulated by the developmental stage, environmental conditions and adaptation processes. Secondary metabolites are involved in defense reaction during pathogen infections; they play a role as attractants or repellents against herbivores and insects as well as provide protection against the harmful effect of UV radiation. They are also involved in protective functions in response to biotic and abiotic stress condition.

Phenolics compound:

Phenolic compounds constitute a large and diverse group of plant secondary metabolites that include phenylpropanoids and their polymers, namely lignins and tannins, as well as flavonoids, isoflavonoids, anthocyanins and coumarins. These low-molecular-weight natural products are synthesized in plants through the phenylpropanoid pathway, in which phenylalanine is the key substrate. Accumulation of phenolic compounds is regulated by environmental stresses, such as UV irradiation, light, wounding, pathogen attack, herbicide treatment, nutrient deficiencies.

Terpenoid:

Terpenoids constitute a broad class of lipophilic secondary metabolites synthesized in plants from isoprene units, which may be further assembled and modified in many different ways. These natural products exhibit a positive effect against both biotic and abiotic stress factors. Terpenoids show an antioxidant and antibiotic activity, take part in defense responses against herbivores, play an important role in the stabilization of the lipid membrane and improve environmental stress tolerance. Drought causes changes in the level of chlorophyll and carotenoids. The decreased content of these terpenoid compounds was also reported under drought stress.

Nitrogen-containing secondary metabolite:

Glucosinolates are plant secondary metabolites that contain sulfur and nitrogen and are derived from glucose and amino acids. These natural products take part in response to different biotic and abiotic stress factors. Another group of nitrogen-containing secondary metabolites are alkaloids. Most of these compounds have bitter taste and play an important role during the plant defense reaction against herbivores and pathogens attack. Moreover, the production of alkaloids is induced under abiotic stress. Some plants produced a higher level of the alkaloids under drought conditions. The alkaloid content was also affected by drought treatment applied on different plant growth stages.

SUMMARY

Various abiotic stresses have different impact on metabolome changes; however, a part of the plant response is similar and thus some general conclusions may be drawn. In response to adverse abiotic stimuli, plants orchestrate an array of responses oriented to stress avoidance, defense or resistance, depending on the particular stress tolerance. Whereas stress avoidance involves modifications in growth habits and seasonal quiescence, defense and resistance are necessarily associated to strong metabolic modifications. Among all metabolic responses, alterations in the primary metabolism are the most evident and involve changes in levels of osmotic adjustment, sugars and sugar alcohols and aminoacids, showing elevated concentration level in response to abiotic stress. However, changes in the secondary metabolism are more specific of a given species and are highly specific of the particular stress condition.

Bacterial blight of Pomegranate and its Management

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The Pomegranate (*Punica granatum* L.), is a fruit-bearing deciduous shrub or small tree growing between 5–8 meters (16–26 ft) tall, belongs to the family Punicaceae. Pomegranate is an ancient fruit crop of India. It is native to Iran but extensively cultivated in Mediterranean regions especially in Spain, Morocco, Egypt and Afghanistan. It is also grown in Burma, China, Japan, USA, USSR, Bulgaria, India and Southern Italy. It is regarded as "vital cash crop" of an Indian farmer. The pomegranate fruit has a wide consumer preference for its attractive, juicy, sweet, acidic and refreshing arils. There is a growing demand for good quality fruits both for table use and processing into juice, syrup and wine. Seeds with fleshy portion of sour pomegranates are dried and marketed as "Anardana", which is being used as a condiment for curries. Fruits are the important raw materials for wine industry because of easy fermentation. Other value added products are juice, jelly, anarub and rind powder. Pomegranate is good source of carbohydrates and minerals such as calcium, iron and sulphur. It is rich in vitamin C and citric acid is the predominant organic acid in pomegranate. Glucose (5.46%) and fructose (6.14%) are the main sugars with no sucrose in fruits. At the global level, Iran is the world's largest producer and exporter of pomegranates with an estimated annual production of 670,000 tonnes, In addition to Iran, other countries including India, Turkey, Spain, Tunisia, Morocco, Afghanistan, China, Greece, Japan, France, Armenia, Cyprus, Egypt, Italy and Palestine also cultivate this crop.The cultivation of pomegranate was introduced quite early in the Mediterranean and eastern countries like India.Total world trade of pomegranate is 1,00,000 -1,12,000 tonnes. Spain is biggest exporter to European Union and to some extent to Gulf countries, trading 60-70% of the total world exports. Iran exports about 15,000 tonnes every year, while Indian export of pomegranate is 6,303 tonnes having export share of 6.4 % in the world market.India occupies an area of about 107.00 thousand ha under pomegranate and production is around 743.00 thousand tons. The total production of Pomegranate is concentrated mainly in the Western Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Tamil Nadu and Rajasthan in India. Maharashtra is the leading State with 82 thousand ha area under pomegranate cultivation, followed by

Karnataka and Gujarat with 13.60 thousand ha and 5.80 thousand ha respectively, Andhra Pradesh and Tamil Nadu stood at fourth and fifth position with 2.80 and 0.50 thousand ha.

Bacterial blight of pomegranate (also known as oily spot) caused by *Xanthomonas axonopodis*pv. *punicae* has become increasingly serious threat for pomegranate growers of India. The disease continued to damage the crop for subsequent years until now, although farmers have adopted all possible and available protection measures, the disease could not be mitigated effectively due to rapid buildup of inoculum and wide spread of the disease. Pomegranate "the boon commercial fruit crop to the farmer turned as a big bane after the severe outbreak of bacterial blight. Many growers finding no options to mitigate the disease effectively have uprooted their crop owing to unbearable losses.

Symptoms

Bacterial blight symptoms were observed on all the above ground plant part viz., leaf, stem, twigs and fruits. Initially small, water soaked, translucent, irregular to circular lesions were noticed on the leaves. Correspondingly on the upper surface small brown to black coloured spots were seen (Plate 1). Spots were round, angular to irregular in shape. As the disease progressed, these spots also grew, increased their size (2.0 – 5.0 mm in diameter), coalesced and produce large patches that may results in shedding of infected leaves. Dark spot symptoms developed on stem nodes start off cracking and easily break off the branches. Severely infected leaves turned yellow, became chlorotic and finally shed off. Stem infection was manifested in the form of long, narrow and elongated light brown to black coloured lesions (1 – 4 cm long) on the main stem and branches. The lesions later on became rough and cankerous. As the disease advanced, stem girdling and breaking was seen at the point of infection. Symptoms were also noticed on flower buds in the form of small water soaked lesions (Plate 1), later on developed into brown to black coloured spots, leading to dropping of buds under severe cases. On developing green fruits, symptoms were noticed as small, pin head sized, black lesions with diffused water soaked margin (oily spots), which later on develops into black coloured, medium to big sized spots (2 – 10 mm in diameter). Single to many such spots were seen on the single fruit. Severely affected fruits split opens with L/Y/star shaped cracks (Plate 1) within the spot. Infected fruits do not further develop nor suddenly drop, but dried up and remain hanged in the plant itself.

How Disease Spreads

Once the inoculums entered in the orchard the disease spreads easily within the orchard through one or more of the following methods:

1. **Plant** to **Plant** Contact: Orchards where high density planting is done at a close spacing , plants touch each other and under this condition the pathogen may pass on from disease to a healthy Plant.
2. **Rains, Run off water and Rain**/Spray **Water** Splashes: All these are effective in spreading the disease within a plant. The pathogen spreads along with water drops from upper to

lower parts. Hence, unnecessary and ineffective sprays should **be** avoided by following recommended spay schedules at recommended **doses** and at proper time.

3. **Wind Blown Rain** Splashes: During rains or at the time of spraying if wind is there, the water drops dripping form infected plants may blown to short distances **with** wind. **The** drops may carry the pathogen along with them and **may** fall on some nearby healthy plant on its way, where it may cause infection under favourable weather conditions.
4. **Person Handling the Plants:** People working in the orchards while conducting various operations like pruning, spraying etc. may carry the diseases from infected **plant** to **a** healthy plant.
5. **Contaminated Tools:** Secateurs or other tools used for pruning if used without disinfecting **after** pruning of each plant may carry the pathogen **to** healthy plants.
6. **Insects:** Various insects which visit an infected plant may carry the inoculum on **its body** parts and transmit it on visiting another plant, thus one should keep them under check. **Bees, ants,** butterflies, flies etc. commonly are **seen** in orchards;**apart** from **them** other insect pests like leaf miners may also **be** responsible for spread **of** disease.
7. How the Disease Causing Agent Survives till Next Crop Season the oily spot bacteria cannot survive in soil without plant debris, however, it can survive on infected plant debris lying in the orchards for more than 8 months. It can also survive for long periods on infected twig cankers on plants in orchard or in dormant buds. Infected fruits in the stores are also potential source of Twig cankers, dormant buds and plant debris are therefore major sources of primary inoculums for next crop season. Now, you are well aware how the pathogen enters your orchard, spreads and survives till next crop season, you should take all measures to avoid its spread and survival in the orchard. Clean cultivation and orchard sanitation is the best method to keep not only bacterial blight, but also other diseases and insect pests under check. It not only reduces unnecessary sprays but also reduces cost of cultivation and environment pollution.

Management of Bacterial Blight Disease of Pomegranate

- Avoid Mrig bahar in bacterial blight affected orchards. Bacterial blight (BB) is most severe during the months of June to October because Temp. 25 to 35^{o} C + RH > 50 % + rains + wind is most favourable for blight development which are available in the rainy season.
- Disease free Planting material should be used from reliable sources like M.P.K.V Rahuri or certified nurseries.
- Sanitation measures should be followed strictly. Infected leaves,twigs and fruits should be collected and burnt.
- The regions where disease is more severe during the kharif season it is advisable to discontinue kharif crop and

encourage Rabi crop. This practice would reduce the build up of inoculum during the period conducive for disease development.

- Rest period of three to four months particularly from June to September, would drastically reduce the build up of inoculum which would minimize the chances of initial infections in crops taken during the ensuing Rabi season.
- Disinfection of pruning tools in copper oxychloride solution (15 gm / lit) prior to use

  Checks spread of disease to healthy plants. Infected twigs should be removed and immediately after pruning plants be sprayed with recommended fungicide and antibiotic solutions.
- In case of sudden increase in Bacterial blight on fruits take 3-4 sprays at 5 days interval

Spray 1:
Copper hydroxide (2.0 g/ l) + Streptocycline (0.2 g/l) + 2-bromo, 2-nitro propane-1, 3-diol (Bronopol) @ 0.5g/l + spreader and sticker (0.5ml/l)

Spray 2:
Carbendazim (1 g/l) + Streptocycline (0.2 g/l) + 2-bromo, 2-nitro propane-1, 3-diol (Bronopol) @ 0.5g/ l + spreader and sticker (0.5ml/l)

Spray 3:
Copper oxychloride (2.0g/ l) + Streptocycline (0.2 g/l) + 2-bromo, 2-nitro propane-1, 3-diol (Bronopol) @ 0.5 g/l + spreader and sticker (0.5ml/l)

Spray 4:
Mancozeb (2 g/l) + Streptocycline (0.2 g/l) + 2-bromo, 2-nitro propane-1, 3-diol (Bronopol) @ 0.5g / l + spreader and sticker (0.5 ml/l)

Note 1: The above spray sequence should be continued at an interval of 15 days during rains, high humidity and cloudiness. If these conditions do not prevail then spray should be given at an interval of 20 days if no infestation is observed then spray at 30 days interval. Use sticker @ 0.5ml/l during rainy season

Note 2: Spraying should **be**stopped 30 days before harvest if the weather is dry, whereas in rainy season it should be stopped 20 days before harvest.

a) Infection on leaves

b) Infection on twigs

c) canker like lesions on stem

d) Infection on fruits (early)

e) Infection on fruits (later)

Plate 1: Typical symptoms of bacterial blight on different parts of pomegranate plant

Immune Stimulating Complex (ISCOMS) In Vaccine Formulations

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The immune stimulating complex (ISCOMs) is one of the most attractive vaccine formulations. ISCOM is a special cage-like nanoparticle about 40-60nm in size containing viral antigens, lipids and immune stimulating compounds (saponins of plant origin). ISCOM induces broad spectrum of immune responses (humoral, cellular and mucosal) is due the combination of successful antigen presentation and the powerful immune modulatory capability of plant compounds. They are used as a delivery system for vaccine antigens, targeting the immune system both after parenteral and mucosal administration. It is made up of saponin, lipids and antigen usually held together by hydrophobic interaction between these three components. The compulsory elements to form the ISCOM structure are cholesterol and saponin.There are a number of saponins that can form ISCOMs, and many other substances (including antigens, targeting and immuno-modulating molecules) can be incorporated into the ISCOM provided they are hydrophobic or rendered to be hydrophobic. Thus, it is possible to create ISCOM particles with different properties.When the antigen is omitted the ISCOM-MATRIX is formed.

Types of ISCOMS

1. **Classic ISCOM** - Formed by the combination of cholesterol, saponin, phospholipid and viral envelope proteins.
2. **ISCOM matrix** - Also called empty ISCOMs or ISCOMATRIX. Both forms are made identically with the exception that no protein is added to the ISCOM matrix but they still retain the basic ISCOM structure.

Mechanism of action

Viral peptides (or) antigens placed into ISCOMs micelles are delivered to the cytosol of APCs when ISCOMs fuse with the cell membrane. The released viral peptides are transported into the endoplasmic reticulum, where they can be bound by newly synthesized MHC class I molecules and hence transported to the cell surface as peptide/ MHC class I complexes. Similar as viral infected cells, ISCOMs trigger a T cell-mediated antiviral response.

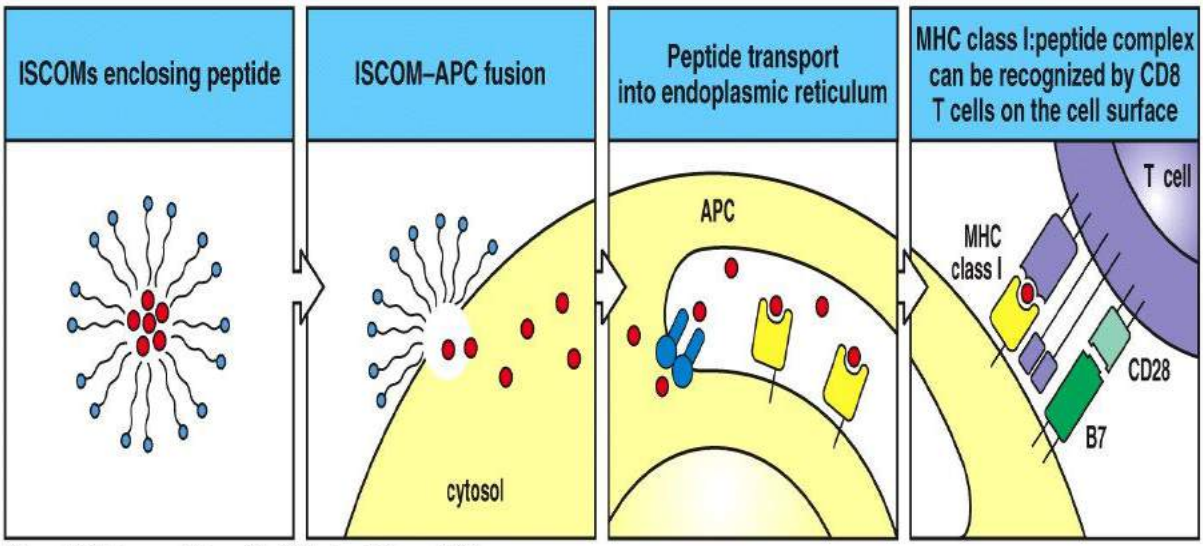

Figure 14-27 Immunobiology, 6/e. (© Garland Science 2005)

Immune response generated by ISCOMs

ISCOMs are generally capable of inducing both antibody and T-cell responses. After mucosal administration by the intranasal or the intestinal routes, the ISCOM induces strong specific mucosal IgA responses in local and remote mucosal surfaces. Also T cell responses are evoked by the mucosal administration.

