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Growing seed

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BLACK UREA: A NEW PARADIGM SHIFTS FOR HUMIC ACID COATED SLOW RELEASE UREA FERTILIZER

Article Id: AL202125

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In recent time, black urea is becoming a substantial technology for reduction of nitrogen loss, cost effectiveness and greater nitrogen use efficiency. Black urea is granulated urea which is coated in an organic complex of carbon and biological stimulants which enhances the microbial activity the granule and optimizes nitrogen use efficiency. Black urea is distinctively developed to reduce the losses. Thus 30% more nitrogen than un-coated urea reaches to crops. Black urea technology works through small improvements in each leg of the nitrogen cycle in the soil. It promotes a reduction in losses through volatilization and leaching as it helps in stabilization of nutrients in the soil by the use of biological processes. Black urea controls nitrogen availability through maximizing N use efficiency. It provides lower burn potential over traditional urea fertilizers. It contains 21% carbon, which enhanced soil microbial activity and nutrient availability in soil.

Nitrogen (N) being an integral component of enzymes, amino acids, chlorophyll, and nucleic acids is the essential plant nutrient among all the nutrients. It plays a crucial role in the formation of carbohydrate and its use for stimulation of plant growth and development along with uptake of other essential plant nutrients. To ensure the required crop production, the required N is applied in the soil through various N fertilizers in plant-available forms i.e. nitrate (NO_3^-) and ammonical (NH_4^+) (Sanchary and Huq, 2018). Among all the N fertilizers, most of the nitrogen is supplied through urea fertilizer. Urea has received a special attention a major N fertilizer material within the last four decades or so and has gained the most used N fertilizer place across the world. Though urea has been accepted as most common N fertilizer globally, many agricultural researchers have reservations about the use of urea and its cost effectiveness due to problems related to urea use i.e. the adverse effect of biuret on seedling germinations and early growth; urea phyto-toxicity due to the release of ammonia and/or

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accumulation of nitrite; nitrogen losses through denitrification; leaching and volatilization processes (Tisdale *et al*., 1985).

But, research activities in the last two decades have shown that use efficiency and cost effectiveness of urea can be increased with little bit modifications of urea fertilizer i.e. coating of urea with different materials. Various scientific measures have been adopted gradually for enhancement of effectiveness, decreased manufacturing cost and increased release time of N from urea. Among these scientific measures are formaldehyde treated urea, urea solution with 1.5% biuret, granular urea and very recently the advance step of coating of urea with other nutrient elements i.e. phosphate coated urea, sulphur coated urea and/or coating with calcium/magnesium chloride. Very recently, the latest invention in the field of urea coating is the coating of urea granules with carbon material i.e. humic acid, termed as Black urea.

Application of humic acid coated urea aims to reduce the nitrogen (N) losses during soil application and improve the plant uptake of applied urea through reduced ammonia volatilization, biological denitrification and nitrate leaching. Black urea is claimed as cost effective and more efficient N fertilizer as the coating material i.e. humic acid contains the other plant nutrients like phosphorus, potassium and micronutrients, are also incorporated. Coating of urea with humic acid stimulates the microbial activity in the soil, which enhance the conversion of urea N to ammonia and nitrate more quickly and efficiently, thus accelerate the plant uptake process. Coating material i.e. humic acid being a carbon source, increase the plant conversion of nitrogen to amino acids.

Researches have proved that use of black urea as a source of N supply helps in improvements to different legs of the nitrogen cycle. Use of organically coated urea stimulate the biological processes which enhance the stabilization of nutrients in soil and nitrogen losses through leaching and volatilization can be significantly reduced. Black urea has targetablly been developed to improve the profits from crop production on low fertility soils and also for sustainable farming practices (Web-2). Use of black urea in place of white urea has been proved better in terms of maximizing N use efficiency, lowered burning potential, N losses through various process and their impacts on the environment and improved soil microbial activity and nutrient availability due to presence of 21% carbon in black urea (Web-1).

Black urea concept basically works on the following principles

1. Maximize the nitrogen use efficiency

2. Minimize the input use
3. Maximize the profit

1. Maximize the nitrogen use efficiency

Use of organic material for coating gives the unique quality of extended release capabilities of N from black urea to the applied crops. Many researchers have observed that higher biological activity in black urea applied fields deliver more activity into the nitrogen cycle, which results in 25% extra N absorption into the plants (Web-2). Use of carbon organic-catalysts i.e. humic, fulvic, amino acids, ulmic, peptides, polysaccharides, vitamins, surfactants and minerals as coating material serves as an extremely high energy packet for soil microorganisms and provide a very high nutrient exchange capacity around the fertilizer granule. Use of organic material as coating material helps in:

- Stabilization of nitrogen in soil as protein (in microbes) and ammonium with a sustained release to nitrate which is controlled by the plant-soil interaction (rhizosphere).
- Stabilization of phosphorus with carbohydrate avoids the reactions with multivalent cations (tie-up).
- Coating with organic material is the only nitrogen stabilizing technology which can be used with urea, UAN, liquid urea and GAS.

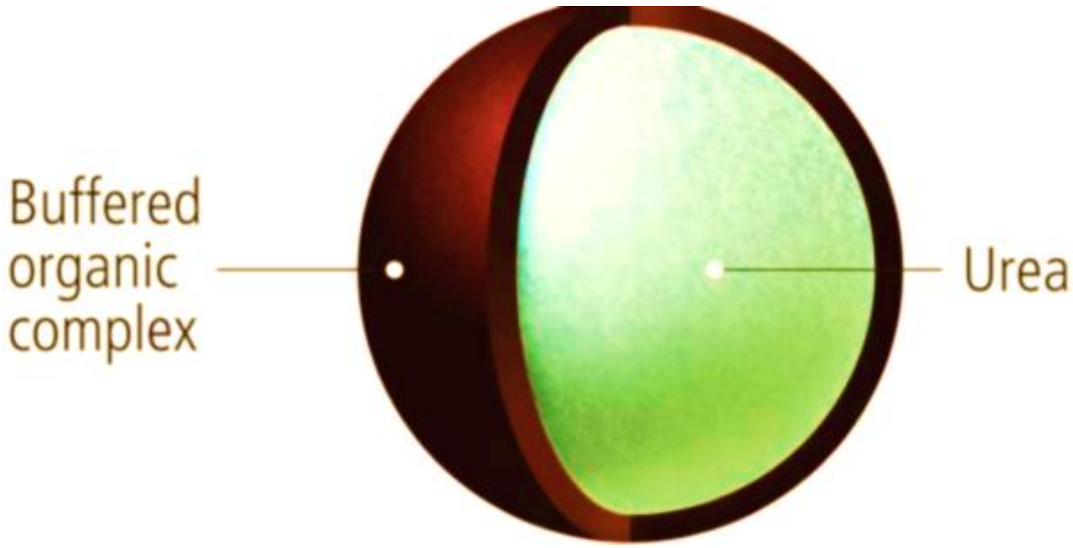

Fig 1. Use of organic material i.e. humic acid, fulvic acid, and other polysaccharides for urea coating.

