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Effect of Nitrogenous Fertilizers and Bio Fertilizers on the Growth and Development of Cereal Fodder Crops: A Review

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ABSTRACT

Livestock contributes significantly to the agricultural and National GDP (gross domestic product). India is known as one of the most important countries containing a larger livestock population. Hence, to sustain the livestock population, the production of quality forage is the most important factor. Currently, the lack of dry and green forage yield is increasing day by day due to an insufficient supply of required fertilizers to the fodder crops and farmers are not willing to cultivate fodder crops as it provides smaller net returns. Moreover, the availability of smaller land holdings is another cause of the fodder deficit in the country. In cereal fodder crops, nitrogenous fertilizers have an immense role in determining the crude protein and fibre content of the plant when it is applied with appropriate doses that differ from crop to crop. Moreover, biofertilizers are products that contain stains of different microorganisms. Inoculation of biofertilizers such as *Azospirrilum, Azotobacter, Acetobacter, Pseudomonas, Bacillus, Clostridium, etc.* to the cereal fodders (sorghum, maize, oat, barley, ryegrass, *etc*.) leads to a considerable increase in yield attributes as well as the quality of the yield can be sustained also without deteriorating the soil fertility. Again, the combined application of both *i.e*., biofertilizers and nitrogenous fertilizers at a suitable proportion provides the maximum possible quality yield with higher net profit. Therefore, it is necessary to apply fertilizers (nitrogen and biofertilizers) at the time of crop requirement for maximum production. Hence, this study is conducted to observe the performance level of cereal fodders under the impact of nitrogenous fertilizers and biofertilizers.

Key words: Bio fertilizers, Crude fibre, Crude protein, Fodder crops, Nitrogen.

Agriculture plays a vital role in the development of the rural as well as the Indian economy as it is known as the greatest sector of employment generator for farmers and youths, hence, it engaged the world's half total labor legion (Shukla and Mishra, 2020). Moreover, agriculture is the most cabbalistic sector, contributing 14% to the National GDP and 35% to the National revenue. Moreover, the Indian agricultural allied sector is composed of livestock, fisheries, crops and aquaculture. Crop alone contributes 9.63% to the National GDP and 60.2% of the GDP of the total agricultural sector, whereas, livestock provides 4.03% to the National GDP and 26.1% of the agricultural GDP. 11% of dry fodder and 36% of green forage or fodder is a net deficit faced by the Indian farmer (Nisha *et al.,* 2020). Therefore, to fulfilthe production demand for livestock population, meat and milk, fodder crops play an immense role. 8.3 million hectares is the whole area cultivated under fodder based on the sole crop. Nowadays, food security and the livelihood of many people in the country directly depend on livestock production. Hence, to obtain satisfactory livestock production, it is needed to accentuate the quality of forage and fodder production. In India, the price of food products for animals is high because of inadequate or poor-quality forage production to meet their feeding requirement. Therefore, to fulfil the requirement of fodder crops in India, it is essential to elevate the production of an adequate amount of roughage, enhance the area of forage production and improve the technique of quality forage production in the country. The forage or fodder crops are known to be consummate if it provides the highest products of livestock per unit cultivated area or the maximum produce of nutrient digestible per unit of land area. Forage or fodder crops are the indispensable feed of ruminants and several other pasturage animals; therefore, it is an essential portion of a lucrative enterprise of livestock (Singh *et al.,* 2012).

The green forage contains 5 to 14 times the common source of essential quality composition or parameters such as TDN (Total Digestible Nutrient) and digestible CP (Crude Protein) (Singh *et al*., 2022). Enhancement of productivity and production of forage quality is needed to sustain the productivity of livestock or animal sector as the cost of feed is solely responsible for approximately 65 to 70 per cent of the whole milk producing cost (Makkar, 2016). Among the various forage crops, ryegrass (*Lolium multiflorum*) plays an important role in fulfilling the feeding value of animals. Generally, forage crops are the source of both protein and carbohydrates essential for the animal diet. In addition to that, ryegrass is one of the other forage crops that have the

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highest or maximum potential for forage production, it serves as animal feed and is also known as high nutrient use efficiency forage grass (Akdeniz *et al.*, 2019). Ryegrass is mostly grown for forage purposes rather than the production of seed. Moreover, like oat and barley which is grown in winter climates for the production of feed, ryegrass is also grown in temperate and cool climates as another source of pasture grass (Cinar *et al.,* 2020). Besides serving as a feed product for the animals, ryegrass is also used as silage or hay.