Parenteral administration

After parenteral immunisation of the ISCOM, the T cell response is first detected in the draining lymph node.Subsequently, the T cell response is localised to the spleen, while the B cell response is first found both in the draining lymph nodes and in the spleen. Later, the majority of the antibody producing cells is found in the bone marrow (BM).In contrast, antigens that have been adjuvanted in an oil emulsion, limit the T cell response to the draining lymph nodes while the B cell response is found in the draining lymph nodes and spleen, but not in the BM.

Clinical and protective effects of ISCOMs

ISCOMs have been shown to be effective against a great number of pathogens in a number of species.The early ISCOMs were mostly formulated with the surface antigens from viruses, which are also targeting devices of the corresponding viruses such as the envelope proteins of influenza and respiratory syncytial viruses (RSV), which are used by the pathogens to penetrate the mucus membrane of the respiratory tract.

Horses

The first commercial ISCOM vaccine was used in horses and it contains the envelope proteins haemagglutinin (HA) and neuraminidase (NA) from influenza virus. This vaccine induces a long lasting immune response, i.e. >15 months including a cytotoxic T cell response. Recently, an anti-conception vaccine using ISCOM-MATRIX has been registered in Australia and New Zealand for horses. It is mainly used in mares to suppress estrus, which is a disturbing factor when stallions are around. An ISCOM vaccine with the envelope antigens from EHV-2 was shown to protect against natural infection with RE. At the same time this experiment showed

that EHV-2 was a major contributing factor for foal lameness by allowing opportunistic infection with RE. Crucial factor for the success of the ISCOM vaccine is the capacity to induce immune response in 10-day-old foals in contrast to the commercially available conventional vaccines.

Ruminants

In a Canadian vaccination experiment ISCOMs containing the BHV-1 envelope proteins administered intramuscularly to cows induced protection to disease and reduced by a 1000-fold virus excretion after challenge with virus infection of the respiratory tract.In a similar experiment carried out in Hungary, 2 weeks after the second vaccination, all the animals were challenge-infected intranasally with a virulent BHV-1 strain and 4 days later with a virulent *Pasteurellamultocida*, in order to mimic hard field exposure. When exposed to challenge infection, all the animals vaccinated with the ISCOMs were fully protected. No virus could be recovered from their nasal secretions and no clinical symptoms were recorded. In contrast, the animals vaccinated with the commercial vaccine responded to challenge with moderate fever and loss of appetite and the virus was isolated from the nasal secretions. The animals in the control group developed severe clinical symptoms. In the sera of ISCOMvaccinated animals, the virus neutralisation titres reached levels of 1/3500 or higher. Bovine virus diarrhoea virus (BVDV) is a major concern in cattle causing abortion, respiratory disease and enteritis. In a sheep model, an ISCOM vaccine containing the BVDV induced protection against experimental infection.Recently a BVDV vaccine using ISCOM-MATRIX as adjuvant has been registered in Australia and New Zealand

Dogs & Cats

In the cat, infectious diseases are often chronic and even persistent. One such persistent infection is caused by feline leukaemia virus (FeLV). In dogs vaccine against CPV was developed.

Chicken

An experimental ISCOM vaccine containing a number of proteins including p64 and p56 from *Mycoplasma gallisepticum* protected chickens against experimental infection with a single administration of a dose as low as Ag.The protection was measured by a significantly reduced lesion score in the air sac after challenge. Both the route of administration and the antigen concentration of ISCOMs, containing *Eimeriatenella* antigens and saponins from native plants, were evaluated in their ability to stimulate humoral immunity and to protect chickens against a challenge infection with E. tenella. Broiler chickens were immunized with ISCOM preparations containing *E. tenella* antigens and the purified saponins Gg6, Ah6 and Gp7 isolated from *Glycyrrhizaglabra*, *Aesculushippocastanum* and *Gipsophilapaniculata*, respectively.Single intranasal immunization was the most effective route for administering ISCOMs although the in ovo route was also quite effective.Immunization of birds by any of the three routes with *E. tenella* antigens alone or antigens mixed with alum hydroxide adjuvant resulted in lower serum antibody and reduced protection to challenge relative to immunization with ISCOMs.

CONCLUSIONS

The ISCOM is a versatile delivery system, which allows interchange of vaccine antigens, targeting molecules as well as the immune modulating components. Since the ISCOM and the ISCOM-MATRIX can be blended with live attenuated vaccine antigens without hampering the proliferation of the live vaccine antigens, it opens the possibility to use the ISCOM adjuvant system in a mixture of live and killed vaccine antigens. We can expect that more ISCOM products will soon come to the market.

Therapeutic Bioproducts From Transgenic Animals

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Transgenic animals are animals that are genetically altered to have traits that mimic symptoms of specific human pathologies. They provide genetic models of various human diseases which are important in understanding disease and developing new targets. ATryn the first drug approved by USFDA from transgenic animals was developed and it has opened door to drugs from transgenic animals. Use of transgenic animals will provide solutions for drug research, xenotransplantation, clinical trials and will prove to be a new insight in drug development. Since the first transgenic mice were generated in 1982, transgenic animal models have been used extensively to investigate biomedical important mechanisms underlying a variety of diseases, to develop and evaluate new therapies. Thus transgenic animals have the ability to fulfill the needs of the pharmaceutical industry and in coming years they are looked as potential contributors to the drugs and research in medicine.

Development of Transgenic Animals

There are three types of laboratory animal models, they are spontaneous, induced and transgenic. Spontaneous models shape up as a result of naturally occurring mutations. Induced models are produced by a laboratory procedure like administration of a drug or chemicals, feeding of special diets or surgical procedure. The third category includes transgenic models.Transgenic refers to insertion of cDNA (complimentary deoxyribonucleic acid) made from specific mRNA (messenger ribonucleic acid) into cells. A transgenic animal is defined as an animal which is altered by the introduction of recombinant DNA through human intervention.

The foreign DNA can be inserted into the pronucleus or cytoplasm of the embryo using microinjections or transposon. Other methods of DNA transfer are by lentivirus, sperms, pluripotent cells and cloning. The last three methods allow random gene addition and targeted gene integration *via* homologous recombination or gene replacement thus causing mutation.Targeted mutation refers to a process whereby a specific gene (removal of a gene or part of a gene) is made nonfunctional (knocked-out) or less frequently made functional (knocked-in).A transgenic organism carrying more than one transgenes is known as multiple

transgenic.These methods do not create new species, but only offer tools for producing new strains of animals that carry novel genetic information.

Transgenic Animal models of various diseases

An animal model is a living, non-human animal used for research and investigation of human disease, for the purpose of better understanding the disease without the added risk of causing harm to a human being during the entire drug discovery and development process. Transgenic animal models are created by the insertion of a particular human DNA into fertilized oocytes which are then allowed to develop to term by implantation into the oviducts of pseudo pregnant females. There are different models of transgenic animals for various diseases.

Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome (HIV/AIDS):

Tg26 HIVAN Mouse Model was the first transgenic model developed in 1991 for HIV. These transgenic animals can express HIV-1 proteins; develop symptoms and immune deficiencies similar to the manifestations of AIDS in humans. Other models are AIDS Mouse and Smart Mouse.

Alzheimer's disease: No animal models existed for the disease before transgenic technology was employed. Immunization of Amyloid precursor protein A42 in transgenic mice showed that vaccination against Alzheimer's disease could have potential as a therapeutic approach. Different animal models like Alzheimer's mouse, amyloid pathology mouse models like PDAPP mice, Tg2576 mice and presenilin transgenic models like ApoE knockout are developed to study Alzheimer's disease.

Cardiovascular disease: Various transgenic animal models for gain and or loss of function of angiotensin, endothelin, natriuretic peptides, catechoalmines, Calcium binding-signaling, sodium channel transporters, and nitric oxide synthesis involved in cardiovascular regulation are used to study cardiovascular diseases. Transgenic models of heart failure and hypertrophy like Gene overexpression of Calmodulin, Gene mutation of alpha cardiac myosin heavy chain and Knockout gene model of transforming growth factor are developed.

Diabetes Mellitus: Transgenic models are developed for studying the genes, and their role in peripheral insulin action. Models of insulin secretion such as glucokinase, islet amyloid polypeptide, and hepatic glucose production in type 2 diabetes are developed. A transgenic mouse model that expressed Insulin Dependent Diabetes Mellitus by inserting a viral gene in the animal egg stage is also developed.

Angiogenesis: Mouse models of angiogenesis, arterial stenosis, atherosclerosis, thrombosis, thrombolysis and bleeding addresses techniques to evaluate vascular development.Inhibition of angiogenesis is currently one of the biggest opportunities for new cancer therapies. With the help of angiogenesis transgenic animal models inhibitors are identified which act on specific mechanisms of angiogenesis.

Cancer diseases: Onco-mouse was first transgenic animal to be patented. Its germ cells and somatic cells contain an activated human Oncogene sequence

introduced into the animal at an early embryonic stage to ensure that the oncogene is present in all the animal cells. Transgenic animal models are used in the assessment of mutagenicity, carcinogenicity and tools for understanding metabolic enzymes and receptors.

Products from Transgenic Animals

Most transgenic species are studied for research applications as well as potential commercial pharmaceutical productively. Some of the transgenic animals and their products in development are listed below.

Goats: Monoclonal Antibodies (MAbs) , Ig fusion proteins, tPA (tissue Plasminogen Activator), ATryn (recombinant human antithrombin III) is the first transgenic recombinant protein from transgenic animal approved by the United States Food and Drug Administration (USFDA) inJanuary 2009.

Chickens and Eggs: Vaccines; interferons, cytokines; Human Serum Albumin (HSA), insulin,MAbs.

Pigs: organs for xenotransplantation, human hemoglobin, human protein C.

Cows: Factors VIII and IX, protein C, recombinant antithrombin III (rATIII), recombinant HSA, and human milk protein.

Mice: expression of malaria protein for vaccine development; MAbs, ATIII, beta interferon; cystic fibrosis transmembrane regulator; Factor X, HSA, tPA, myelin basic protein; prolactin; fibrinogen and antineoplastic urinary protein.

Rabbits: recombinant human C1 inhibitor, human erythropoietin, human alpha antitrypsin, human interleukin 2, tPA, alpha glucosidase, and human growth hormone.

Sheep: sheep milk includes fibrinogen (major constituent, with thrombin and Factor XIII) human Factor VII, Factor IX, activated protein C and alpha-1-antitrypsin.

Problems with drugs from transgenic animals:

Erythropoietin could not be expressed in the mammary gland of transgenic cattle. The recovery rates of Factor VIII protein were low. Another concern is leakage of a target protein into the circulation by way of the mammary epithelial cells and as measured by increased plasma levels of the protein designed to be expressed only in the animal's milk. There is also a risk of transmission of infection from animal to man. There are some unique concerns such as premature lactational shut down observed in some animals expressing recombinant proteins in their mammary gland. While there are problems associated with transgenic animals, the benefit derived from them is far superior and with the increase in technology this could be solved.

CONCLUSION

Major prerequisites for success and safety of transgenic animals will be a continuous refinement of reproductive biotechnologies. In coming years genetically modified animals will play a significant role in the field of biomedicine especially in drug development, animal disease models, xenotransplantation, antibody production, gene-pharming and blood replacement. The regulatory aspects and ethics should be given due consideration while using transgenic animals.From research, pigs and

transgenic animals derived products like milk, eggs seems to be promising in developments of therapeutic strategies. Drugs from transgenic animals can minimize the attrition rate in clinical trials by increasing the quality of the target and compound combinations making the transition from discovery into development. Transgenic technology can impact at many points in the discovery process, including target identification and target validation.

Bull Breeding Soundness Examination For Better Quality Semen Production

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Abstract

The breeding soundness examination (BSE) forecasts about bull's ability to get cows pregnant. It is done to know the libido, fertility status of bull and screening of various genital diseases. The examination of bull for breeding soundness though is rarely required (compared to females) but needs clinical competency, acquaintance with bull's psychology, patience, common sense, knowledge of clinical pathology and sometime also the senseful courage and athletic power in the veterinarian. Examination of bull should be done in a pre-planned manner. Outcome of breeding soundness examination is given on the basis of evaluation of various components like history, clinical examination, semen analysis and various diagnostic tests.

Introduction

The breeding soundness examination (BSE) is a prediction of a bull's ability to get cows pregnant and is typically performed on bulls that are used for natural service. Animals are usually presented for a breeding soundness exam for four basic reasons. The first reason is a prebreeding exam. Bulls are examined, usually a month before breeding, so that one knows for sure that they are normal before they are placed in with females. 3 The second reason for a BSE is during the breeding season when an abnormal number of females are returning to estrus. A third reason is a pathology consideration in which the bull is suffering from frostbite, testicular swelling, an inability to service, or a systemic disease. The final reason for a BSE is a presale exam, thus making sure the animal is a sound potential breeder before the bull is sold in the ring.

Procedure

The examination of bull for breeding soundness though is rarely required (compared to females) but needs clinical competency, acquaintance with bull's psychology, patience, common sense, knowledge of clinical pathology and sometime also the senseful courage and athletic power in the veterinarian. Examination of the bull should be conducted in a pre-planned manner so that no part of significance is left unexamined. Even though the bull is gentle, it should never be trusted. Bull should be well secured in a stanchion

and slowly approached, talking in tones of kindness. First approach should be towards the shoulder instead of back of the bull. Sudden moves, loud noise, sudden entry of the strange person etc. should be avoided during examination so that the bull is not excited. Name and identification of each bull should be recorded. The components of breeding soundness examination are as follows:-

1- Identification, history and general clinical examination
2- Detailed clinical examination of genital tract
3- Observation of mating behaviour and coitus
4- Collection and evaluation of semen
5- Other diagnostic tests

1. Identification, history and general clinical examination

Identification

Sire should be positively identified during the examination. The necessity of identification is clear during generation of health certificate. It is also important when an animal is being examined for infertility. Ear tags help in identifying a bull from a distance.

History

History regarding the Dam's yield, Grand Dam's yield and if possible the yield of progeny should be noted. Timing of puberty and sexual maturity should be noted. The level of exotic inheritance should be known in cases of crossbred bulls. We should record the mating system and rearing system of the bull along with the fertility records. The records of female bred by the bull should also be critically analysed for incidence of abnormal discharge, abortion and delayed return of estrum following service. History regarding the previous infertility should also be recorded. The records of all vaccination should be collected. Examiner should also determine the presence of recessive genes in the bull which can be carried to the next generation and prove lethal, semi lethal or would be undesirable.

General clinical examination

General clinical examination should be conducted in such a way that no organ/part of the body is omitted without investigation. This should take account of the age, sexual maturity, body condition, confirmation, intercurrent illness and temperament. This includes assessment of physical condition, integument and body wall, digestive system, urinary system, circulatory system, lymphatic system, respiratory system and locomoter system. All the mentioned body systems should be normal and free from any abnormalities

2. Detailed clinical examination of genital tract

(a) Examination of the external genital organs- this includes the examination of scrotum with testes, penis and prepuce.

Scrotal and testicular palpation is done to assess size, texture, tone and eveness of testes. The testes should be freely movable within the scrotum and should be firm and resilient. Testicular tone is normally firm while, softness or flabbiness is often associated with testicular dysfunction or degeneration. Excess hardness or an irregular contour may indicate fibrosis or calcification

after degeneration or inflammation. Increased temperature should be noted, as should any asymmetry of the testes. It is generally possible to palpate the head and tail of the epididymis, but the body is often difficult because of its medial position. The tail of epididymis should be assessed for turgidity: a flaccid structure is associated with either a disruption of sperm production or depletion of sperm reserves through overuse. The ductus deferens should be palpated throughout the scrotal neck. The spermatic cord should be palpated up to the level of the inguinal ring for the presence of abdominal contents (scrotal hernia) or abnormalities of spermatic vasculature. Testis volume is highly correlated with daily sperm output. Hence, measurement of scrotal circumference is a common part of breeding soundness examination of animals with a pendulous scrotum. The scrotal circumference is measured with the help of a specialised tape at the widest point of the scrotum ensuring that the testes are in scrotum by pulling them down and kept together. Minimal scrotal circumference for yearling, 2-year-old and >2year old should be 32cm, 34cm and 38cm respectively.