2. Minimize the input use

Coating of urea fertilizer with various coating materials i.e. sulphur, neem, organic material etc. has now become a popular among the growers because of slow release of nitrogen from the fertilizer, reduced rate of application, farm labour and potential soil and environmental impacts due to N losses through various processes (Hara, 2000). The improvement in different legs of the nitrogen cycle through the involvement of biological processes in case of black urea reduces the application rate of nitrogen. Much scientific glasshouse, field and laboratory research trials over last two decades across the globe have proved that nitrogen application to various crops can be reduced up to 25% when it is applied through black urea (Web-3). That means as compared to normal white urea a minimum 25% more nitrogen will be available to plants in case of black urea which makes black urea significantly more economical and highly effective nitrogen alternative compared to normal white urea.

Table 1. Comparison between black urea and normal white urea in terms of economics

Parameters	Black urea (46% N)	Normal White urea (46% N)
Elemental N ($/kg)	$0.97	$1.24
N Efficiency (%)	50	75
N available to plant (kg)	23	34.5
Effective N ($/ kg)	$1.93	$1.65

(Source: https://www.agriwestrural.com.au/AgriWest-Newsletter-August-2016.pdf)

3. Maximize the profit

Application of nitrogen through black urea reduces the fertilizer input rate while delivering the higher yield compared with normal white urea, which gives an overall increase of 10-20% profit to the growers. The increased uptake of nitrogen as a result of slow release from black urea reduces the fertilizer load and increase the cost efficiency up to 10-20% (Web 4). Internationally conducted research trials have demonstrated 15-35% economic superiority of black coated fertilizers (Black urea and black DAP) over the normal fertilizers (Web-4).

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Conclusions

Black urea has proved as a better nitrogen fertilizer compared with other urea as well as nitrogen fertilizers in terms of nutrient content, plant growth and cost effectiveness. Proper application and management practices of black urea can fulfil the target of improved benefits and reduced input costs. The input cost of farm inputs can be reduced by 15-35% with application black urea. Thus in the present scenario of changing climate, black urea is simply a more effective and economical source of nitrogen for crops.

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Web-1: http://www.blackurea.com.au/index.php?page=81.

Web-2: http://www.turfgrassspecialists.co.nz/page/51/granular-fertilizer?#.V3NqEeLHXIU.

Web-3: www.agriwestrural.com.au/black-urea.

Web-4: http://sites.google.com/site/blackureatrials.

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SEED PROCESSING AND ITS IMPORTANCE

Article Id: AL202126

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Seed is a fertilized mature ovule consisting of an embryo, endosperm with a protective seed coat. Seed is the basic input in agriculture. A good quality vigorous seed utilizes the resources and rises as a healthy seedling. Seed also exhibit the greater variation in shape, size, colour and surface characteristics. To overcome all these problems seeds have to be processed to achieve a uniform and quality seeds. After harvesting, seeds are brought to the seed processing unit from the field are frequently at high moisture content. Seed lots also contain inert matters, damaged seeds, trash materials, deteriorated seeds, off-size seeds etc. Seed processing is the vital one to bring the seeds to a safe moisture content level by drying the seeds and also to reduce undesirable materials to the maximum possible. This article outlined the seed processing, objectives, materials removed during processing and sequence of operations.

Seed processing is a fundamental thing which is engaged with making high quality seed. It guarantees the end clients, seeds of high quality with least contaminated. In Agriculture, the term seed handling incorporates cleaning, drying, seed treatment, packaging and storage. Seed processing mainly targets to boost the seed viability, vigour and health.

Purposes of seed processing

1. To lower the expenses of additional processes like storage and transport.
2. This is accomplished by reducing the bulk of the seed lot by cleaning debris and by eliminating empty or fractured seed (pre-cleaning).
3. To increase the life span of seeds; by drying seeds to safe moisture content and treating with synthetic substance.
4. To decrease the variability in vigour by strengthening the seeds and eliminating the low vigour seeds.

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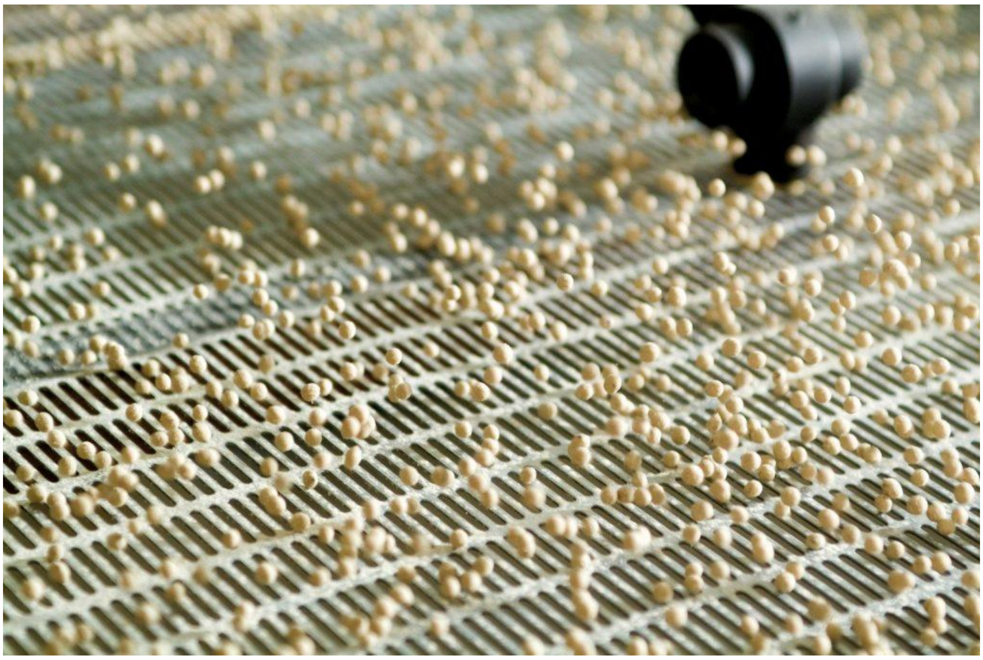
5. To improve the uniformity in seed shape or size by grading or by pelleting.