In grasses, the most used nutrient is nitrogen. The optimum dose of nitrogenous or ammoniacal fertilizers is necessary to increment the protein percentage in grasses, but its excessive application to the plants leads to abnormal growth of the plants. Nitrogen fertilizer application to the ryegrass helps to achieve positive responses (Ertekin *et al.*, 2022; Kusvuran, 2011). Additionally, it was analyzed that, nitrogen which is applied to the plants is mostly about 50-70% is not absorbed by the crops and soil contains residues that are dispersed through several mediums (Hodge *et al*., 2000). As a result, nitrogen is leached through several means from the soil to different water bodies or ponds leading to causes eutrophication (Masclaux *et al*., 2010). Therefore, it is necessary to improve nitrogen use efficiency for better ecological benefits as well as healthier crop growth.

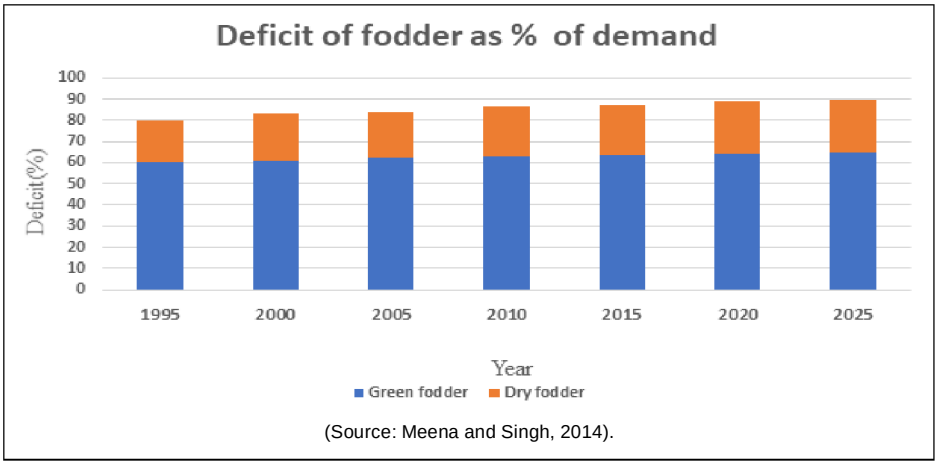
Moreover, bio-fertilizers are the product comprising different stains of various microbes which while, inoculant to plant or soil surface and seed, microorganisms settle the root zone of the plant or colonize inside the plant that helps to enhance growth and development of the crop by transferring the unavailable form of nutrient elements to available or uptake form via various biological method which includes rock phosphate solubilization and (BNF) biological nitrogen fixation (Singh *et al.,* 2011). Plant growth and development can be hastened and enhanced as well as plants can be free from attacks of diseases and pests by the application of preferable biofertilizers containing beneficial microbes or microorganisms (Sabri *et al.,* 2021). To maintain crop productivity (food grain and fodder crops) as well as soil fertility, biofertilizers play a significant role. However, farmers have to be well acquainted with the importance of forage crop cultivation using recommended fertilizer doses to meet their requirement of good quality livestock feed to maintain animal health as well as to obtain a higher yield from animals.