Penis and prepuce can be examined at the time of semen collection using AV or by palpation. There should be full penile development. There should not be any abnormality, trauma, inflammation and adhesion in the penis and prepuce.

(b). Examination of internal genital organs

This includes the per-rectal examination of accessory sex glands. Ampulla, vesicular gland, bulbourethral gland, and prostate are the accessory sex glands present in the bull. Except prostate, all the accessory glands are paired. Ampulla is 10-12 cm long and 1-1.5 cm in diameter. They can be palpated as the broadened terminal parts of vas deferens lying dorsal to neck of the bladder. Vesicular gland is located on the pelvic floor on each side of the ampulla. It is about 10-15 cm long and 2-4 cm in diameter. Inflammation of this gland is common in the bulls. Normally the gland is flexible but during inflammation the flexibility may be lost in varying degree. Bulbouethral glands are located on either side of pelvic urethra near the ischial arch.

3. Observation of mating behaviour and coitus

Assessment of libido and serving ability is widely used in the examination of bull for breeding soundness. Libido is scored according to the number and vigour of mating attempts. Number of mounts and effective services are recorded in the serving capacity test.

4. Collection and evaluation of semen

It is of great diagnostic value in determining the cause, severity and the degree of the pathological conditions of the testes and other genital organs. The quality of semen is also of value in predicting the fertility of male. The different tests for semen evaluation are as follows:

1. **Appearance**- semen should not have any flake or debris.
2. **Colour** – normally colour of bull semen is creamy white having slight yellow colour due to presence of riboflavin secreted by seminal vesicle.
3. **Consistency**: normal consistency of bull semen is thick creamy.

4. **Volume:** average volume of bull semen is 4 ml, but it may range from 1-15ml**.**
5. **Mass motility**: mass motility of bull semen should be a grade of more than +3.
6. **Individual progressive motility:** individual progressive motility of bull semen should be >70%
7. **pH**: it is around 6.8, but it may range from 6.2-7.5
8. **Concentration of spermatozoa:** bull semen normally have 300-2500 million spermatozoa /ml
9. **Live sperm percentage**: bull semen should have more thn 70% live spermatozoa
10. **Sperm abnormalities**: in bull semen, major spermatozoa abnormalities should not be more than 10% or total abnormalities should not be more than 20%.
11. **Other tests includes**: Catalase test, Resistance to cold shock, Millovanov's resistance test, Methylene blue reduction test, Resazurine reduction test, Fructolysis index and oxygen utilization test etc.

5. Other diagnostic tests- Testing of bulls for Tuberculosis, Johne's disease, Brucellosis, Campylobacteriosis, Blue tongue and Trichomoniasis should be done. As per OIE guidelines, the breeding bulls should be free from above mentioned diseases.

Outcome

The outcome of a breeding soundness examination may be as follows

• **Satisfactory-** The animal is considered satisfactory in all components of the examination.

• **Re-evaluate/Temporarily unsound**- The sire has failed to meet a satisfactory standard in critical areas (or there have been aspects of its performance that could not be satisfactorily evaluated.) A re-evaluate outcome should be confined to circumstances in which there is a reasonable expectation of improvement with time

• **Unsatisfactory/unsound**- A sire that is not satisfactory in one or more critical components of the examination is 'unsatisfactory' or 'unsound'. Some of these animals are sterile, but most are considered unlikely to have acceptable fertility in the circumstances in which they are expected to work.

• **Qualified pass-** Animals that are close to the 'cut point', in critical criteria between being classified as satisfactory or unsatisfactory, may possibly be considered as candidates for a qualified pass. In giving such an assessment, it should be made clear that there are significant reservations about the animal being usable, but that it may be able to manage a reduced work-load or to work under close observation.

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Estrus Synchronization in Farm Animals

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In the management of livestock, manipulation of normal cyclic activity certain times ensures optimum production and is convenient for the herd manager. Synchronization is the technique by which most of the females in a herd can be brought into estrus at a pre-determined time with a reasonable accuracy.

Advantages:

- Synchronization allows one to predict the time of estrus and thereby reduces the time required for detection of estrus.
- Allows planned breeding of females at a particular time
- Effective management of silent estrus and anestrus
- Grouping of animals into desired parturition pattern
- Uniformity of calves at weaning
- Ability to produce offspring out of season in case of seasonal breeder

Limitations:

- Drug expense and labor
- An existing high level of management is required
- Good handling facilities are required
- Difficulty in adaptation by small animal holders
- Prostaglandins are effective only in cyclic animals

Methods of estrus synchronization:

- Non- hormonal method
  a) Light
  b) Presence of male
  c) Weaning
- Hormonal method:
  a) Extending the luteal phase
  b) Shortening the luteal phase

Cattle:

- Prostaglandins – regression of CL (animal should be in cycle)

Natural 25 mg Synthetic 500 mcg	Two injections 11 days apart	Estrus 3-5 days post treatment

- Progesterone: Prevent estrus and ovulation

CIDR (P4 1.9gm) or PRID (1.55gm) PG 25mg	Vaginal pessary for 7 days with PG injection on 6th day	Estrus 2-3 days post treatment

- Progestogen with estradiol

Estradiol valerate 5mg + Norgestemet 3mg, injection Ear implant CRESTAR (norgestemet 3mg) Synchromate-B(norgestimet 6mg)	E2 + P4 injection on day 1 Ear implant s/c on same day for 9 days PG can be given on 1 day before implant removal	Estrus 3-5 days post treament

- GnRH - Ovulation, terminate follicular wave

GnRH + PG Buserelin (.0042mg/ml) 2.5ml i/m	GnRH day 0 followed by PG on day 6	Estrus 2-4 days post treatment
GnRH + PG	GnRH day 0, PG day 7, GnRH day 9	Estrus 2-4 days post treatment

Sheep and Goat –

- Progestogen-

P4 pessary (CIDR) 400-800 IU eCG	Pessary 12-14 days in sheep 18-21 days in goat eCG at implant withdrawal	Estrus 2 days post treatment

- Prostaglandins-

Natural P4 20 mg	Sheep 2 inj. 9 days apart Goat 2 inj. 11 days apart	Estrus 2-3 days post treatment

- Light –

Decreasing photoperiod synchronizes the endocrine events that trigger the onset of cyclical ovarian activity. Usually starting at the winter solstice, ewes are exposed to artificial light, usually 16–18 hr/day for 8 wk. At the end of this period (e.g.mid-winter), the length of light exposure is reduced to 8 hr/day. This may require darkening windows to reduce exogenous light sources. After 6–8 wk, ewes will start to cycle.

- Presence of male -

Sudden placement of male with females induces an LH surge and ovulation in days (Ram effect and Buck effect in sheep and goat respectively) and degree of synchronization in a herd. Females typically exhibit estrus within 72 – 144 hrs.The physiological basis for response is smell and sight.

- Melatonin (Sheep) –

During the non- breeding season, melatonin implants (18 mg) induce fertile estrus 50–70 days after implant insertion. Better results are obtained when melatonin implants are inserted early or during the transitional period.

Swine-

- Progestogen –

Altrenogest 15-20mg/day	Orally for 14-18 days	Estrus 4- 7 days post treatment

- Weaning of piglets –

If litters from number of sows are weaned at the same time. Occurrence of some degree of synchronization is seen.

- Prostaglandins are not useful as CL do not respond to it during first 12- 13 days of estrus cycle.

Horse-

Progestogen-

Alternogest 0.44mg/kg/day	Orally for 15 days	Estrus 4-7 days post treatment

- Prostaglandins-

Natural 10mg i/m Synthetic 250 mcg i/m	Inj. to mare in diestrus	Estrus 3-5 days post treatment

- Prostaglandins with hCG

Natural PG 10mg hCG 2500IU	PG on day 1followed by hCG on day 7-8 Again PG on day 15 then hCG on day 21-22	Estrus 2-4 days post treatmnt

- Light-
  Artificial light with increasing duration of 25-30 min each week should be provided at end of winter. 16 hrs of daylight produce behavioral response 60- 90 days after program is initiated.

CONCLUSION

Estrus synchronization can be an effective tool for enhancing reproductive effeciency of farm animals

Scenario of insect-pests under global warming and climate change circumstances: An overview

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Abstract

Insects being poikilotherms, temperature is probably the single most important environmental factor influencing their behaviour, distribution, development, survival, and reproduction. Global warming and climate change will trigger major changes in diversity and abundance of arthropods, geographical distribution of insect pests, population dynamics, insect biotypes, activity and abundance of natural enemies, species extinction, and efficacy of crop protection technologies. Changes in geographical range and insect abundance will increase the extent of crop losses, and thus, will have a major bearing on crop production and food security. Distribution of insect pests will also be influenced by changes in the cropping patterns triggered by climate change. Major insect pests such as cereal stem borers (Chilo, Sesamia, and Scirpophaga), the pod borers (Helicoverpa Maruca, and Spodoptera), aphids , and white flies may move to temperate regions, leading to greater damage in cereals, grain legumes, vegetables, and fruit crops. Global warming will also reduce the effectiveness of host plant, transgenic plants, natural enemies, biopesticides, and synthetic chemicals for pest management. Therefore, there is a need to generate information on the likely effects of climate change on insect pests to develop forceful technologies that will be effective in future under global warming and climate change.

INTRODUCTION

Climate change refers to a change of climate that is attributed directly or indirectly by human (anthropogenic) activity that alters the composition of the global atmosphere and climate variability observed over comparable time periods. Climate encompasses the long-run pattern of numerous meteorological factors (e.g. Temperature, humidity, atmospheric pressure, wind, rainfall, sunshine etc.) in a given location or larger region. Past some decades, the gaseous composition of earth's atmosphere is undergoing a significant change, largely through increased emissions from- energy sector, Industry sector, agriculture sectors, widespread deforestation, fast changes in land use, land

management practices. These anthropogenic activities are resulting in an increased emission of active gases, *viz.,* carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), chloroflourocarbons (CFC_S) popularly known as the 'greenhouse gases' (GHGs). According to inter-governmental Panel on climate change (IPCC), the global mean surface air temperature has increased by nearly 1 °C over the past centuary, and it is expected to continue to increase by 1-3°C by the middle to end of 21st Century (IPCC, 2007) in response to two-folds increase in atmospheric carbon dioxide and other GHG_S (Table 1).The global warming is expected to lead to other regional and global changes in the climate-related parameters such as rainfall, soil moisture, and sea level. (IPCC, 2001). Snow cover is also reported to be gradually decreasing. Agriculture is affected by climate change, with particularly adverse effects in developing countries. Climate change also influences the ecology of weeds, pests and disease, with possible implications for crop protection and pesticide use.

Therefore, it is highly expected that, the major drivers of climate change *i.e.* elevated CO2, increased temperature and depleted soil moisture can impact population dynamics of insect-pests. The occurrence of climate changes is evident from increase in global average temperature, changes in the rainfall pattern and extreme climatic events. These seasonal and long term changes would affect the fauna, flora and population dynamics of insect pests (Srivastava *et al*. 2010, Pandey 2008),. The abiotic parameters are known to have direct impact on insect population dynamics through modulation of developmental rates, survival, fecundity, voltinism and dispersal.

Causes of climate change

There are several causes of climate change. Among them some are as following-

(A) Natural Causes

- Continental drift
- Volcanoes
- The Earth's Tilts
- Ocean Currents
- Intensity of Solar Radiation

(B) Anthropogenic Causes

- Green Houses Gases
- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (NO_2)
- Chloro floro carbons (CFCs)
- Ozone (O_3)
- Water Vapors (H_2O)
- Land Use Change
- Deforestation
- Urbanization

Effect of elevated CO2 on insects

Impact of CO2 on insect population via host plants can be studied through open top chambers (OTCs) and free air carbon dioxide enrichment (FACE). OTCs are essentially plastic enclosures placed around a sample of an ecosystem. Air is drawn into a box by a fan, enriched with CO2, and blown through the chamber. Open-top chambers are relatively inexpensive to build because they consist simply of an aluminium frame covered by panels of polyvinyl chloride plastic film. The FACE technology facilitates modification of the environment around

growing plants to future concentrations of atmospheric CO2 under natural conditions of temperature, precipitation, pollination, wind, humidity, and sunlight. FACE field data represent plant responses to concentrations of atmospheric CO2 in a natural setting.

Impacts of Climate Change on Insect-Pest

Insects are the most diverse group of animals on Earth an estimated 6-10 million. The major predictions about impacts of climate change on insect-pests are compiled and presented in table 2.

Loss of ecological biodiversity

The biodiversity signifies the biological wealth of habitat by means of species richness in an ecosystem. For sustainable agriculture development in any given country, biodiversity is of paramount. South Asia in general and India in particular is blessed with ecologically rich natural and crop-related biodiversity due to its unique geographic location and diversified climatic conditions (Fig 1). India is one of the 12 mega-biodiversity centers with three out of 34 biodiversity hotspots in the world. Due to change in the climate pattern in recent decades owing to increasing industrialization and over-exploitation of natural resources for various anthropogenic developmental activities, many species of plants, animals and insects are decreasing at an alarming (Porter *et al*.1991, Lange *et al*. 2006 Kiritani 2006). The loss of biological diversity is still accelerating which may reduce the ecosystem's resilience to the climatic changes. Insects comprise the largest group of animal kingdom and play vital role in providing various ecosystem services. The insect diversity in a habitat indicates the health status of an ecosystem as they are very good indicators of environmental change, play an important role in food chains, are excellent pollinators for many of the economically important and contribute directly to the human economies through valuable products like silk, lac, honey and wax. The climate change may affect the relative abundance of different insect species and the species unable to adapt the changes may be lost in the due course of time. The loss of biodiversity may impact negatively the structure, composition and functioning of ecosystems and wildlife habitat leading to outbreaks of destructive insect-pests and disease.

Fig- 1 showing the indirect effects of climate change are affiliated with host plants, competitors and natural enemies

Increased overwintering survival

Being poikilotherms, insects have limited ability of homeostasis with external temperature changes. Hence they have developed a range of strategies such as behavioural avoidance through migration and physiological adaptations like diapause to support life under thermally stressful environments. Diapause is a period of suspended developmental activities, the manifestation of which is governed by environmental factors like temperature, humidity and photoperiod. As an adaptive trait, diapause plays vital role in seasonal regulation of insect life cycles because of which the insects have better advantage to survive great deal of environmental adversities. There are two main types of insect diapause; aestivation and hibernation to sustain life under high and low temperature extremes respectively .Global warming is occurring notably in winter than in summer and is greatest at high latitudes Looking at the past 100 years climate profile of India, warming was more pronounced during winter season and it was the minimum and not the maximum temperature where significant increase was observed. The temperature in India is expected to increase by 1-50C within next 100 years. Thus, insects undergoing a winter diapause are likely to experience the most significant changes in their thermal environment. Accelerated metabolic rates at higher temperatures shorten the duration of insect diapause due to faster depletion of stored nutrient. Warming in winter may cause delay in onset and early summer may lead to faster termination of diapause in insects, which can then resume their active growth and development.

Increase in number of generations

Temperature being the single most important regulating factor for global increase in temperature within certain favourable range may accelerate the rates of development, reproduction and survival in tropical and subtropical insects (Fig 2). Consequently, insects will be capable of completing more number of generations per year and ultimately it will result in more crops.

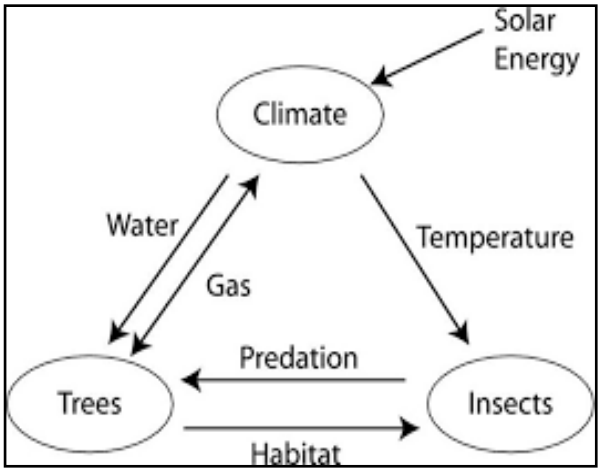

Fig-2 showing the interaction between insect-pests and climate change

Risk of introducing invasive alien species

Even though the causes of biological invasions are manifold and multifaceted, changes in abiotic and/or biotic components of the environment (climate change, biological control) are recognised as primary drivers of species invasion. Globalization and liberalization of world agricultural trade coupled with the rapid transport and communication means nowadays, have substantially and plausibly

increased the chances of exotic introductions.