Principles and objectives

The seed quality is improved in two ways during processing: Separation of inert matter, the disposal of low quality seeds.

The maximum pure seed percentage with maximum germination capacity is acquired by seed processing. Harvested produce is heterogeneous in nature. By seed processing, we can get the product as homogeneous nature. This will help in getting uniformity in the field. Seed processing can be carried with the approval of the Director of Seed Certification. Seed processing is an important process to achieve uniform seeds by using suitable processing methods.

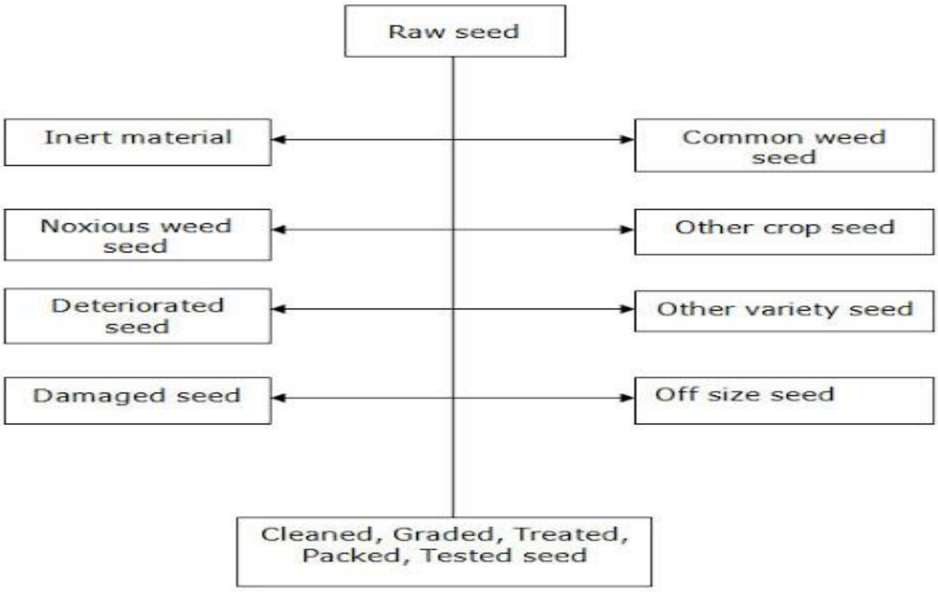


Types of materials removed during seed processing

Inert materials, Common weed seeds, Noxious weed seeds, Deteriorated seeds, damaged seeds, other crop seeds, other variety seeds and Off-size seeds

Sequence of operation in seed processing

Each seed crop possesses unique seed structure. Seed processing can be carried out on the basis of seed shape, size, weight, length, surface characteristics, colour and moisture content. Therefore suitable operations carry out using suitable equipment's. However, sequences of operation in seed processing are drying, receiving, pre-cleaning, conditioning, cleaning, separating or upgrading, treating (Drying), weighing, bagging and storage or shipping.



Conclusion

Seed processing should be done to get high quality seeds at a sufficiently high rate per hour to minimize the cost and make it commercially viable. Seed processing assures the good quality of seeds to the end users.

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PHYSIOLOGICAL AND MORPHOLOGICAL ADAPTATION OF ANIMALS IN THE DESERT

Article Id: AL202127

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Desert is marked by long dry season with little precipitation. During summer in hot deserts, the daytime temperature may exceed 45 °C (113 °F), and during winter night time, the temperature comes below freezing point. Plants and animals living in the desert need a special adaptation for surviving in this harsh climate. According, the amount of particles in the vegetation increases, which is most difficult for small mammals, such as rodents, which rely on this source for their metabolic water for this climate. Excluding breeding season, respiration, urine, faeces and thermoregulatory process such as sweating and evaporative cooling are the main physiological pathway for water loss in small rodents. Therefore, increasing of urine concentration and reducing the volume of urine are important adaptations (Palgi & Haim 2003; Shanas & Haim 2004). Rodents present in the desert, have reduced their resting metabolic rate (RMR) values than their body mass as per allometric equations (Kleiber & Rogers 1961). This decreasing value is an important adaptation to xeric environments as it allows decreasing heat production on the one hand and conservation of water for thermoregulatory purposes on the other (McNab 1968; Haim & Izhaki 1993).

Desert animals mostly deal with two main adaptations, firstly how to deal with lack of water and secondly how to deal with extremes in temperature. Most desert animals get their water from the food they consume, succulent plants, seeds, or their prey’s blood and body tissue, because of water scarcity. Desert animals, who adapted to live in harsh climate are called xerocoles. Animals face challenges for surviving in the desert environment. Most of the animals behave as a nocturnal, means they sleep during the day in burrows or tunnel under the ground to stay cool and come out during night time, for example, gerbil, jerboa, and kangaroo rat. They rarely need to drink and consume water from the food, which is also known as metabolic water.

Thermoregulation

For mammals, homeostasis of body temperature is important for the survival of life. When the ambient temperature is increased, decreasing the internal heat production is essential, either by decreasing generation of internal heat production, or increasing activity of the heat dissipation mechanisms. If the high ambient temperature is continuous, as in the desert during summer, acclimation to heat occurs in animals. This low value is an important adaptation to xeric environments as it allows decreasing heat production on the one hand and conservation of water for thermoregulatory purposes on the other (McNab 1968; Haim & Izhaki 1993). The process of heat acclimation, studied in rats and mice in the laboratory, under conditions of chronic exposure to an ambient temperature at the upper limit of the thermoneutral zone, comprises two distinct phases: (i) short-term heat acclimation, after 2 days; and (ii) long-term heat acclimation, after at least 30 days of exposure to the same conditions (Horowitz 2002). This process ends with reorganization at the level of gene and protein expression, as was discovered in the hypothalamus: the thermoregulatory centre (Schwimmer et al. 2006).

Vasopressin

One of the physiological responses to water restriction and reservation is releasing the hormone Vasopressin (VP) from the pituitary. Vasopressin is an antidiuretic hormone, produced from the cell bodies of the magnocellular neurons of the supra-optic and paraventricular nuclei in the hypothalamus. It is released to the bloodstream from the neural pituitary gland and acts on the kidney glomeruli and contraction of this arterioles helps in reabsorbing of water from the collecting ducts. This direct action of VP in the kidney glomeruli leads to a lowering of plasma filtration and prevents water loss from the vascular compartments to the urine. It also acts on the thermoregulatory responses, as central administration of VP elicits hypothermia, maybe by affecting the metabolic rate as well as peripheral blood vessels vasodilation (Nelson 2005).

Melatonin

Melatonin is the main secretory product of the pineal gland. Pineal melatonin production occurs during the night time and is suppressed by the presence of light. The effects of plasma melatonin are to exhibit a circadian rhythm, with high levels at night and

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low levels during the day. Longer nights are correlated with a longer period of secretion of melatonin (Cardinali & Pevet 1998). As melatonin is quickly cleared from the circulation following the cessation of its production, the time and duration of melatonin peak reflect the environmental night period (Cardinali & Pevet 1998; Pandi- Perumal et al. 2006). In mammals, melatonin has a various critical role like physiological neuroendocrine and reproductive functions. Melatonin also regulates the reproductive function of seasonal breeding mammals through its inhibitory action at various levels of the hypothalamic–pituitary–gonadal axis. It has been shown that melatonin suppresses GnRH gene expression in an exponential pattern over a span of 24 hours (Roy & Belsham 2002). Melatonin plays a crucial role in the synchronisation of xeric adaptation in particular species and different populations.

Adaptation of desert animals

Camel: The camel is well adapted in the harsh desert environment. It is able to withstand the extreme heat, sparse vegetation, and scarcity of water in desert condition. Its special adaptation includes:

1. Long eyelashes, thin and lit nostrils that can close, which will protect them from blowing sand.
2. Translucent eyelids that will help them to see relatively well.
3. Thick far and wool helps them to withstand cold desert night and provide insulation during day time.
4. Camel hill like hump used for storing fat, not water, they can survive many days without food.
5. Have hard and tough lips for picking up dry and hard vegetation.
6. Can drink up to 30% of its body weight (200 litters in 3 minutes).
7. They have extremely long intestine (colon) for reabsorbing water, and they rarely sweat.
8. Concentrated urine for preventing water loss as much as possible.
9. They have long padded feet that will help them for traveling over soft desert sands and to protect from the heat of the sand.
10. Long strong legs for carrying load on back and for keeping body further away from the sand.

11. A hard flat layer of skin around the stomach and thick leathery patches on knee, protects them from extreme heat while resting on sand.

Fennec fox: This is the smallest of all fox species and are found in the Sahara Desert and elsewhere in North Africa. They are nocturnal which helps them deal with the heat of the desert environment. Some physical adaptations are:

1. They have thick fur and feet for protecting from the heat of sand.
2. Large ear for insulation.
3. Thick and light colour hair coat for protecting cold and provide insulation during daytime.

Conclusion

Desert adaptation impairs physical & mental performance. The key to the survival in hot, dry environment consists in avoiding climatic extremes as far as possible, by a combination of seeking refuge from the most adverse conditions, morphological adaptations, behaviour and specialized physiology. In desert, physiological and morphological adaptation are elongated body shape, water conserving capacity with vasopressin hormone, long legs, ears, thin skin and light skin colour. The exploitation of desert habitat involves a vast complex of adaptation compromises between physiological factors like thermoregulation, water conservation through VP hormone and melanin function etc. Thermal reactions are primarily behavioural; adaptation responses to aridity are mostly physiological. Thus desert adaptation mainly relays upon conservation of water, ability to withstand and protect themselves from the extreme temperature changes.

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PLANT NUTRITION: A CHALLENGE FOR SUSTAINABLE DEVELOPMENT

Article Id: AL202128

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In scientific language, plant nutrition is the word to describe the whole process of absorption, translocation and assimilation of nutrient by the plant. As par the essential requirement of nutrients, basic nutrients are carbon (C), hydrogen (H), oxygen (O); primary nutrients- nitrogen (N), phosphorus (P), potassium (K); secondary nutrients- calcium (Ca), magnesium (Mg), sulphur (S) which are required in large quantity. Besides, micro nutrients also have similar importance in plant nutrition, but it is required in small quantities viz., iron (Fe), manganese (Mn), copper (Cu), zinc (Zn), boron (B), molybdenum (Mo), chlorine (Cl) and nickel (Ni). These seventeen nutrients are very much essential in plant growth and its metabolism process. In continuation of essentiality criteria, the deficiency of particular nutrient in the soil can be corrected by that nutrient only and lastly it is found that the deficiency of nutrients results in failure to complete the life cycle. So, the presence of nutrients in the soil (soil fertility) and the ability of the soil to avail that nutrients for plants (soil productivity) are much essential. Usually, soil fertility is the function of nutrient status of soil and soil productivity is the function of soil fertility, management and climate. In another way, it can't find that fertile soil always be productive, but it would be productive when several factors like soil nutrient, soil environment, climate and also management part will favourable for nourishing the plant.

Role of different essential elements in plant system

All these 17th essential nutrients along with different beneficial nutrients (sodium, silicon, cobalt & vanadium) are so functional for the nourishment of plant. Therefore, it is an urgent need to study the functions of these (21th) nutrients. Among these functional nutrients,

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C, H, O are the basic nutrients which are the major constituents of organic material and the role of remaining nutrients are discussed in the following:

Primary (Macronutrients):

- Nitrogen (N): It requires in large amount for adequate plant growth. it is the component of amino acid and integral part of chlorophyll which imparts green colour to the plants.
- Phosphorus (P): It is responsible for energy transfer and an important structural component of nucleic acid (DNA, RNA).
- Potassium (K): It takes part in disease and drought resistant in many crops and also helps in osmotic and ionic regulation.

Secondary (Macronutrients):

- Calcium (Ca): it plays a major role in cell division, maintenance and in membrane integrity.
- Magnesium (Mg): component of chlorophyll and act as a cofactor for many enzymatic reactions.
- Sulphur (S): it is associated with chlorophyll formation and sulphur containing amino acids (Methionine, cysteine, cystine).

Rest of the nutrients are required in trace amount (micronutrient) and beneficial element (not established as an essential but required) for the plant.

Factors affecting the Phytoavailability

As it was discussed in the previous section that all fertile soil doesn't have productivity or sometimes fertile soil unbales to provide the nutrients as per the requirement of the plant. Therefore, it is important to know the reason how fertile soil is incapable of supplying the nutrients for the plants?

✓ **Soil organic matter (SOM)**

Soil organic matter influences the improvement in soil structure, porosity, water holding capacity (WHC) in a results soil moisture and soil temperature is maintained, which is primary prevailing conditions for nutrient availability. It improves the chemical properties like Cation exchange capacity (CEC) and buffering capacity of the soil., those are directly

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responsible for supplying available nutrient. Otherwise, it is well known that SOM act as a food source and storehouse for microbes and nitrogen, respectively. Thus, its deterioration by any means mostly tillage operation from the soil, hamper the nutrient availability and affect in nutrient retention in soil.