Reduced effectiveness of biological control agents

Biological control of insect-pests is one of the important components of integrated pest management, safeguarding the ecosystem. Natural enemies of crop pests *viz*., predators, parasitoids and pathogens are prompt density responsive in their action subjected to the action of abiotic components. Being tiny and delicate, natural enemies of the insect-pests are more sensitive to the climatic extremes like heat, cold, wind and rains. Precipitation changes can also affect predators, parasites and pathogens of insect-pests resulting in a complex dynamics. With changing climate, incidence of entomopathogenic fungi might be favoured by prolonged humidity conditions and obstinately be reduced by drier conditions. Natural enemy and host insect populations may respond differently to changes in climate. Hosts may pass though vulnerable life stages more quickly at higher temperatures, reducing the window of opportunity for parasitism which may give great set back to the survival and multiplication of parasitoids

Adaptation Strategies to Climate Change

- Developing cultivars tolerant to heat and salinity stress.
- Resistant cultivars to flood and drought.
- Modifying crop management practices.
- Improving water management.
- Adopting new farm techniques such as Resource Conserving Technologies (RCTs).
- Crop diversification.
- Improving pest management.
- Better weather forecasting.
- Crop insurance and harnessing the indigenous technical knowledge of farmers.
- Developing Climate-ready Crops.
- Diversification of crop and livestock varieties

Adaptation Measure for Climate Change

- Integrated pest management
- Using available early warning system for insect pest.
- Biological control measures.
- Utilization of indigenous traditional knowledge base for Pest control.
- Soil solarization technique.
- Breeding for pest, disease and drought resistance varieties.
- Careful tracking of geographical distribution of pest.
- Phytosanitary regulations to prevent or limit the introduction to risky insect pest.

CONCLUSIONS

The greatest challenge facing humanity in the coming century will be the necessity to double our global food using less land area, less water, less soil nutrients, droughts from global warming. The exact impacts of climate change on insects and pathogens are rather uncertain. Global warming and climate change will have serious consequences on diversity and abundance of arthropods, and the extent of losses due to insect pests, which will impact both crop production and food security. Prediction of changes in geographical distribution and population dynamics of insect pests will be

useful to adapt the pest management strategies to mitigate the adverse effects of climate change on crop production. Pest outbreaks might occur more frequently, particularly during extended periods of drought, followed by heavy rainfall. Some of the components of pest management such as host plant resistance, biopesticides, natural enemies, and synthetic chemicals will be rendered less effective as a result of increase in temperatures and UV radiation, and decrease in relative humidity. Climate change will also alter the interactions between the insect pests and their host plants. As result, some of the cultivars that are resistant to insect pests, may exhibit susceptible reaction under global warming. Adverse effects of climate change on the activity and effectiveness of natural enemies will be a major concern in future pest management programs. Rate of insect multiplication might increase with an increase in CO2 and temperature. Therefore, there is a need to have a concerted look at the likely effects of climate change on crop protection, and devise appropriate measures to mitigate the effects of climate change on food security.

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Table 1. Abundance and lifetime of greenhouse gases in the atmosphere

Parameters	CO_2	CH_4	N_2O	Chlorofluorocarbons
Average concentration 100 years ago (ppbV)	290,000	900	270	0
Current concentration (ppbV) (2007)	380,000	1,774	319	3-5
Projected concentration in the year 2030 (ppbV)	400,000-500,000	2,800-3,000	400-500	3-6
Atmospheric lifetime (year)	5-200	9-15	114	75
Global warming potential (100 years relative to CO2)	1	25	298	4750-10900

Source: IPCC (2007)

Table 2: The major predictions about impacts of climate change on insect-pests

CO_2	Effect on insect-pests
Increasing	Food consumption by caterpillars Reproduction of aphids Effect of foliar application of *Bacillus thuringiensis* Consumption and N utilization efficiency in pine saw fly and Gypsy moth Larval growth in pine saw fly Pupal weight in blue butterfly Feeding and growth rate in tobacco caterpillar Fecundity of aphids on cotton
Decreasing	Insect development rates Development and pupal weight in *Chrysanthemum leaf miner* Response to alarm pheromones by aphids Lipid concentration in small heath Parasitism Effect of transgenics to *Bacillus thuringiensis* Nitrogen based plant defence Control of grain aphids with sticky traps

Direct Impact of temperature on Insect-pest

Temperature	Effect on insect-pests
Increasing	Northward migration Migration up elevation gradient Insect development rate and ovipositions Potential for insect outbreaks Invasive species introductions Insect extinction
Decreasing	Effectiveness of insect bio-control buy fungi Reliability of economic threshold levels Insect diversity in ecosystem and Parasitism

(Source: Das et al., 2011; Parmesan, 2006; Bale et al., 2002; Thomas et al., 2004)

Clinical Handling of Genitalia Prolapse in Bovines

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Prolapse is an important clinical condition having serious implications on production and reproduction. The prolapse of genitalia could be prepartum (before parturition) or postpartum (after parturition) where a portion of the female genitalia is dislocated posteriorly. It can be cervico-vaginal prolapse in pregnant animals or complete uterine prolapse at the time of calving or in the immediate postpartum period.

Etiology

Among the possible etiological factors for its occurrence, besides heredity, deficiency of minerals, oxidative damage to the tissues and endocrine alterations leading to relaxation of perenium are the important causes. Excessive straining by the animal or pulling the retained fetal membranes can also induce uterine prolapse.

Important steps followed while handling

Taking proper history from the owner regarding the case being presented before the clinician.

Securing of animal in order to reduce any sort of injury to both animal and clinician.

Administration of epidural anaesthesia in the form of 2% lignocaine (5ml) at the site of lumbosacral or first intercoccygeal space. Within 1-2 minutes perianal area will be anaesthesised which can be assessed by flaccidity of tail.

Proper anaesthesia will prevent straining and defecation while repositioning the prolapsed mass back to its anatomical position. In addition to above, following steps need to be done sequentially

a) Drainage of urine

Due to prolapse of vagina a kink develops in the urethra that leads to retention of urine in the urinary bladder. This increases the size of the prolapsed mass. Thus, drainage of urine will often reduce the size of the prolapsed mass. Simply lifting the prolapsed mass upward straightens the kink in the urethra and releases the retained urine. Alternatively, it can be drained by using urinary catheter.

b) Reduction of edema

Due to occluded blood supply, the prolapsed mass develops edema. Lifting the prolapsed mass above the level of ischial arch can reduce this edema. Cold water, ice packing or applying hypertonic sugar solution on the prolapsed part can further reduce it. The local administration of oxytocin in the uterine musculature in the uterine prolapse will

also reduce the size of the prolapsed mass.

c) Repositioning of the prolapsed mass

Repositioning of the genitalia is always done under epidural anesthesia**.** Slight lifting of rear parts of the animal will help in easy repositioning. After epidural anesthesia and evacuation of the bladder, thoroughly clean the prolapsed mass with weak Candy's lotion, weak $KMnO_4$ solution or mild detergent and water so as to remove all the dirt, dung or straws sticking to the mass. This helps reduce irritation to the tissues and is an important step for successful treatment of prolapse. Before reposition of the prolapsed mass, tears or lacerations if any should be properly sutured with chromic catgut. Apply antibiotic and anesthetic ointments (lignocaine jelly) on the prolapsed mass to control straining and check the local infections. This also lubricates the tissue and will help easy repositioning. Start repositioning from the lateral walls, then the middle portion followed by roof of vagina and straighten the organ. While repositioning the mass, do not put pressure with the fingertips; instead use the palm to put pressure. In cases of uterine prolapse, putting the arm in the uterine lumen or filling the saline in the uterine horns should ensure complete straightening of the uterine horns. Make sure that most of the infused fluid is drained out.

d) Retention of the prolapsed mass

A number of methods are used for retaining the prolapsed mass such as rope truss, Buhner's sutures, Flessa sutures, winklers technique, reefing operation, modified quill technique, pudendral neurectomy etc. Retention along with supportive therapy ensures that the tissue regains strength and occupies its original position. Among all these remedial procedures following two are commonly employed

1. Rope Truss

Take a 30 feet long rope. Double it and make an 8-knot on the loop side at a distance of 2-3 feet. Adjust it around the neck of the animal. Put another 8-knot at the hump region. 3rd, 4th and 5th knots are put at the level of last rib, sacrum and on the base of tail, respectively. 6th and 7th knots are placed at the dorsal and ventral commissure of the vulva. The free ends of the rope are passed below the hind limbs on the sides of the udder and tied in front of the tuber coxae as a quick releasing knot. The knot below the ventral commissure of vulva is most important as it puts pressure on the part to retain it.

Precautions

- Always use a cotton rope and never use the jute or nylon rope for making truss.
- Avoid too much pressure on the vulvar lips and open the knot at the time of delivery.
- The part of rope around the vulvar lips should always be bandaged/covered so that the rope does not cut through the vulvar tissue.

2. Buhner's sutures

These are applied under epidural anesthesia with a special needle, the Buhner's needle. An incision on the skin is made one inch below the ventral commissure of vulva. Thoroughly sterilized Buhner's needle is passed below the skin at a distance of two inches from the vulvar lips towards the dorsal commissure of vulva and taken out between anus and the dorsal vulvar commissure. Here the skin may also need a small incision. A nylon ribbon, umblical

tape or bandage (about two feet long) dipped in antiseptic solutions like povidone iodine (Betadine), is passed through the eye of the needle and the needle is withdrawn from the same tract. Then pass the needle on the other side of vulvar lips from the same ventral incision and bring out of the same dorsal incision. The free end of tape is loaded into the eye and the needle similarly withdrawn. This forms an encircling sub-cutaneous stitch around the vulvar lips. Finally, an easy release knot is tied at the ventral commissure keeping a gap of 4 inches between the dorsal and ventral commissure of vulva. This puts a uniform pressure on vagina and helps retain the prolapse. It does not obstruct regular flow of urine and prevents vulvar edema. Occasionally if edema develops, slightly loosen the knot. This will prevent venous congestion and establish normal blood circulation. Buhner sutures can be kept for up to two weeks if the incision site remains clean.

Treatment

Before doing any sort of medecation, per rectal examination of genatilia is must. This is due to the reason that the prolapse of genatilia may be due to ovarian cyst (follicular cyst). If it happens to be there, accordingly line of treatment may be followed as: injection of GnRH analogue, receptal 5ml or LH (2000-3000 I.U) may be given. Besides it, phosphorus injection/ mineral mixture and vitamin B–complex may be given, in the form of tonophosphan 15 ml intramuscularly, to rule out any sort of phosphorus/mineral deficiency. Further any broad spectrum antibiotic may be injected to rule out any chance of secondary infection being established.

Prognosis

Success of treatment depends upon the severity of condition and associated complications like urinary tract infections. Earlier the treatment given, better is the response.

Research Paper

Effects of Human Urine on Grassland Ecosystem

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Abstract

From various experiments it was found out that human urine can be utilized as fertilizer for agricultural propose but it has certain adverse effect on ecosystem due to its salts and pathogen content. The present study was conducted to observe the effects of natural human urine on plant ant soil in a grassland ecosystem. Continuous treatment of soil with human urine has remarkable side effects including decrease in number of plants and lowering of soil pH from 7.3 to 6.5. Decrease in the net biomass of the plants in the ecosystem had also been observed.

Keywords: *Cynodon dactylon* (Linn.), pH, Biomass.

Introduction

With the increase in human population the need for food also increases which forced the farmer to use more chemical fertilizers in field to increase the crop yield. These causes harm to environment and increase the demand of fertilizers. To fulfill this demand alternate fertilizing agents like animal waste are also being used. But human urine contains different types of salts and pathogen that damage the ecosystem.

Sodium inhibits plant growth since disrupting the water uptake in the root, dispersing soil particles, restricting root growth and/or interfering with the uptake of competitive nutrients (Asano et al. 2007; Rosen et al., 2008). In other hand, excess of nitrogen can affect negatively amount of sugar and vitamins in vegetables and build up in the plant tissues causing therefore health and taste issues to consumers (Turan and Sevimli 2005).

The objective of this study was to investigate the effects of human urine on plant and soil in grassland ecosystem.

Materials and method

Ecosystem: Test was conducted in a rectangular container of 20 cm in length, 10 cm in breath and 5 cm in height, filled with white sandy soil and grass *Cynodon dactylon* (Linn.) to form a miniature grassland ecosystem under natural condition during month of November, 2015 at RPRC, Bhubaneswar, Odisha, India.

Irrigation: 200 ml of tap water was used once in a day for irrigation.

Urine treatment: 50 ml of fresh urine is applied to the miniature ecosystem twice a day. Urine sample was collected from the person on balance diet as the composition of urine fluctuates from one

person to another and depends mainly on diet and physical activity (Pradhan et al., 2010b).

Analysis: All the data were collected at every 10 days interval from initial day till 30th day (1 month). Effects of human urine on number of grass, net biomass of ecosystem and pH of soil was observed with comparison to control miniature grassland ecosystem grown under natural conditions including 200 ml tap water irrigation but without human urine treatment.

RESULTS

Effect of human urine on number of grass:

The initial number of grass was maintained nearly at 45 to obtain more accurate data. Grass which was more than 5 cm in height was counted. Ecosystem that was not treated with urine had a steady number of plants while in case of the ecosystem treated with urine had more number of plants (54 ± 2.07) on 10th day. Then the number of plants reduced and after 30 days it was 41 ± 1.67 which is less than control ecosystem.

Table 1.Total numbers of grass in control and treated ecosystem

Ecosystem	No. of grasses			
	Initial	10th day	20th day	30th day
Control	45 ± 1.48	49 ± 1.30	46 ± 1.51	47 ± 1.14
Treated	45 ± 1.14	54 ± 2.07	48 ± 1.14	41 ± 1.67

Effect of human urine on net biomass of ecosystem:

From the above data it was observed that the biomass was increasing gradually in case of controlled grassland ecosystem where as the biomass of treated grassland ecosystem increased quickly till 20th day and then it decreased.

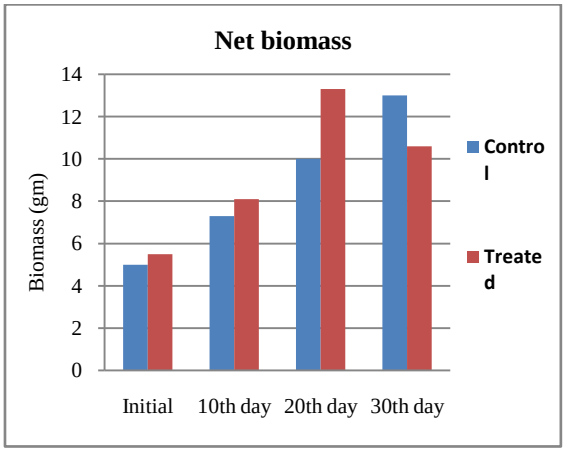

Fig. 2. Effect on biomass of control and treated grassland ecosystem

Effect of human urine on soil pH:

Table 2.Change in soil pH of control and treated ecosystem.

Ecosystem	Soil pH			
	Initial	10th day	20th day	30th day
Control	7.3	7.3	7.2	7.3
Treated	7.3	7.0	6.7	6.5

The pH of soil in the control as well as treated miniature grassland ecosystem was 7.3 at the beginning of the experiment. In control ecosystem soil pH was 7.3 till 30th day but in case of ecosystem that is treated with urine the soil pH gradually decreases to 6.5 after 30 days.

CONCLUSION

1. Increase in numbers of grass and net biomass till 20th day indicated the nutritive activity of human urine.
2. Decrease in soil pH level due to the acidic nature of urine harms the growth and development of plants and reduces fertility of soil.
3. Human urine can be used as fertilizer if its acidic salts contents are removed.