✓ **Problem soil**

Acid soil is predominant in areas where high rainfall has occurred as a result exchangeable bases are leached and Al, Fe are dominant in surface layer which produced toxicity to the plant. However, soil acidity affects in different nutrient availability like phosphorus availability is decreased and decreased amount of Ca^+ & Mg^+ is found in acidic soil etc. Microbes like bacteria and actinomycetes activity are decreased when soil pH dropped below 5.5. Another problem of soil is sodic or alkaline soil that contains an excess amount of sodium. Sodic soil caused the dispersion of soil colloid, and due to dispersion soil aeration, water intake, hydraulic conductivity, drainage, and microbial activity are hampered. Among the problem soil, saline soil is one of the, which contain an excess of soluble salts. Due to salt accumulation at the root zone of the plant and high solute concentration in saline water, the plant doesn't take water even though water is available in the soil. India has 24.3 mha area under problem soils (2010) which consist of acidic soils- 17.9 mha, alkaline soils- 3.7 mha, saline soils-2.7 mha (GOI, 2016, New Delhi). Other than, submerged soils are soils that are saturated with water for a long time. It has three distinct horizons like 1) partially oxidized 'A' horizon 2)a mottled zone where oxidation-reduction alternately happened 3) a permanently reduced zone. Rice is the only food crop with stand-in submergence. It exhibits several unfavourable conditions for a plant like a greater amount of soil solution, decreased oxygen level in a result, reduced microbial activity and altered chemical status of the soil. In submerged condition following nutrients transformation is occurred:

- Nitrogen losses through volatilization, leaching and denitrification
- Phosphorus level has been decreased over the time of submergence
- Exchangeable K^+ content is increased which may replace by Fe^{2+} & Mg^{2+} ions
- Sulphate (SO_4^{2-}) in submerged condition produced H_2S
- Micronutrient zinc (Zn) availability is decreased due to submergence

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✓ **Nutrient mobility**

Nutrient mobility is one of the reasons of nutrient deficiency in any system either in soil or in plant. In soil, most of the anionic nutrients are mobile in nature as because they are doesn't fix in clay colloid, except manganese (Mn^{++}) and most of the cations (NH_4^+, K^+, Ca^+, Mg^{++}, Cu^{++}) are absorbed by the clay complex in a result their mobility is reduced. Likewise, nutrient mobility has also importance in plant system, or knowledge of the nutrient mobility in the plant helps in finding what nutrient is deficient.

Table 1: Different nutrients deficiencies due to its mobility

Nutrients	Nature of mobility	Deficiencies Symptoms	Deficiencies in which portion
N, P, K, Mg	Highly mobile	• N-Yellowing of leaves including veins • P-Bronzy appearance • K-Nacrotic spot at margin or top of leaves • Mg-Yellowing take place (between veins)	Old leaves
Zn	Moderately mobile	• 'Khaira' disease of rice • Plants appears bushy due to reduce internodal elongation	Middle leaves
S, Fe, Mn, Cu, Mo	Less mobile	• S- Light yellowing without any dead spot • Fe- Interveinal complete chlorosis • Mn- Chequered appearance • Cu- Leaves are yellowish tending towards whiteness • Mo- Translucent spots	New leaves
Ca, B	Immobile	• Ca- Chlorosis start from tip to base • B- Chlorosis starts from base to tip	Terminal buds

✓ **Nutrient interaction**

Some of the nutrients have antagonism effect with other nutrients as a results deficiency occurred. Likewise, excess phosphorus (P) encourages the deficiencies of zinc (Zn); Iron (Fe) has antagonistic effect with copper (Cu), zinc (Zn) & manganese (Mn); high level of nitrogen (N) shows the deficiency of Cu & Zn; high level of sodium (Na) or potassium (K) affect manganese (Mn) uptake.

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Agronomical interventions

✓ **Reclaim problem soil**

Those area are prone to acidity, alkalinity and salinity, it is recommended to ameliorate that condition through agronomical interventions for growing of crops. Use of liming material like oxide, hydroxide and carbonate of Ca and Mg for reclaiming the acid soil. However, rock phosphate and press mud also help in reclamation of soil acidity.Soil alkalinity also creates problem in establishing agriculture in some areas. To lower down the pH of that soil, it is recommended to apply gypsum ($CaSO_4$, $2H_2O$) and iron pyrites (FeS_2). Accumulation of salt at the root zone of the crop cause salt injury to the crop. This type of salt stress can be avoided through some general procedures like flooding followed by leaching, irrigation with quality water, adequate drainage facilities and growing of salt-tolerant crops.

- **Flooding followed by leaching**: Combination of flooding then after leaching is the most effective method to eradicate salts from surface soil. Leaching of basic cation below the root zone lower down the pH of the soil into neutral condition.
- **Quality of irrigation water**: Apply water through irrigation after analyzing the electrical conductivity (EC), total soluble salts (TSS) and pH. Besides, it is essential to reduce the conveyance loss which influences the salt accumulation trough seepage during irrigation.
- **Drainage facilities**: Proper drainage through proper lining is the effective method in salinity condition—good drainage facility retards the salt accumulation in surface soil.
- **Growing of salt tolerant crop**: The use of salt resistant crops is an important feature of successful management of saline soil.

Table 2: Salt resistant crops

Degree of resistance	Crops
High	Barley, sugarbeet, cotton, dhaincha, mustard, tobacco
Moderate	Wheat, rice, maize, sorghum, pearlmillet, oat
Low	Beans, reddish, sunhemp, pea, ground nut, moong, urd, black gram, green gram

Rice is the only food crop growing in submergence condition. However, proper drainage facility in submerged soil give favourable condition for growing of other crops.

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- ✓ **Sustain optimum soil condition**

"Healthy soil yields the healthy crops". But what is healthy soil and how to achieve it? Therefore, it is advisable to go with the diversification of crops with crop rotation, modern tillage (Minimum & zero), the establishment of micro-irrigation, increasing the soil organic carbon (SOC) and do not disturb the microbial diversity. Diversification of crops with crop rotation helps to reduce the soil erosion through permanent soil cover throughout the year, and diverse crop improves the soil health. Tillage has a negative impact on the soil as it burns the of soil organic carbon and creates soil compaction. It is found that soil organic carbon increases the nutrient use efficiency by reducing the nutrient losses with its chelation property. As soil microbes are an important component of healthy soil so, it is acceptable to protect them by any means. Microbes is a potential indicator of soil quality because it solubilizes the nutrient into an available form, secretes phytohormones and stimulates the immune system against pest-diseases which is beneficial for growth and development of plants.

- ✓ **Fertilizers management**

Indiscriminate use of chemical fertilizers over a long period and no use of organic manure destroy the soil structure as a results soils are prone to erosion and decrease the soil fertility. As soils don't have the capacity to retain nutrients, thus nutrients are losses through the different process like volatilization, denitrification and leaching. Therefore, efficiently use of fertilizers by the crop is the prime objective of fertilizer management. In fertilizer management, four main things are very much important like the quality of fertilizer, frequency of application, time of application and placement of fertilizer. In this perspective, the frequency of application means fertilizer are applied in different split doses like nitrogen at a specific stage of crop when it requires. However, placement of fertilizer is an important thing which helps to increase the fertilizer use efficiency (FUE).

Conclusion

Nutrients availability to the plant is the main constrain of obtaining high crop yield that can be corrected by only agronomical management in an economical manner. Keeping view of all the above-discussed aspects, it is concluded that the use of agronomical interventions increases the yield of the crop, the productivity of land and protect the environment in a sustainable manner.

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FORAGE QUALITY ATTRIBUTES AND ANTI-QUALITY FACTORS: A NUTSHELL DISCUSSION

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When it comes to fodder production; there has always been an unseen tug-war between land allocation for food crops (for human) and fodder crops. This is often more prominent in countries which have both large human population and along with large herds of cattle. India should be considered as an ideal example of such a scenario. On the one side, we are worlds second most populated nation, and on the other; we are also accommodating worlds largest livestock population; in addition to that, the cultivable land is also shrinking. This scenario leads us to a condition when the quality of fodder comes second to quantity. The consequence is an overall reduction in animal performance, illness and sometimes even death.

Forage quality designates a fodder's overall characteristics to meet the nutritional necessity of livestock which are consuming them. In general, green fodder and concentrates are two key components which fulfil the overall nutritional demand of the animal. The forages are a much cheaper option of nutrition than concentrates; hence its quality has the utmost importance in animal nutrition. The forage quality generally consists of three key factors; **selection of appropriate maturity stage of harvest, suitable forage species selection and customized nutrient management**. Forage quality characters significantly influence the digestibility and voluntary feed intake both have significant role animal performance as it has been said merely having all nutritional factors present in forage are not enough as the presence of anti-quality factors can limit overall digestibility.

The quality and anti-quality factors in forages; both have their origin from the plant cellular mechanism and biochemical synthesis mechanism. There are mainly three biochemical components which are essential in plant nutrition per se; this are**1. Carbohydrates, 2. Proteins, and 3. Lipids**. However; these are not the only biochemical components present in forage plants instead there are two more sets of biochemical

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compounds; the first set consists of nucleotide molecules such as DNA and RNA which are although extremely important from plants perspective however have little value when it comes to providing a food source for the animal due to their meagre quantity. On the other hand, the other set comprises of non-nutritional components **anti-quality** components like lignin, tannin, phenolic compounds etcetera. Most animals cannot digest these components, hence having no utility in energy supply, although their mere presence can reduce the availability of other essential components.

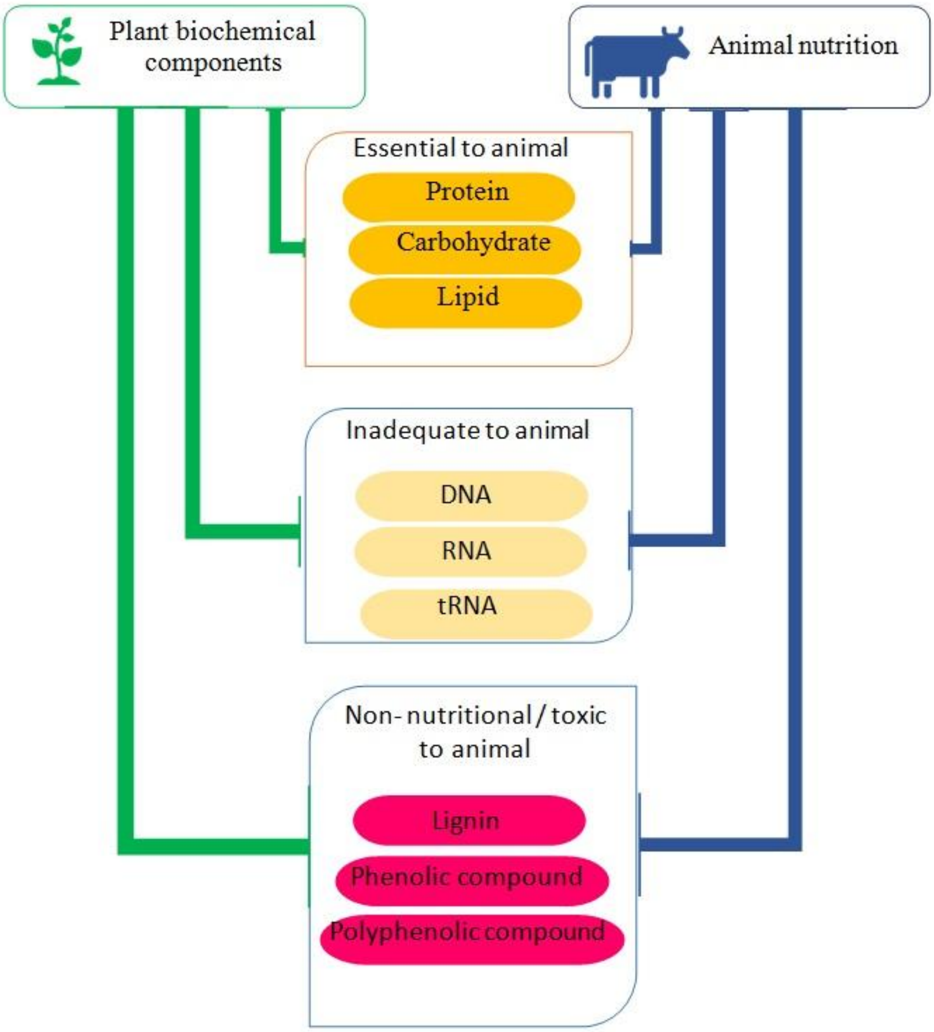

Figure 1: Different biochemical component found on forage plants and their utility on animal nutrition

Although seen as negative attributes from animals' nutrition's perspective, these anti-quality attributes have a significant role to play in plant physiology, metabolomics, and eluding mechanism against adversaries. In addition to that, minerals and vitamins can also play a positive role in playing plant production and animal nutrition.