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Use Of Hormones As Growth Promotants In Animal Production

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Growth promotants are among the many sophisticated tools used by feedlots and other producers to raise more beef, more rapidly, using less feed, while maintaining high standards of animal health, carcass quality and food safety. Growth promotants include ionophores, hormone implants, and beta-agonists. Growth promoters, such as implants and beta agonists, are available for use in cattle. Implants have been available for cattle producers since 1975, but beta agonists for beef cattle became commercially available in 2004. These growth promoters primarily change partitioning of energy from feed and shuttle more to muscle instead of fat deposition, thereby increasing weight gain, rib eye area, and total red meat yield when used. The implants can have a functional life of up to 400 days and contain either oestrogenic or androgenic compounds or combinations of both. The increase in live weight due to HGP implants is well documented with an increase in live weight gain of 10-20 kg over 100 to 150 days. However the effect on meat quality is less clear. Some studies have found that the use of HGPs leads to tougher meat but others have found little effect or that the increased toughness is so slight as to be not commercially significant.

INTRODUCTION

Hormones are chemicals produced by animals to co-ordinate their physiological activities. They act as messengers, produced in and released from one kind of tissue to gradually stimulate or inhibit some process in a different tissue over a long period. Steroid hormones fulfil an important role at different stages of mammalian development comprising prenatal development, growth, reproduction and sexual and social behaviour. The importance of individual hormones varies between sexes and age and a disruption of the endocrine equilibrium may result in multiple biological effects.

One hormone can have multiple actions, e.g. the male hormone testosterone controls many processes from the development of the foetus, to libido in the adult. Alternatively, one function may be controlled by multiple hormones, e.g. the menstrual cycle involves oestradiol, progesterone, follicle-stimulating hormone and luteinising hormone. Hormones produced by the bodies of humans and animals are called endogenous or natural hormones.

Compounds chemically synthesised to mimic the effect of natural hormones are called synthetic or xenobiotic hormones.

Hormones are vital in normal development, maturation and physiological functioning of many vital organs and processes in the body. However, like any other chemicals of natural or synthetic origin, hormones may be toxic to living organisms under certain circumstances. The toxicity may be due to an excess of its normal action. This may be the result of excessive exposure to the substance, for example following absorption of a large dose, or because the physicochemical nature of the substance gives it greater or more prolonged activity of the same type, or because the hormonal action occurs at an abnormal time during development or adult life, or is an action on an organism of the inappropriate sex. Hormones, like other chemicals, may also exert direct toxic actions not related to their endocrine ('physiological') effects. Due to the obvious ability to improve weight gain and feed efficiency in meat producing animals, natural hormones and/or the synthetic surrogates have been used in agricultural practice for several decades.

HISTORY

As early as the 1930s, it was realized that cows injected with material drawn from bovine (cow) pituitary glands (hormone secreting organ) produced more milk. Later, the bovine growth hormone (bGH) from the pituitary glands was found to be responsible for this effect. However, at that time, technology did not exist to harvest enough of this material for large-scale use in animals. In the 1980s, it became possible to produce large quantities of pure bGH by using recombinant DNA technology. In 1993, the Food and Drug Administration (FDA) approved the recombinant bovine growth hormone (rbGH), also known as bovine somatotropin (rbST) for use in dairy cattle. Recent estimates by the manufacturer of this hormone indicate that 30% of the cows in the United States (US) may be treated with rbGH.

The female sex hormone estrogen was also shown to affect growth rates in cattle and poultry in the 1930s. Once the chemistry of estrogen was understood, it became possible to make the hormone synthetically in large amounts. Synthetic estrogens started being used to increase the size of cattle and chickens in the early 1950s. DES was one of the first synthetic estrogens made and used commercially in the US to fatten chickens. The earliest use of hormone enhancers in farm animal production included iodinated proteins fed to dairy cows for increased milk production and estrogen implants (diethylstilbestrol (DES) and dienestrol) in growing chickens (broilers) for enhanced fat deposition. The first ''steroid-like'' hormone used in beef cattle and sheep for growth, efficiency and lean meat promotion was DES in 1954. Because of potential carcinogenicity from the use of DES in humans, not in farm proved for cattle, this compound was banned for use in cattle and sheep in 1979 by the US Food and Drug steers Administration (FDA). In 1982 Silicone rubber–estradiol implant was approved for cattle by FDA. In 1994, FDA approved the TBA / estradiol (10:1) implants for heifers where as in 1996 TBA / estradiol implants at the dose of 10:1 for steers and Estradiol / TBA

implants at dose of 5:1 for growing cattle.

Implanting hormonal growth promoters is currently widespread in the beef cattle industry of many non-EU countries for the better performance in growth and improvement of feed efficiency. These hormonal implants may enhance growth during suckling, growing and finishing stages of production. Growth hormones are implanted under the skin (usually behind the ear) of the animal in the form of depot capsules, where they release a specific dose of hormones over a fixed period of time.

The hormone types most widely used in milk production includes,

1) Recombinant bovine growth hormone (rbGH) — to promote milk production (may also see it as bovine somatotropin [BST])

2) Estrogens, testosterone, and progesterone—steroid hormones added to promote growth and production.

Beef cattle and animals for meat purpose are often given steroid additives to increase growth and development. Common steroids include:

1) Natural steroids like estradiol, testosterone, and progesterone.

2) Man-mad steroids from compounds of estrogen, androgen, and progestin.

These additives have proven benefits for increasing milk and meat production, but it does not come without controversy.

HORMONE PREPARATIONS USED IN ANIMAL PRODUCTION

Estrogens

Estrogens are the major class of compounds used in growth promoting implants. As shown in the chronology, estradiol, its benzoate ester (EB) and zeranol are the estrogen compounds used commercially. All implant products are estrogen based, with one exception, and this seems to be the first requirement for a growth response. Combinations with other compounds often enhance the growth response, including TBA, testosterone (as the propionate ester) and progesterone. Estrogenic activity is an apparent requirement since alpha-estradiol and *cis*-DES (nonestrogenic isomers), and stilbene, estriol and estrone do not result in growth promotion. Also, diets containing DES lost estrogenic potency and growth promoting ability in parallel during storage. Several other synthetic estrogens (poly-diethylstilbestrol, hexestrol, diallylhexestrol and dienestrol) give responses comparable to DES. Few nonestrogenic analogs have been studied which may prove to be a fruitful research endeavour.

Zeranol is a nonsteriodal macrolide, a compound in a class of natural products known as beta-resorcylic acid lactones isolated originally from corn infected with the fungus, *Fusarium*. The estrogenic activity of this class of compounds (natural and synthetic) has been characterized. There are also many plant estrogens but these have not been well characterized for their growth promotion potential. Coumestrol has only weak growth potentiation properties. Smilagenin, a nonestrogenic plant steroidal sapogenin, gave a growth response in lambs and cattle similar to DES.

Testosterone

Testosterone and its more active metabolite, 5-dihydrotestosterone (DHT), are the main sex hormones secreted by males. Testosterone is responsible for the early development, and the appearance

and maintenance of male secondary sex accessory organs (prostate, secretary glands, penis size, etc.) during adulthood. Testosterone secretion is also affected by the complex interaction among all endocrine glands, especially with those in the brain.

Testosterone is metabolized and as a result, metabolites of different activity are generated. Some of these metabolites play a more active role in certain organs than in others. The actions of both testosterone and DHT are mediated through their high affinity and high specificity binding and activation of an intracellular protein, the androgen receptor (AR). This AR protein is a member of the steroid hormone superfamily. The ligand-activated androgen receptor mediates its effects on cell growth and differentiation through the activation and/or suppression of specific gene transcription in target organs. Androgen receptors are detected in tissues of females, as well as males. The presence of this receptor in organs such as the ovary indicates significant activity of androgens in both sexes. In animals, testosterone or testosterone propionate, alone or in combination with other hormonally active substances, is used primarily to improve the rate of weight gain and feed efficiency. This effect is most likely a consequence of the anabolic action of androgens.

Early research with testosterone was generally disappointing regarding growth promotion. However, the synthetic anabolic steroid TBA has been shown to increase growth and nitrogen balance in rats as well as cattle and sheep. The relative androgenic and anabolic activity of TBA is 3–5 and 8–10 fold greater, respectively, compared to testosterone. In combination with estrogens, gain, efficiency and leanness are increased by TBA over an estrogen alone in steers, bulls and wether lambs. In heifers, TBA alone results in significant increases perhaps in combination with endogenous estradiol. The dichotomy between the anabolic and androgenic activity for this class of compounds is very apparent.

Progesterone

Progesterone is synthesized and secreted mainly by the corpus luteum in the ovary of cycling females, and, during pregnancy, by the placenta. As all hormones, progesterone synthesis and secretion is regulated by a series of positive and negative feedback mechanisms in which polypeptide hormones secreted by the brain (hypothalamus, pituitary) affect circulating progesterone levels. Progesterone and synthetic progestins are used pharmacologically in female in conjunction with ovulation stimulation drugs as well as during early pregnancy in cases of luteal phase dysfunction. No animal studies on the effects of progesterone during the postnatal development have been published recently. It is well established that progesterone not only serves as the precursor of all the major steroid hormones (androgens, oestrogens, corticosteroids) in the gonads and adrenals, but also is converted into one or more metabolites by most tissues in the body.

Dehydroepiandrosterone

Dehydroepiandrosterone (DHEA, 3β-hydroxy-5-androsten-17-one) is a steroid hormone that is secreted by the adrenal cortex in mammals. It is known to have

several physiological effects, including antiobesity, antidiabetes and anticarcinogenisis, when administered to rats and mice. A number of studies have demonstrated that DHEA decreases fat intake and body weight in rats, decreases serum triglyceride levels in hyperlipidemic rats and directly affects the peroxisomal β-oxidation pathway in mouse hepatocytes. Although some research has been conducted in the area of DHEA regulation and lipid metabolism in rats and mice, there is little information available on the effect of DHEA on the activities of lipid metabolic hormones and parameters in poultry, especially in broiler chickens. Currently, the production of broiler chickens with excessive body fat is a significant economic problem in the poultry industry. Several factors, such as nutrient availability and genetics, contribute to the tendency for broilers to accumulate excess body fat. The accumulation of abdominal fat in chicken's results in increased poultry feed cost and decreased final product quality. Adding DHEA to the diet significantly decreased serum concentrations of thyroxine (T4), serum free triiodothyronine (FT3), and serum free thyroxine (FT4), but significantly increased the serum leptin (LEP) and glucogon (GLU) levels in male broiler chickens. However, female broiler chickens showed pronounced differences in LEP, FT3 and FT4 only, while there were no differences in the other three metabolic hormones (T3, T4 and GLU). Overall, these results indicate that DHEA improves lipid metabolism through the regulation of metabolic hormones and metabolic parameters, while not adversely affecting growth performance in broiler chickens

Trenbolone acetate

Trenbolone acetate (TBA) is a synthetic steroid with an anabolic potency that may exceed that of testosterone. It is a prodrug that converts into its active form 17ß-trenbolone, which isomerises into 17ß-trenbolone. 17ß-trenbolone is the major form occurring in muscle tissue, whereas the 17ß-epimer is the major metabolite occurring in liver and in the excreta including bile. It is assumed to exert its anabolic action via interaction with androgen and glucocorticoid receptors. Experiments with cattle tissues have shown that 17ß-trenbolone binds to the androgen receptor with similar affinity as dihydrotestosterone. It also binds to the progesterone receptor with an affinity that exceeds that of progesterone. The other metabolites of TBA, including 17ß-trenbolone (17ß-hydroxy-estra-4, 9, 11-trien-3-one) and TBO (estra-4,9,11-triene-3,17-dione) show a significantly lower binding affinity to both types of receptors. Reports regarding the (mis)use of TBA as an anabolic agent in sports people describe several adverse effects, including liver cell injury with an increase in liver-specific enzymes in serum, cholestatic jaundice, peliosis hepatitis and various neoplastic lesions. Moreover, decreased endogenous testosterone production and spermatogenesis, oligospermia and testicular atrophy may be associated with the repeated use of TBA as anabolic.

Somatotropin releasing hormone, somatostatin

The first researches on the effects of somatotropin (growth hormone; GH) in

growing ruminants showed greater growth in cattle and nitrogen retention in lambs. Later research using daily injections, sustained release injections or pellets containing recombinant GH has generally shown increased gain and feed efficiency, no effect or decreased feed intake, no effect on wool growth, equivocal effects on carcass weight (dressing percentage), increased carcass protein and decreased fat, decreased plasma or serum urea, and increased blood GH and markedly increased insulin-like growth factor-1 (IGF-1) concentrations in cattle and sheep. In cattle, required daily amounts of injected GH for maximum plasma urea-N (PUN) depression and increased gain ranged between 16 and 64 mg GH / kg body weight whereas carcass leanness effects were observed through 300 mg GH / kg body weight.

Growth hormone releasing factor (GRF) has also been shown to promote growth in lambs and steers. Daily doses required (1–10 mg / kg body weight), however, are not that much lower compared to GH. Of interest is the conclusion that the effects of GRF and steroidal implants on plasma IGF-1 and PUN in steers were additive.

Immunizing lambs against their own somatostatin has been shown to increase growth rate in most studies. Immunizing steers against their own GRF decreased gain and feed efficiency, increased carcass fat, decreased serum GH, IGF-1, insulin and glucose, and increased serum urea-N.

Others

Melengestrol acetate (MGA) is a synthetic progestogen that is 30 to 125 times more potent that progesterone and is used in the diet as an estrus suppresser in feedlot heifers; MGA also improves rate of gain in heifers, presumably because of greater follicular development and therefore greater endogenous estradiol secretion. A long-lasting formulation (DEPO-MGAE) injected subcutaneously in the ear suppressed estrus for up to 325 days but effects on gain were equivocal. Recently, implants containing increasing doses of norgestomet, a potent synthetic progestogen, reduced pregnancy rate in heifers on pasture for 154 days and increased rate of gain in a dose dependent manner. The growth response of steers to MGA at doses commonly fed to heifers is equivocal.

Cortisol administration in cattle and sheep increased weight gain but in contrast to estrogen administration, carcass fat was increased.

Hormonally-active substances used in animal production

MECHANISMS OF GROWTH PROMOTING HORMONE IMPLANTS

Synthesis /release of GH

The early explanation was that these compounds caused an increased synthesis and secretion or release of endogenous GH, based on increased anterior pituitary size, increased proportion of acidophilic cells in the anterior pituitary, increased GH secretion or release, and increased circulating concentrations of GH and insulin. However, many of these same changes have been observed in vitro and in vivo, primarily in rats. Estrogens (DES) depress the growth of rats, in both intact and castrate male rats. Volatile fatty acids are the major energy substrate in ruminants whereas in monogastric animals glucose is the major energy

Substances	Form	Main use - Animals
Oestrogens alone:		
DES	Feed additive	Steers, heifers
DES	Implant	Steers
DES	Oil solution	Veal calves
Hexoestrol	Implant	Steers, sheep, calves, poultry
Zeranol	Implant	Steers, sheep
Gestagens alone:		
Melengestrol acetate		Heifers
Androgens alone:		
TBA	Implant	Heifers, culled cows
Combined preparations:		
DES and Testosterone	Implant	Calves
DES and Methyl-testosterone	Feed additive	Swine
Hexoestrol and TBA	Implant	Steers
Zeranol and TBA	Implant	Steers
Oestradiol-17β and TBA	Implant	Bulls, steers, calves, sheep
Oestradiol-17β benzoate and testosterone propionate	Implant	Heifers, calves
Oestradiol-17β benzoate and progesterone	Implant	Steers

substrate, which has been speculated to be the explanation for the difference in the response of oestrogens between ruminants and rats. In one experiment, the growth of guinea pigs was increased by low doses of DES and since there is significant fermentation in the large intestine and therefore absorption of volatile fatty acids in guinea pigs, energy substrate may be involved in the differential response. Calves prior to significant rumen function do not respond to anabolic steroids.

Independent action

If enhancement of endogenous GH is the mechanism for growth stimulation, then there should be no additional growth response to GH in the presence of an anabolic steroid, assuming both are given at their optimum dose. Early research with Zeranol and GH indicated there was an additive response. Using plasma urea nitrogen (PUN) reduction as a measure of anabolic effect, an additive response was observed using optimum doses of estradiol and GH for maximum PUN reduction. Subsequent feedlot experiments confirm that the response to GH and either estradiol 1 progesterone 1 TBA or estradiol 1 progesterone is additive. Additionally, there was an opposite response in feed intake and magnitude differences in plasma IGF-1 and carcass fat changes.

Thus it seems that these two growth promoter class of compounds have additive and independent actions in the growth of ruminants and therefore argues against enhancement of endogenous GH secretion as the mechanism for anabolic steroids.

Cell receptors

Estrogen receptors are present in cattle and sheep muscle although their concentration is many folds less than in uterine tissue. Estrogen receptors, however, are also present in rat skeletal muscle. Androgen receptors are present in the cytosol of skeletal muscle from sheep treated with TBA and TBA alters the responsiveness of skeletal muscle satellite cells to fibroblast growth factor and IGF-1. Corticosteroids have catabolic effects on muscle protein metabolism and androgens (e.g. TBA) compete for corticosteroid receptors thereby decreasing muscle protein degradation. Therefore, implant hormones could have

direct effects on skeletal muscle cells but this has not been demonstrated in vitro.

Binding characteristics of liver membranes in young steers when implanted with estradiol revealed increased GH receptor capacity compared to non implanted controls; rate of weight gain was significantly correlated with ''high affinity'' GH receptor capacity. Perhaps because of this increased GH binding capacity, wether lambs implanted with estradiol 1 TBA had 150% higher hepatic levels of ''steady-state'' IGF-1 mRNA compared to controls and implanted steers had 68% higher ''steady-state'' IGF-1 mRNA in the longissimus muscle compared to non implanted controls; circulating levels of IGF-1 were increased 32%. Thus increased local production of IGF-1 following implantation may play a role in increasing circulating IGF-1 as well as stimulating muscle growth through autocrine and / or paracrine mechanisms.

Muscle protein turnover and cellular response

The anabolic effect of growth promoting steroids in ruminants occurs very fast, within 2–7 days for PUN reduction, by 3–5 days for decreased urinary N excretion, 2–3 days for increased concentrations of circulating IGF-1, by 24 days for cellular changes in the anterior pituitary gland and 7–40 days for increased growth and carcass protein deposition that ''declined in concert with decreasing concentration of serum estradiol''. Initially this increase in muscle protein was attributed to a decrease in muscle protein degradation together with a lesser reduction in muscle protein synthesis. Subsequent research failed to confirm a reduction in muscle protein degradation during a period (0–30 days) when muscle protein accretion was increased 21 and 82% in steers implanted with estradiol or estradiol 1 TBA, respectively. Implantation with anabolic steroids in cattle enhances muscle growth factors (e.g. IGF-1, IGF-2) in the serum, and the responsiveness and proliferation of muscle satellite cells.

BENEFITS OF HORMONE SUPPLEMENTATION

1) Benefits to the Producer and Consumer

The improvements in growth rate and feed efficiency due to implant use in the meat animals have decreased the cost of gain for producers. Because feed costs consistently represent the largest annual expense for all phases of meat production, the economic benefits are significant for individual producers and collectively for the industry as a whole.

Consumer's benefit from the use of hormonal implants because they make cattle leaner thereby reducing the amount of unwanted fat. Additionally, implants decrease the cost of production which is passed on to purchasers of processed beef products. Implants have been a major part of the range of technological advances which have increased meat quality and consumer acceptance especially in western countries.

2) Benefits to the Environment

Improved efficiencies attributable to implants have enabled the production of more beef products on less land and have reduced the amount of grain necessary for a given unit of animal growth. Implants accomplish this without

harming the animals treated or adversely affecting the human food supply.

3) Impact on Meat Quality

There are many factors that affect eating quality of beef. Cattle age, carcass fat, carcass aging, and other post harvest procedures all affect consumer satisfaction. Studies on the palatability of beef from implanted cattle vary depending on fatness of the carcass at the time of harvest. Implants increase the deposition of lean tissue and decrease the deposition of fat. Fatness is positively correlated with palatability. Therefore implanted cattle must be fed longer so that comparisons can be made at the same level of carcass fatness. When this comparison is made, differences in tenderness and overall acceptability of the beef from non-implanted and implanted cattle are minimal.

Are Growth Promotants Safe?

Hormone implants are regulated by the Food and Drug Administration and extensive toxicological testing is conducted prior to the approval of any new growth promotant in USA. This toxicological testing also includes assessments of the breakdown of these products before they enter the environment. Residues of the synthetic hormones are routinely monitored by the Food Safety Inspection Service of the USDA to ensure safety of the beef. The natural hormones are not tested since they are not different than those naturally produced by the animal and the quantities are a small percentage of what is normally produced. Prior to 1981, the EC had no universal policy on the use of growth promoting hormones in Meat animals. The use of hormones had been banned in Italy since 1961, in Denmark since 1963, and in Germany since 1977. Belgium and Greece had never permitted the use of hormones for fattening purposes. However, Spain, the United Kingdom, France and Netherlands permitted the use of most hormones for speeding growth in beef cattle. The natural human production of both androgens and estrogens is several thousand times the content of a generous serving of beef produced with hormone implants. Also other common foods are naturally much higher in estrogen than implanted beef including eggs and milk.

Food	Estrogenic Activity (ng/500g)
Soy flour defatted	755,000,000
Pinto beans	900,000
White bread	300,000
Peanuts	100,000
Eggs	555
Butter	310
Milk	32
Beef from implanted steer	7
Beef from non-implanted steer	5

Tissue residue allowance

Safe tissue levels have been determined for both the natural and synthetic hormones used in growth promotants. For the implants using naturally occurring hormones, the maximum allowable levels are 6-15 times greater than the highest residues found in treated cattle. As an added safety measure, the FDA maximum safe tissue residue allowed for the synthetic hormones is 77 and 150 times greater (trenbolone and zeranol, respectively) than the levels detected in treated cattle.

Endogenous hormone level

Because human tissues and organ systems produce and require hormones as part of their physiological life processes, numerous of them are normally present in the human body in varying amounts. These include steroid hormones of the same type as those used in implants. The natural production of these hormones in the human body substantially exceeds the PDI from animals treated with implants.

Cancer risk

Multiple assays designed to assess damage to DNA which can lead to mutations have been used to evaluate growth promotants. All of these assays have been negative. At extremely high doses, some studies with rodents have reported increased tumour development; however no studies have reported the same results with higher order mammals.

A Brief Overview on Caprine Natural Remedies

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Small ruminant sector plays an important role in the national economy. This enterprise is associated with the social and cultural fabric of millions of resource of poor farmer. Small ruminant especially goats gain importance mainly on account of their short generation intervals, higher rates of prolificacy and ease with which they can be marketed. Total population of goat in India is about 140.54 million in 2007 (Census estimate of livestock population in 2007). The Indian goats possess highly carcass, heat resistance and water stress also, then other kind of livestock. Goat is most converters of rough feed in to goat cash product and fertilized land. The goat plays a major role in animals production by way of producing meat, milk, fibre, skin and manure, hence it is popularly called "Poor man cow" and also know for quick return. A natural/home remedy is a treatment to cure a disease or ailment that employs certain spices, vegetables, or other common items. Natural remedies may or may not have medicinal properties that treat or cure the disease or ailment in question, as they are typically passed along by laypersons. A common error is to confuse home remedies with homeopathic remedies. In fact, the two concepts are unrelated.

Natural/Home remedies have become increasingly popular as the expense and hassle of conventional medicine continues to rise. Beyond the convenience, home remedies have found favour with a public that wants to take a more holistic approach to its ailments.

Today herbs are catching a lot of attention due to their very nature of cure: simple, no side effects, no chemicals, inexpensive, plus the ability of being able to cure yourself. This trend for resorting to home remedies is not new. In fact, they have their origin in ancient times. Traditionally, in India, plants with medicinal value, were grown in home gardens. These plants were used effectively as self help remedies for managing primary health care. There are many ways to care for dairy goats naturally, without chemical intervention that includes:

i. Deworming

The main concern of most goat owners and breeders is that of deworming and using natural medicines for other common goat illness. Parasites of the

same type vary from location to location, whether it be size, habitat, reproduction rate or whatever. Every location has its own special environmental concerns, times of parasite explosions, types of parasite concerns, etc., so trying to develop a natural worming product that is the correct strength and correct combination for every situation would be very difficult at best, and the cost of such a perfect product would be well out of reach of nearly all goat lovers!

Plant medicines are more useful in deworming cases in goats as compared to the homeopathic remedies. They are readily available and many can be grown in home farm and fields for free choice use. What can't be grown in a particular area is easy to purchase from many available sources in bulk, which reduces costs and keeps plenty on hand for use as needed. Plant medicines are foods with natural nutrients and natural assisting constituents. Plant medicines do not create withholding times for human consumption of goat milk or meat.

Keeping in mind that the proper mineral rations will also help reduce worm load. Copper deficient goats are usually wormy; increasing copper through the year many times will clear up the chronically wormy goat. Mineral deficiencies in general leave a goat vulnerable to any number of parasites. There are many plants that have anthelmintic and vermifugal properties. Some very popular and easy to grow items would be pumpkin seed, black walnut, garlic, wormwood, wild mustard and wild carrots. It is not possible that just one herb to clear out parasite so medicinal herbs work best when combined with similar and supporting herbs, and thumb rule applies to worming as well. As an example, use garlic and parsley (Coriander) combined for pregnant does and weanling kids and also often use neem for worming schedule, but, did not to give to buck during breeding because neem will naturally drop semen count as a side effect.

A tincture can be made using apple cider vinegar as the liquid menstrum (apple cider vinegar having its own nutritional values), which can then be used in the drinking water, as a drench, on food, etc. Measured amounts of the dried herbs can be added to their mineral mix and offered free choice.

Apple cider vinegar (ACV)

It has many nutritional qualities all by itself. It is high in potassium, which aids in keeping the blood flowing properly—very important in our pregnant does, especially when she is carrying multiples.

Plant is used to expel internal parasite

Name of Plant and Dosage	Preparation Method
Aloes	Aloes balls are made with 6-8 drams of juice
Castor Oil	4 tablespoons given once
Garlic	2 bulbs or whole plants twice daily
Lemon	seeds crushed in honey, 1-Tbs. daily
Potato	Juice raw
Mustard seeds	2 handfuls of the whole herb or the seeds fed raw twice daily
Walnut	2 handfuls leaves brewed in 2 pints water add honey
Mulberry	several handfuls of fruit twice daily

(Taken from Complete Herbal Handbook for Farm and Stable)

Add ACV to livestock water to assist in keeping down the algae growth, assist in preventing hatching of mosquito larvae, as well as help my bucks keep from getting urinary calculi and kidney stones. This works for humans, too, by the way.

ii. Kidding

If the doe has been fed adequate nutrition through her gestation, she delivers a healthy kid. We can make kidding a bit easier by providing items that help her uterus, such as raspberry leaf. Fresh or dried, these herbs help to tone the uterus a couple of weeks before and after parturition, and can help strengthen her contractions, shortening labor time. These are also well known herbs for helping increase milk supply.

For those kids that are born weak, or whose mother abandons them on a very cold day and must be handfed to get started, use colostrum, preferably from the mother, mixed with the natural molasses and spirulina.

iii. Mastitis

Garlic, echinacea, and ginger given frequently is the best treatment. Hot compresses can help when applied directly to the udder, afterwards rub in some peppermint oil to stimulate the blood vessels within. Again, good nutrition prior to freshening will prevent this from occurring.

iv. **Respiratory Ailments**

Best choices for this include: peppermint. Garlic and ginger are also useful in this combination giving equal parts.

v. Diarrhea

If diarrhea occurs due to coccidian, then treat for a week with a mixture of antibiotic and antiviral herbs to both clear up the coccidia. Once the diarrhea has passed, some good natural yogurt will help get the rumen running well again. Yogurt is also good to give during and after chemical antibiotic and worming treatments.

vi. **Bloat**

Bloat can kill a goat quickly, and without proper treatment the goat will die. Bloat is caused when the goat simply overeats and is unable to release the gas that has built up in the rumen. This can be caused from over eating grain, and eating lush pasture. In some cases plants like milkweed can cause bloat. There are several options to treat bloat naturally. Baking soda should be given free choice to your goats to help prevent bloating. Once the goat is bloated, baking soda should be given in a drench. Bloating can also be helped by giving the goat vegetable oil. Homemade vegetable oil is easy to make and inexpensive, so having this stored is important. Another natural treatment for bloat is to give the goat a stomach massage. Rub the stomach until the goat is able to pass the gas.

vii. Wounds

Generally mix together apple cider vinegar, aloe vera juice and echinacea, put it in a spray bottle, and spray the affected area several times a day.

viii. Agalatia

Alfalfa leaf has ability to increase milk, as well as being an herb that is safe to take while pregnant. Alfalfa hay is fed daily to milking goats and other dairy animals. Alfalfa is rich in chlorophyll and vitamin K, a nutrient necessary for blood clotting. In the last trimester of pregnancy, alfalfa can decrease postpartum bleeding or the chance of haemorrhaging.

Administration of Herbs

The easiest way to dose the goats with their herbs is to just add it to their grain

at feeding time. Another popular method is to make "dosage balls" out of the herbs and some molasses.

Conclusion

Most of the herbs are free of side effects or reactions. They are inexpensive and easily available. Residual part of herbs are not present in the body as the chemical compound and hamper milk and meat products of the goat and make unfit for the human consumptions. This is the reason why natural remedies growing in popularity across the globe. Natural treatments for goats should not be confusing or frustrating. Most are very simple yet very cost effective when purchased in bulk and mixed according to needs. A truly healthy goat herd is a blessing for goat lover.

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Nitrogen Fixing Bacterium *Gluconacetobacter diazotrophicus* in Sugarcane:

A Potential Bio-Fertilizer For Sustainable Agriculture

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Abstract

Sugarcane, Saccharum officinarum L., is a perennial grass in the family Poaceae grown for its stem (cane) which is primarily used to produce sucrose. It is a renewable, natural agricultural resource because it provides sugar, besides biofuel, fibre, fertilizer and myriad of byproducts/co-products with ecological sustainability. Nitrogen is an essential plant nutrient and, in agriculture, fertilization with nitrogen products is widely and increasingly practiced to increase the production yield of food. However, the use of elevated doses of fertilizers, as well as pesticides, may have negative and unpredictable effects on the environment, and contribute to the contamination of soil, water and natural areas. Such impacts pose a serious threat to human and animal health. An interesting alternative to avoid or reduce the use of N-fertilizers could be the exploitation of plant growth-promoting bacteria (PGPB), capable of enhancing growth and yield of sugarcane, several of agronomic and ecological significance. Gluconacetobacter diazotrophicus (PGPB) is a nitrogen fixing bacterium originally found in monocotyledon sugarcane plants in which the bacterium actively fixes atmosphere nitrogen and provides significant amounts of nitrogen to plants. It is capable of promoting plant growth through different mechanisms including, the biological nitrogen fixation (BNF), and the enzymatic reduction of the atmospheric dinitrogen (N2) to ammonia, catalyzed by nitrogenase. Hence it helps in sustainable agriculture by improving soil fertility, plant tolerance and crop productivity. Consequently Gluconacetobacter is a potential bio-fertilizer for sugarcane and other grasses.