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Forage enzyme proteins

Protein enzymes are the most significant nutritional component of forages from the plant's perspective as other critical components like carbohydrate, protein, and lipids depend on enzymes for their synthesis. Among these enzymes, ribulose bisphosphate carboxylase **(RuBisCO)**is the front runner constituting 40-60% of whole leaf protein. The essentiality of RuBisCOlies in CO_2 fixation and glucose phosphate production are the starting point of energy or building blocks.

Proteins found on the seeds are somehow different from found in vegetative parts; although most forages are harvested before the reproductive stage, RuBisCO remains the most crucial enzyme protein. Majority of the forages have similar amino acid composition and generally hard to change through simple genetic selection tools or molecular breeding approaches.

Modern genetic engineering tools involving the insertion of genes in forages that will resist protein degradation seem prosing. Currently, low levels of gene expression for higher Sulphur contained proteins have already been achieved in alfalfa forage, which resulted in lesser protein degradation.

Protein loss from forages and its preventive measures

Protein is always very delicate biomolecules. In the case of forages, the highest quantity and quality of proteins is observed before the crop harvesting but immediately starts falling just after the crop harvest, which possesses an eminent management challenge. The highest concentration of forage animal accessible crude proteins (**CP)** is found on leaves highly perishable. The losses begin from the leaf fraction's mechanical damage and end with the animal's final distribution. The loss of leaf protein is higher in legume crops than cereals both in fresh and preserved condition. The loss directly correlates with dry matter content and generally higher when preserved as hay than silage. Research indicates that a legume loses 23-25% of its leaf protein on DM from harvesting to hay preparation while the loss is less than half in case of silage. The loss of CP is more in hay than silage primarily because of the loss of leaf matter in the former. However; there is catch in this otherwise simple statement, which indicates that despite the quantitative higher loss of proteins from hay; the quality of the protein is higher in hay than silage.

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The only managemental approach to control this loss of protein is improved harvesting and handling process. There has been not much development in harvesting mechanism since a long time which genuinely requires a long haul. A newer strip-off harvesting method where protein-rich leaves are separately harvested than fibre-rich stalk seems promising although it takes much longer harvesting period.

Non-Protein Nitrogen (NPN) and its management

Formation of NPN and its management is a significant challenge in forage production and management. Once the plant with higher true protein values harvested, wilting begins, further initiating proteolysis, which finally produces NPN. During any average wilting scenario;8-18% of the total protein converts to NPN. This is a particular issue of concern in the hay, especially if the drying condition is not optimal. In the case of silage, this primarily depends on fermentation and acid production as lower pH inhibits proteolytic activity. Although the proteolytic activity cannot be ceased entirely; it can be significantly reduced if the pH drops to 3.8- 4.0. Since acidic condition prevents proteolytic activity in silage; hence manual addition of acids like formic acid can significantly lower the NPN even by one-third of the supposed concentration. Another promising method is the addition of red clover, which contains polyphenol oxidase (PPO) responsible for inhibiting proteolysis. Red clover, although have this promising characteristic but has lower DM yield. A genetic modification of plants to produce more PPO can be a promising way out.

Forage carbohydrate, its components and management

Carbohydrate is the primary source of digestible energy in forages. The carbohydrates in forage crops are divided into two groups, i.e., **Structural** and **non-structural carbohydrates**. Structural carbohydrates are referred to as polysaccharide, responsible for providing structural integrity to the plant and often found in the cell wall. Non-structural carbohydrates are generally storage food materials of the plants like starch, fructans and sucrose—all kinds of carbohydrates originate from photosynthesis and production of glucose.

When it comes to foraging quality, the structural carbohydrate has a special place as it generally decreases the digestibility. The cell wall-related carbohydrates require additional discussion. The cell walls of forage crops are a large pool of potential energy; however, their recovery is complicated. Among all these components of cell walls, **Cellulose** is the most

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copious one. **Pectins** are another group of complex carbohydrates which are more prominent in legume forages than grasses. Cell-wall carbohydrates often entangle with lignin and hydroxycinnamic acids which are non-carbohydrate components and strongly reduce forage crops' digestibility. The forages raised on the stressed condition and facing moisture, and nutritional deficiency has higher lignin content. Moreover, the lignin content increases over time hence delayed harvesting results in more lignin accumulation.

Common forage secondary metabolite anti-quality factors

Some of the secondary metabolites which plant produces are outright harmful to the animals. As a result, these compounds are highly influenced by the selection of fodder crops, season and managemental practices. Major anti-quality factors generally found in forages are discussed below:

Polyphenolic compound

In general, notion, **tannins** are a common type of anti-quality polyphenolic compound found in forages. Tannin,a secondary product of the shikimic acid pathway, has a specific chemical nature that can precipitate the proteins. Tannins are of two types, i.e., **hydrolyzable tannin**and **condensed tannin**. Hydrolyzable tannins are generally consisting of different phenolic acids and its adjuvants like gallic acid with a hexose. However; hydrolyzable tannins are not as much noxious as condensed tannins which are more relevant to forage quality. Tannins in plants generally occur in leaves, stems and roots and found more in legumes than grasses. From the plant sciences, standpoint, tannins and polyphenols play a specific role such as Anthocyanidins adds different colour pigments in flower petals that attract insects for pollination. Some other condensed tannins also help the plant deter overgrazing and plant damage and play an antimicrobial agent.

The concentration of tannins is dependent on several factors such as genetic makeup, environment and climate etc. The effects of seasonal variation on tannins are not universal as some of the forages have higher tannin concentration in summer while some other have in winter but in general, a winter season forage will have more tannin in summer vice versa. Nutritional deficiency is another important factor. Absence of nutrients such as phosphorus and Sulphur significantly hike the tannin content. In the case of Pearl millet; boron deficiency also increases tannin concentration.

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Presence of condensed tannins in forages creates multiple problems including suppressing microbial population in the rumen and inhibiting digestive enzymes. Tannin also bonds with protein with hydrogen bonds and hinders its utilization. A higher concentration of tannin (5% and above on a DM basis) reduces the animal's voluntary feed intake. Concentrations up to 40 g condensed tannins kg^{-1}DM are ideal for forage crops. Additionally, tannin presence also prevents plants' decomposition in case of green manuring and exhibits allelopathic effects.

There are not many technologies available to control tannin; however, mixed or intercropping with cereal-legume, proper nutrition management and deterring plant from facing any stress can reduce tannin production.