Introduction

Sugarcane is an important commercial crop of the country occupying around 5.01 million hectares area with an annual cane production of around 350.02 million tones and yield 69838 kg/hectare during 2013-14 (Suman 2001). India's share in the world production of sugar was 17 percent in 2014-15 the biggest producer and exporter of sugar in the world is Brazil (23% of total production and 50% of total exports in the 2010-11 fiscal year). A significant amount of sugar is also produced in India, China, Thailand and the United States. Sugarcane is a C4 plant, which has an efficient photosynthetic system, and it can convert up to 2% of

incident solar energy into biomass. Sugarcane (*Saccharum* spp. hybrid) is a tall, perennial grass (family *Poaceae*, subfamily *Panicoide*), and is cultivated in tropical and warm-temperate regions between 35°N and 35°S and from sea level to altitudes of 1,000 m in a wide variety of soil types. Most of commercial sugarcane varieties are hybrids with *Saccharum officinarum*. The optimal temperature for sugarcane cultivation is between 20^0C and 35^0C and the minimum rainfall requirement is 1,200mm per year. The stalks (stems) of sugarcane are harvested at 9 to 18 months after planting the mother stem cutting (setts). Once planted, sugarcane can be harvested several times, because new stalks, called ratoons, repeatedly grow from the stubble. For many years, sugarcane has been used for sugar and an alcoholic drink production. Recently, the use of sugarcane alcohol (ethanol) as an automotive fuel to replace gasoline has rapidly increased. At the moment, sugarcane is the most economically and environmentally advantageous crop for bio-ethanol production.

The over increasing population of the world has already touched the number of 6.8 billion. To feed this burgeoning population, farmers heavily rely on the use of chemical fertilizers especially inorganic nitrogen. Application of inorganic fertilizer has many repercussions, as it leads to ground and surface water contamination due to leaching and denitrification, which is detrimental for human and animal health. Secondly, manufacturing of industrial nitrogen fertilizer uses non-renewable resources like natural gas and coal and causes production of green house gases viz., CO_2 and NO_2 contributing to global warming. Therefore, it's high time to opt for alternative fertilizers which can be used in sustainable agricultural practices without affecting the environment. Application of plant growth promoting associative bacteria can be a potential option for enhancing growth and yield of plant in sustainable manner. On the basis of area of colonization, Plant Associated Bacteria (PAB) can be grouped into associative bacteria that include rhizospheric (in vicinity of root) and rhizoplanic (on surface of root) bacteria and, endophytic bacteria. Term 'endophytic bacteria' is referred to those bacteria, which colonizes in the interior of the plant parts, *viz.,* root, stem or seeds without causing any harmful effect on host plant. These bacteria may promote plant growth in terms of increased germination rates, biomass, leaf area, chlorophyll content, nitrogen content, protein content, hydraulic activity, roots and shoot length, yield and tolerance to abiotic stresses like draught, flood, salinity etc. PAB can promote plant growth directly through Biological Nitrogen Fixation (BNF), phytohormone production, phosphate solubilization, inhibition of ethylene biosynthesis in response to biotic or abiotic stress (induced systemic tolerance) etc., or indirectly through inducing resistance to pathogen .*Gluconacetobacter diazotrophicus* is a endophytic bacteria. *G. diazotrophicus*–sugarcane relationship represents a model system for monocot–diazotrophic association. *G. diazotrophicus*

is able to promote plant growth and that the mechanisms attributed include nitrogen fixation and phytohormones production (Meenakshisundaram and Santhaguru, 2010, Dobereiner and V. M. Reis 1993). This bacterium has also the capacity to solubilize P and Zn compounds, to produce a bacteriocin that inhibits the growth of Xanthomonas albilineas, the causal agent of leaf scald disease in sugarcane as well as having resistance to different antibiotics and heavy metals.

Plant Associated Bacteria (PAB)

PAB has been classified as the plant growth promoting bacteria on the basis of basic mechanisms through which it stimulates plant growth as PGPB, which induces plant growth directly and; bio-controller, which protects plants by inhibiting growth of pathogen and/or insect. PGPB belong to diverse genera, including *Azospirillum, Azotobacter, Herbaspirillum, Bacillus, Burkholderia, Pseudomonas, Rhizobium,* and *Gluconacetobacter*, among others (Table 1). When diazotrophic bacteria (*Gluconacetobacter diazotrophicus*) establishes endophytic association with sugarcane, total content of plant nitrogen rises which may be due to the biological nitrogen fixation or increased ability of nitrogen uptake from soil (Youssef, et. *al.,* 2004, Muthukumarasamy et. al., 2002). This bacterium mainly colonizes intercellular spaces within the roots and stems of sugarcane and does not require the formation of the complex root organ like nodule.

What is Bio-fertilizer ?

Bio-fertilizer are ready to use live formulation of beneficial microorganism, which on application to seed, root or soil mobilize the availability of nutrients by their biological activity and help in building up the miroflora and thus soil health.

Characteristics of *Gluconacetobacter diazotrophicus*

Gluconacetobacter diazotrophicus was discovered within sugarcane plants in Alagoas, Brazil, by Cavalcante and Dobereiner (1988). Since then, *G. diazotrophicus* has been found in places such as Mexico and India and in crops ranging from coffee to pineapple. The bacterium was initially named as *Saccharobacter nitrocaptansand* was later classified under acetic acid bacteria and named *Acetobacter diazotrophicus*, before being reclassified as *Gluconacetobacter diazotrophicus* based on 16S ribosomal RNA analysis. This bacterium is accommodated within the phylum Proteobacteria, the class Alphaproteobacteria, the order Rhodospirillales, the family *Acetobacteraceae*, and genus *Gluconacetobacter* (Fig 1& 2).

G. diazotrophicus is a Gram-negative, nonspore forming, non-nodule producing, endophytic nitrogen fixing bacterium (Fisher and Newton 2005). The bacterium is an obligate aerobe with cells measuring 0.7–0.9 µm by 2 µm and appears as single, paired, or chainlike structures when viewed under a microscope. The bacterium's cells have 1–3 lateral or peritrichous flagella used for motility. *G. diazotrophicus* is an acid-tolerant bacterium, being capable of growing at pH levels below 3.0; however its optimum pH

for growth is 5.5. In the last decades, it has been observed that plant-associated prokaryotes are valuable for agriculture as a tool for improving crop performance and environmental conditions, as they may reduce and avoid the use of chemical fertilizers (Table 2). Within the *Acetobacteraceae family, G. diazotrophicus, G. johannae, G. azotocaptans, S. salitolerans, A. peroxydans* and *A. nitrogenifigens* have been found to fix N_2. High sucrose concentrations (10%) are the best source of carbon for the bacterium's growth, but glucose, fructose, and galactose can also be used However, as the bacterium is unable to transport or take up sucrose it secretes an extracellular enzyme called levansucrase, which hydrolyzes sucrose into glucose and fructose.

Benefits of *Gluconacetobacter diazotrophicus* :

There are several benefits of using *G. diazotrophicus* in sugarcane crop. Among them some are as followings -

- Fix atmospheric nitrogen and enhances the availability of N to sugarcane and produces growth hormone, or Indole Acetic Acid (IAA).
- Results visible after 5-6 weeks of its application.
- Increases size and length of internodes.
- Improve yields (5-20 t/ha) and sugar content (5-15%).
- Stimulate plant growth.
- Biologically activate the soil.
- Restore natural fertilizer
- Provide protection against some soil borne diseases.
- Supplement to fertilizers; replace chemical fertilizers up to 25%.
- Cost effective

Biological nitrogen fixation by endophytic diazotrophic bacteria

G. diazotrophicus is considered to be a major diazotrophic endophyte in sugarcane and has been isolated from leaves, stems and roots of sugarcane plants collected from a number of sites. *G. diazotrophicus* does not survive free in the soil, and it is thought that it is mainly transmitted in the course of vegetative propagation, which is usually done from stem cuttings or 'setts'. Nitrogen (N) is a major essential element for all organisms, and generally the amount of available N in soil is limiting factor for natural and agricultural plant production. Biological nitrogen fixation (BNF) is a process by which atmospheric dinitrogen (N_2) is reduced into 2 molecules of ammonia (NH3) by the enzyme nitrogenase with 8H+ , 8e- and 16 Mg ATP. BNF have important role in N cycle in both global ecosystem and agro-ecosystem. Biological nitrogen fixation (BNF) plays an important role in integrated nutrient management, sustainable agricultural production and the environmental protection. Endophytic diazotrophs establish associations with diverse plant genotypes and fix nitrogen more efficiently than rhizosphere diazotrophs (Döbereiner, 1992 and 1993). They are also reported for their ability to promote plant growth. *Gluconacetobacter diazotrophicus* bacterium specifically associating with sugar rich plants like sugarcane (Cavalcante and Döbereiner, 1988), sweet sorghum and sweet potato was later on reported from other agronomically important crops including

coffee ragi, pine apple and tropical and sub-tropical plants from India (Fig 3). The association of N_2-fixing *G. diazotrophicus* and *Herbaspirillum* spp. with roots, stems and leaves of sugarcane has been reported earlier in Indian sugarcane varieties. Studies have shown that some sugarcane varieties may actually fix N_2 up to 70% of their N requirement BNF has been demonstrated in various field grown varieties in Brazil using the ^{15}N natural abundance technique But such BNF activity is largely variable among sugarcane varieties and it is still unknown which bacteria are responsible for this BNF. However, the endophytic *G. diazotrophicus* has been proposed as a strong candidate for the plant associated BNF in sugarcane.

CONCLUSION

Sugarcane is not only cash crop for the growers, but it is main source of white crystal sugar. It also provides cultivator with a very good substitute of sugar as 'gur' and 'khandsari' (brown sugar). Its tops serve as fodder for the cattle, baggage and leaf trashes as fuel, stubble and roots as organic manure and crop residues as mulch and compost. Sugarcane leaves are used as substrate for the artificial cultivation of edible mushrooms. A big challenge in this century is to develop technologies leading to a sustainable agriculture. The use of chemical fertilizers cannot be eliminated without drastically decreasing food production. At the same time, there is an urgent need to lower the adverse environmental impacts of agricultural fertilizers. Biological nitrogen fixation is a promising alternative to improve N nutrition, as the use of inoculants of *Gluconacetobacter diazotrophic* bacteria in agriculture has been proven to enhance N availability and uptake, to promote plant growth, to increase biomass, and to keep the plants healthy.The associative and endophytic *G. diazotrophic* bacteria naturally colonize and contribute with fixed N to several economically important plant species *Viz*., sugarcane, comprising a natural system to be explored.

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Table 1: Contribution of biological nitrogen fixation by associative/endophytic bacteria

Endophytic bacteria	Associating plant	% Nitrogen derived from air	Reference
Rhizobium leguminosarum bv. *trifolii*	Rice	19 to 28	Yanni et al., 1997; Biswas et al., 2000
Burkholderia	Rice	31	Baldani and Baldani, 2005
Herbaspirillum	Rice	19-47	Ladha and Reddy, 2000
Azospirillum	Rice	19-47	Ladha and Reddy, 2000
Gluconacetobacter diazotrophicus, H. seropedicae, H. rubrisubalbicans, A. amazonense and Burkholderia sp.	Sugarcane	29	Oliveira et al., 2002
K. pneumoniae 324	Rice	42	Iniguez et al., 2004
Burkholderia vietnamiensis	Rice	40-42	Govindrajan et al., 2008

Table 2 -Natural crop habitats of G. diazotrophicus

Country	Crop	Isolation source	Reference
Brazil	Sugarcane	Root, root hair, stem, leaf	Cavalcante and Dobereiner, 1988
Brazil	Cameroon grass	Root, stem	Dobereiner et al., 1988
Brazil	Sweet potato	Root, stem tuber	Dobereiner et al., 1988
Mexico	Coffee	Root, rhizosphere,stem	Jimenez-Salgado et al., 1997
India	Finger millet	Root, rhizosphere, stem	Loganathan et al., 1999
India and Korea	Wetland rice	Root, rhizosphere,stem	Muthukumarasamy et al., 2005
Kenya	Tea	Root	Matiru and Thomson, 1998
Mexico	Pineapple	Root, stem, leaf	Tapia-Hernandez et al., 2000

Fig-1 (a) Structure of Gluconacetobacter bacteria

(b) Gluconacetobacter applied Sugarcane crop

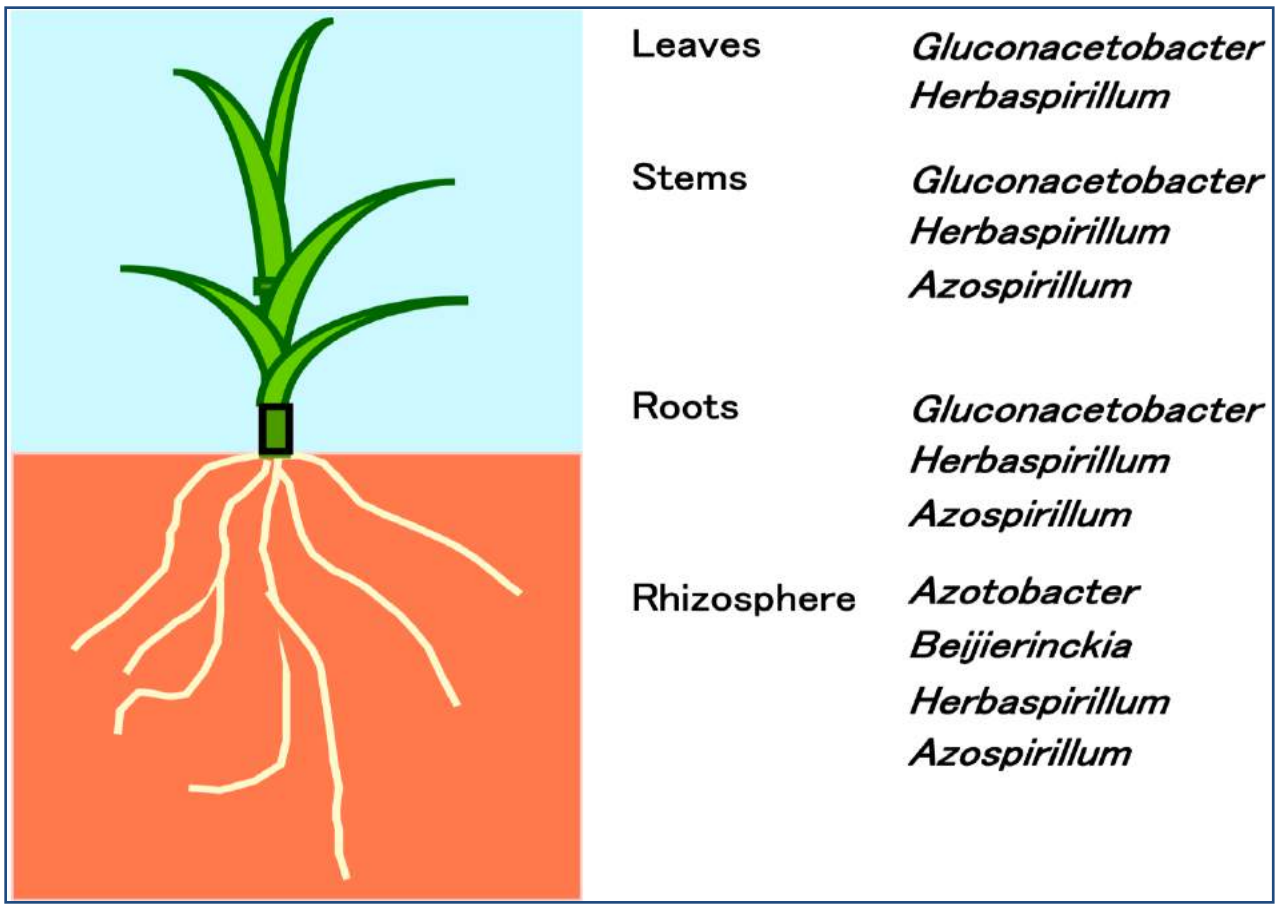

Fig 2- Presence of major diazotrophic endophytes in sugarcane

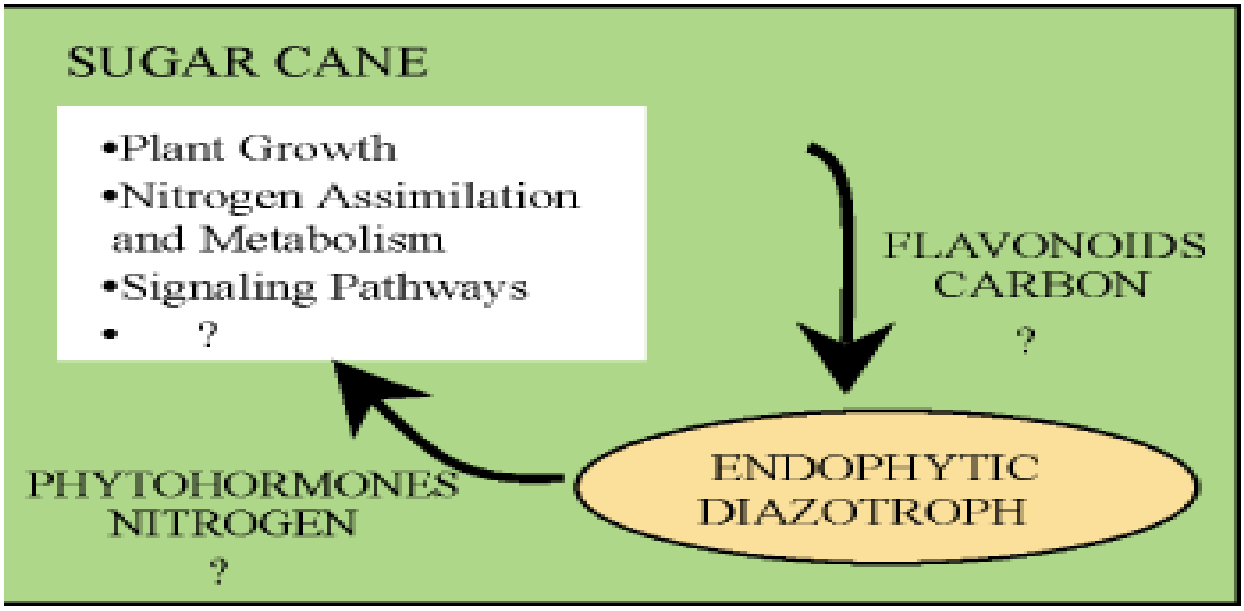

Figure 3 – Biological Nitrogen Fixation (BNF) in sugarcane

Keys to Dairy Calf Management

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The replacement heifers and bulls are crucial for the profitability of dairy farms. Therefore, the success of dairy enterprises depends to a great extent on the proper management and care of the calves.Well-managed calf rearing should aim for:

1. Good animal performance with minimal losses from disease and death.
2. Optimum growth rate and feed efficiency.
3. Optimal cost inputs such as feed (milk, concentrates and roughage), animalhealth (veterinary fees and medicines) and other operating costs (milk feeding equipment, transport, bedding material, etc.) to achieve well-reared calves.
4. Minimum labour requirements.
5. Maximum utilisation of existing facilities such as sheds for rearing and pastures for grazing.

To accomplish these goals, there is need to review the feeding and management practices for dairy calves in light of the new research that illustrates their importance on calf health and future productivity.

Management concept 1: Underfeeding or overfeeding the dam does not change the Calf's birth weight.

Reason: By decreasing the nutrition of the dam, the size of the calf is not changed. Basically, the size of the calf is genetically predetermined. Studies have shown that energy or protein to the dam can decrease the ability of the calf to regulate its body temperature after birth. Thus, underfeeding the dam during the last two months of gestation can increase mortality of the calf within the first two weeks of life. Also, dams with body condition scores at 4 or greater have a higher incidence of dystocia. These calves also have higher mortality rates than those born without calving difficulty. Mineral nutrition of the dam also affects the quality of colostrum available to the calf after calving. Research shows that it is critical to meet the requirements of dry cows for healthy, productive calves.

Management concept 2: Hand feed calves 2-3 litres of colostrum within 1-2 hours of birth.

Reason: The newborn calf should be fed colostrum during the first few days after birth it reduces health problems and ensures bettergrowth. Calves are born without antibodies against diseases and need to absorb the immunoglobulins found in colostrum to protect against disease. Colostral immunoglobulins (IgG) are

absorbed most efficiently within the first 4-6 hours of life. At 12 hrs of age, absorption of antibodies is approximately one-third of the rate at birth and is essentially zero by 24 hours of age. Several studies have shown that dairy calves that suckle their dam do not receive adequate amounts of colostrum and thus do not receive adequate protection against disease. Calves should receive 2-3 litres of colostrum at the initial feeding after their birth. More recent studies have shown that colostrum supplies additional immune and nutritive factors besides immunoglobulins. Feeding adequate amounts of colostrum also can improve rumen growth and health and absorption of nutrients from the small intestine. The calf may be allowed to suckle the mother's udder or may be pail or bottle fed within one hour of birth. The calf is needed to be trained for pail feeding as follows: At the beginning offer a finger to the calf for suckling and then slowly dip the finger in the milk pail. Subsequently the finger has to be lowered and gradually taken out of the pail till the calf begins to drink directly from the pail.

Management concept 3: A calf's first meal should be colostrum not manure.

Reason: Both the cow and her calf need to be managed to insure the calf's first meal is clean colostrum not manure-laced. Contaminated colostrum can increase the incidence of diseases which cause scours and might decrease the ability of the calf to absorb immunoglobulins from colostrum. Remove the calf from the cow immediately after the calf has been cleaned to avoid the calf getting "a manure meal" from the calving environment, dirty teats or dirty legs, etc. of the dam. Milk the cow in clean equipment and wash the cow. To quickly cool colostrum, place clean pop/soft drink bottles with frozen water in the milk bucket. .

Management concept 4: Calves need warm, draft-free housing.

Reason: However this can require a large investment both financially and in terms of labour. There is long-term recognition of the benefit to dairy calf health of outdoor housing in hutches, especially for the prevention of diarrhoea and respiratory disease. Respiratory disorders frequently occur in non-weaned calves and are regularly associated with housing system. Factors including the number of animals per group, relative animal density, housing facilities and ventilation conditions significantly contribute to transmission in grouped calves.Calves in the first week of life spend 80% of the day lying down. The time spent lying down only deceases to 75% in week 2 of life. Thus, the housing environment where calves lay down is critical to their survival. New-born calves have very little body fat and consequently their comfort zone is between 50 ° F and 78 F. By a month of age, a calf's comfort zone widens and is between 32 F and 73 °F. Thus, during cooler temperatures calves need additional milk for energy and need to be bedded with straw. Straw allows the calf to "nest" into the straw and stay warm. .

Management concept 5: By three days of age, calves should be fed a small amount ofcalf starter and free-choice water in addition to their appropriate amount of milk or milkreplacer.

Reason for providing calf starter: Calves only eat small amount of starter the firstcouple weeks of life, but this small amount is important in rumen development. Studies haveshown that more rumen development occurs when starters are textured versus pelleted or ground. Calves should be weaned when they are eating 4-5 lbs of starter for 3 days in a row.

Reason for providing free-choice, clean water: Providing clean water year round is important for rumen development. Calves provided with water gain 33% more and have less cours. Water needs to be provided separately from milk. Reason for not feeding hay until the calf is at least 2 months of age: Feeding hay to calves before they are consuming 5 lbs of calf starter decreases rumen development. Digestion of starter in the calf's rumen helps develop the rumen papillae that absorb the VFA's that supplyenergy to the calf. Calves have only a limited ability to digest forages.

Management concept 6: Growth performance ·

Reason: The potential for attaining optimum body weight is an important factor that affects the economy and success of a dairy farm. Growth parameters at an early age can be used as one of the important selection criteria. The ideal birth weight of a calf may range between 15 to 35 kg depending on the breed and sex. · The body weight of calves should be recorded at weekly intervals

Dense Phase CO_2: A Novel Food Preservation Method

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Dense phase CO_2 is a collective term used for CO_2 when it is in either the supercritical or liquid states. The term "dense phase" (DP) as used here denotes those phases of matter that remain fluid, yet are dense with respect to gaseous CO_2. The dense phase exists above the critical point (31.1^{0}C, 73atm). Dense phase carbon dioxide (DPCD) is a non-thermal technology that combines the bactericidal efficacy of CO_2 and high pressure at a temperature much lower than that during conventional thermal treatments thus without exposing foods to adverse effects of heat. It retains the fresh like physical, nutritional and sensory qualities of the foods. The pressures typically used in pressurized CO_2 processing approaches to about 70 MPa. DPCD is a cold pasteurization method that affects microorganisms and enzymes through molecular effect of CO_2 under pressures below 50 MPa without exposing foods to adverse effects of heat and retaining their fresh like physical, nutritional, and sensory qualities. DPCD technology is also known as supercritical fluid technology or high pressure carbon dioxide technology. It inactivates vegetative bacterial cells, some spores, yeasts and molds, some viruses and some enzymes. The traditional approach to develop a DPCD process for a new product involves a complex experimental plan to investigate microbial and safety effects. DPCD temporarily reduces the pH of liquid foods and because oxygen is removed from the environment, and because the temperature is not high during the short process time (typically about five minutes in continuous systems), nutrients, antioxidant activity and vitamins are much better preserved than with thermal treatments.

History of DPCD

This technology has been investigated over the past 50 years, particularly in the past 2 decades. Due to the low viscosity of dense phase, super critical carbon dioxide (SC-CO_2) has been used for enhanced oil recovery (EOR).

Properties of CO_2 useful for dense phase technology

- **High diffusivity**: The low viscosity and high density of CO_2 in the dense phase makes it highly diffusible and it can easily penetrate through the cell membrane of the microorganisms which increases its efficiency for their destruction.
- **Non-flammable**: CO_2 is a nonflammable gas. So it is safe to use.
- **Non-toxic**: CO_2 being nontoxic does not have any harmful effect on the food and hence so on its consumers.
- **Odorless**: CO_2 is a non-odorous compound, so it does not give any residual odor which can adversely affect the sensory appeal of the treated food.

- Thus it is well acceptable in the food industry.
- **Cheap**: Economics is the most important criteria for any industry to use a certain technology and CO_2 being a cheap gas is easy to afford.

Key factors for the inactivation of microorganisms using supercritical-CO_2

- **Pressure**: A higher pressure enhances CO_2 solubility, facilitating both acidification and cellular contact.
- **Temperature**: Higher temperatures stimulate the CO_2 diffusivity, and can increase the cell membrane fluidity to enhance penetration.
- **Microbial species**: DPCD affects different microbial species differently. So the destructive effect of DPCD is also dependent on the microbial species it is acting upon.

Mechanism of Food Preservation by DPCD

Dense Phase Carbon dioxide preserves food by affecting:

- The Microorganisms; and
- The Enzymes

Mechanism of Inactivation of Microorganisms by DPCD

The exact means of microbial inactivation by DPCD are not clear. Studies show that several mechanisms may be involved (Spilimbergo *et al*., 2003). DPCD may inactivate microorganisms by:

(a) Lowering of pH:

CO_2 can lower pH when dissolved in the aqueous part of a food by forming carbonic acid, which further dissociates to give bicarbonate, carbonate and H^+ ions lowering extracellular pH:

$CO_2 + H_2O \leftrightarrow H_2CO_3$

$H_2CO_3 \leftrightarrow H^+ + HCO_3^-$ (pKa = 6.57)

$HCO_3^- \leftrightarrow H^+ + CO_3^{-2}$ (pKa = 10.62)

The internal pH of microbial cells has the largest effect on their destruction. When there is sufficient CO_2 in the environment, it penetrates through the cell membrane consisting of phospholipid layers. It lowers internal pH by exceeding the cell's buffering capacity. Cells have a tendency to maintain a pH gradient between the internal and external environments by pumping H^+ ions out of the cell. This is overwhelmed when enough CO_2 permeates to reduce the internal pH. This may inactivate microorganisms by inhibiting essential metabolic systems including enzymes (Ballestra *et al*., 1996).

(b) Physical disruption of cell: The 1st suggested mechanism of inactivation of microorganisms by DPCD was the physical disruption of cells. E. coli cells were killed at 50.7 MPa in less than 5 min by bursting due to the rapid pressure release and the expansion of CO_2 within the cell. *Saccharomyces cerevisiae*cells in beer treated with a continuous DPCD system (27.5 MPa, 21°C, 10% CO_2/beer ratio, 5 min) (Folkes, 2004). Cell rupture is possible by DPCD, but not necessary for cell inactivation. Cells may be completely inactivated even when they remain intact or show only signs of deformation.

(c) Modification of cell membrane and extraction of cellular material: Another mechanism suggested by the researchers is based on the lipophylicity and hydrophilicity and solvent characteristics of CO_2. Kamihira *et al*., (1987) mentioned extraction of intracellular substances such as phospholipids as a possible mechanism of microbial inactivation. Isenchmid *et al*., (1995) proposed that molecular CO_2 diffused into cell membrane and accumulated there because the inner layer is hydrophilic. Accumulated CO_2 increases

fluidity of the membrane due to the order loss of the lipid chains, also called the "anaesthesia effect," and this causes an increase in permeability. Lin *et al*., (1992) suggested that once CO_2 has penetrated into the cell, it can extract cellular components and transfer extracted materials out during pressure release. Extraction of lipids or other vital components of cells or membranes causes inactivation. These hypotheses have been investigated by researchers by measuring the amount of materials in the supernatant of treated cells or by micro structural observations on the treated cells.

(d) Oxygen elimination: The gas decreases the growth rate of aerobic microorganisms by displacing O_2which also minimizes oxidative rancidity by preventing the food to come in contact with oxygen, thus extending its shelf life.

(e) Extraction of intracellular substances: CO_2 causes extraction of intracellular substances which causes microbial destruction.

Enzyme Inactivation by DPCD

Inactivation of certain enzymes that affect the quality of foods by DPCD has been shown by several researchers. DPCD can inactivate certain enzymes at temperatures where thermal inactivation is not effective. Among these enzymes, pectin esterase (PE) causes cloud loss in some fruit juices; polyphenol oxidase (PPO) causes undesirable browning in fruits, vegetables, juices, and some seafood; lypoxygenase (LOX) causes chlorophyll destruction and off-flavour development in frozen vegetables; and peroxidase (POD) has an important role in discoloration of foods and used as an index of heat treatment efficacy in fruit and vegetable processing. Although limited in number, studies on enzyme inactivation by DPCD indicate good potential, especially in fruit and vegetable juice processing where these enzymes cause quality deterioration if not inactivated. Enzyme inactivation by DPCD could be due to many causes such as pH lowering, conformational changes of the enzyme, and inhibitory effect of molecular CO_2 on enzyme activity.

Advantages of DPCD over other methods

(a) Better retention of color: DPCD treated foods have better retention of their natural color than those treated with other conventional methods of heat treatment.

(b) Retention of aroma and flavour: The aroma and flavour of the DPCD processed foods are to thermally processed products.

(c) Better retention of nutrients: The treatment of the foods with DPCD retains their nutritional quality far better as compared to those treated with any other thermal processing methods.

(d) The pressure used is at least one order of magnitude less than that used for HPP processing.

(e) The capital and operating costs are much lower than those of other non-thermal technologies (e.g. HPP).

(f) DPCD being nontoxic and nonflammable is safe to use.

Other applications of DPCD

1) DPCD can be used for casein production, due to the pH lowering effect CO_2.

2) DPCD is used for a wide range of commercial cleaning applications of metal surfaces, glasses, microbial contaminated surfaces etc.

3) Due to high diffusivity of DPCD, it is widely used in oil extraction for specific uses.

Commercial outlooks and suggestions

Significant differentiation of the DPCD product from those existing in the market regarding taste, quality and shelf-life is needed to justify the added cost. Niche areas where no other conventional processing is possible need to be found, such as tropical fruit juices that are very sensitive to heat. Regulatory issues facing young technologies must be addressed. For example, approval of the process or the labelling of the product.

Conclusion

Dense phase CO_2 (DPCD) is a non-thermal technology. It can inactivate certain microorganisms and enzymes at temperatures low enough to avoid the thermal effects of traditional pasteurization. It is a quite new technology. It has found to be effective in the destruction of pathogens, spoilage bacteria, yeasts and moulds and various enzymes. The foods treated with DPCD retain the nutrients and sensory characteristics far better than the conventional methods of food preservation used. DPCD is a potential preservative technique for safe food but still has not achieved commercial operating status. DPCD treatment of liquid foods results in better sensory quality and nutrient retention and less quality changes compared to thermal pasteurization.

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