Phytoestrogens

These are another group of phenolic compounds sometimes found in forages. These group commonly contains **coumestans** (coumestrol, 4-methoxycoumestrol, repensol and trifoliol), Isoflavones (diaidzein, formononetin, genistein and biochanin) and Isoflavan (Equol)are generally reported to be found on alfalfa and berseem. In ideal conditions, these compounds' concentration is very less in the plant but significantly hikes in pathogenic fungal infection in plants such as *Pseudopeziza medicaginis*. The concentration of these compounds generally decreases with time; after first cutting red clover, up to 40% have been reduced. Haymaking also reduces the concentration of phytoestrogen. The negative impact of phytoestrogens on animals are mainly concerned with reproductive system as cattle shows impaired fertility, enlarged uterus, swollen vulva, cyst formation in ovaries etc.

Cyanogenic Glucosides

These are a group of nitrogenous compounds found in some forages like sorghum, white clover etc. Plant releases HCN, a keto- sugar compound when the tissue is damaged. The lethal dose of HCN ranges from 0.5 to 3.5 mg kg^{-1} body weight. However, research and modern plant breeding practices have significantly reduced the dhurrin in sorghum and linamarin and lotaustralin content in white clover. The occurrence happens in sorghum when the mean daily temperature reaches below 15°c. The dhurrin content is also higher in younger plants and the portion where regrowth happened. The occurrence of toxicity is more in grazing systems; however; in modern animal husbandry practice, mortality is rare. In certain

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rare cases, an animal may face troubling oxygen breathing, grasping, convulsions and even paralysis. Although the rumen environment can detoxify the cyanide compound, the compound can also quickly adsorb by the rumen wall, eliminating the problem. The toxicity is more if the animal is hungry and taken well above the toxin's safe limit that the rumen detoxification mechanism is overloaded.

Alkaloids

Alkaloids are the primary nitrogenous compound contained secondary metabolites. Among all anti-equality components, Alkaloids possess one of the highest threats. The higher number of alkaloids in forage results decreased serum calcium, and magnesium as oxalates binds with Ca and Mg. Grasses such as Setaria, Buffelgrass, Sugarbeet contains alkaloids. Environmental factors significantly influence the alkaloid accumulation. Alkaloid concentration increases in the late spring season but ceased in late autumn.

Nitrate toxicosis

Nitrogen is the basic structural building block of proteins and extremely important to both animal and plants. However, a different form of nitrogen in nitrate causes severe problems in animals such as weight loss, abortion of fetus or even death. All the plants are capable of accumulating nitrate; however, the plants growing in high nitrogen-enriched soil and facing overcast weather can accumulate very high amount of nitrate. Nitrates are very toxic to ruminants than non-ruminants. When an animal consumes high nitrate-rich forage, the microbes found in rumen convert the nitrate to nitrite and then to ammonia which finally converted to protein. This also increases the rumen microbial protein. However, in the case of excessive nitrate condition, rumen microbes get overwhelmed by the higher nitrate content; hence the cycle does not proceed smoothly, and higher accumulation of nitrites in rumen causes the toxic effect. Higher nitrate in bloodstream oxidizes haemoglobin and makes it methaemoglobin, a brownish compound incapable of transporting oxygen. The management practice includes ensiling of drought or stressed affected crops or mixing with other forages before feeding to the animal. The harvesting can also be delayed until the stress condition gets normalized.

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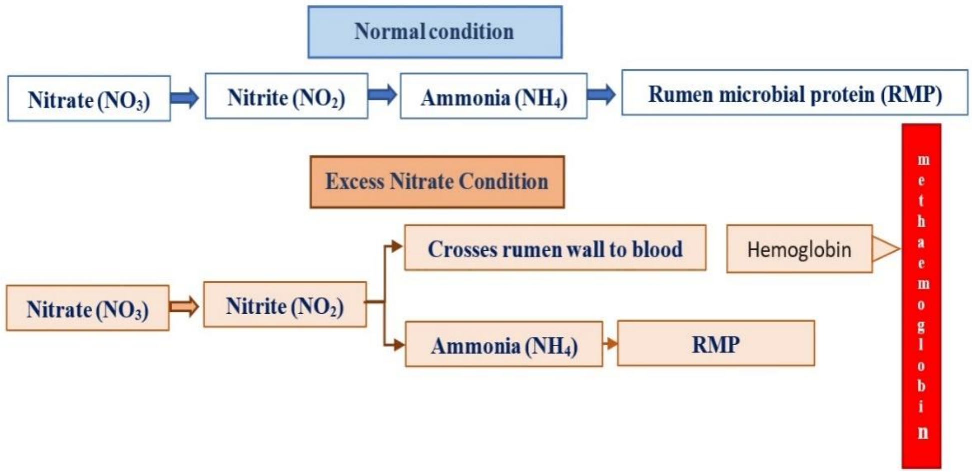

Table 1: Major anti-quality factors, their occurrence and management practices

Anti-quality factor	Forages	Conditions	management
Nitrate-nitrite	Sorghum, Sudan grass, Oat, Barley, Turnip and Sugar beet	• Excessive supply of nitrogenous fertilizer, FYM • Moisture deficit • Excessive exposure to cold conditions • Excessive application of 2,4-D herbicide	• Harvesting at maturity stage • Silage, hay making
Oxalates	Bajra, Guinea grass, Setaria and some weed	• Young plant has more oxalates • Excessive use of nitrogenous and potassium fertilizers	• Starved animal doesn't allow to graze that plant containing more level of oxalates • Supplementation of mineral mixture in the animals' diet
Prussic acid	Sorghum, Sudan grass, Guinea grass, Johnson grass, Lima bean, White clover, Cassava	• Young upper leaves and new shoots • Excessive use of 2,4-D herbicide • Soil containing high nitrogen and low phosphorus status	• Don't allow to graze sorghum less than 45-50 cm in height • Forage conservation (silage & hay) • Never grazed where frost is likely to occur
Tanins	Sorghum, Subabul, Dhaincha, Lucern, Mustard oil cake etc.	Drought conditions or moisture deficit situation	Avoid tannin containing diet

Mimosine	Subabul	Prolonged feeding of subabul Young leaves have high mimosine	Fed subabul by mixing with other diet
Aflatoxin	Aspergillus flavus (causing agent)	Stored feed in moisture condition (10-40%)	Avoid moistened condition for feed storage

Conclusions

Quality and anti-equality factors have a multitude of dimensions. Some of the biochemical compound which are considered to be anti- quality component has a significant role in plant physiology. However; advancement to the modern scientific procedure has opened new opportunities to find a middle ground to effectively curb issues related to the anti-quality factor of forages. The integration of selective modern breeding practices, with agronomic managemental approach married with better animal feeding practice, can easily overcome the issue of anti-equality factors and sustain forage quality attributes.

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