Major constraints faced by fodder crops

Now, the fodder contribution has declined to nearly 50 per cent of the gross demand in comparison to what has been analyzed as 60 per cent in the year 1990s. Increment demand for main food crops leads to increasing contestation between the utilization of land for fodder crops and other maincrops cultivation, therefore any further extent of land for forage crops cultivation is unfeasible (Singh *et al*., 2021). Therefore, to meet the demand for fodder needs it is necessary to utilize the non-cultivated or wasteland area for the production of fodder crops with vertical deployment from the cultivated or arable land area (Dhillon and Sidhu, 2020). Currently, India is suffering a shortage of total digestible nutrients (TDN) and crude proteins (CP), 19.9% and 24.6% respectively, it has been also predicted for upcoming days of TDN and CP is 15.47% and 16.81% in 2050 and 17.52% and 20.78% in 2030, respectively (Anonymous, 2020). 15% of the livestock or animal population and 2% geographical area of the world are derived from India, which imparts immense biotic or living oppression on the land (Koli and Bhardwaz, 2018). Although India has a gross cropped area of only about 4.9% for cultivating fodder crops and also has a tremendous scarcity of concentrated feed, dry and green fodder at the rate of 41%, 26% and 35.6% respectively, India is still known as a country having greatest production of milk with largest livestock population (Rachel Jemimah *et al*., 2015). Another major issue of forage production is due to the presence of a lesser area under cultivation of fodder crops approximately 8.4 mha in India and further increment of the area is not possible because of increasing higher demand or need for foods of people leads to replacement of conventional cereal crop by commercial food crops (Muttalik Desai *et al.,* 2020). Currently, climatic aberration or changes also cause a major problem in maintaining fodder crop production (Raza *et al*., 2019). Therefore, it is important to promote high-yielding, quality, sustainable and wider adaptable forage variety which can grow in such aberrant climatic circumstances. The scarcity of fodder feed is the prime constraint factor that affects the improvement of animal productivity (Khan *et al.,* 2023). Currently, India faced the problem of net deficiency of green forage (35.6%), residues of dry crops (10.95%) and concentrated feed material (44%) (IGFRI VISION 2050). Lacking quality fodder yield is perhaps caused by the inadequacy of good quality or certified seed of enhanced fodder variety and the scarcity of upgraded cultivation methods for improving the approximate commercial seed and fodder yields (Patil *et al.,* 2018).

Fodder and feed availability scenario and future need

Mishra *et al.* (2009) observed that forage and feed resources lacking (both quality and quantity), lower production ability of livestock, inadequate supply of ticklish inputs and services in accurate time as well as ingress to markets and capital leads to lower productivity of milch livestock or animals. The declining availability of forage production land causes enormous animal or livestock pressure on forage and feed availability (Meena and Singh, 2014). Since the amount of land available for producing fodder has been declining, animals are placing a great deal of strain on the supply of feed and fodder. Scenario of fodder and feed availability till 2025 is mentioned below as per prediction of planning commission.It is obvious from Fig 1 that deficit in dry fodder and green fodder is increasing every year while the Table 1 indicated that the gap for concentrates is almost statics. But this difference is significant since it will dictate the kind of animals and husbandry techniques that must be used.



(Source: Meena and Singh, 2014).

Fig 1: Year wise deficit of fodder as % of demand.

Table: 1 Year wise production of feed (in million tonnes).

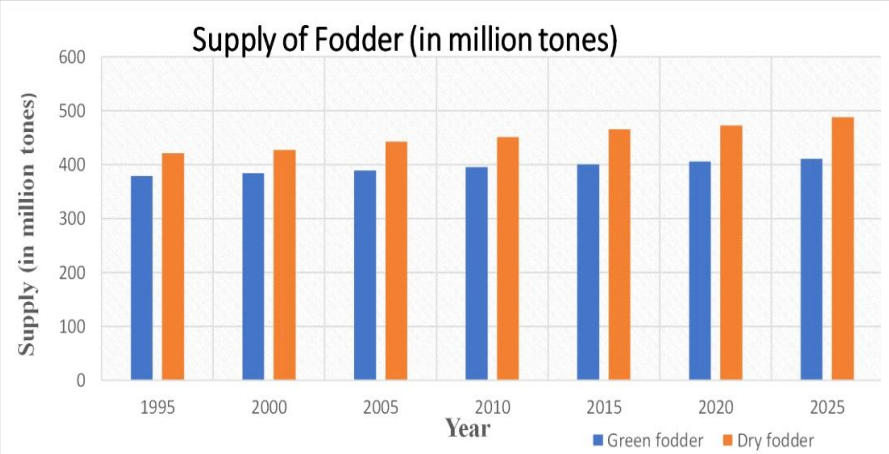
Components / Years	Available concentrates	Required concentrates	Deficit concentrates
2002-2003	41.96	117.44	64.27
2003-2004	43.14	120.52	64.21
2004-2005	44.35	123.59	64.12
2005-2006	45.63	127.09	64.10
2006-2007	48.27	130.55	63.03

(Source: Meena and Singh, 2014).

Fig 2 and Fig 3 indicated that supply and demand of fodder (green and dry fodder) is increasing year after year. Therefore, it is necessary to increase the area of fodder cultivation to meet this demand of fodder supply.

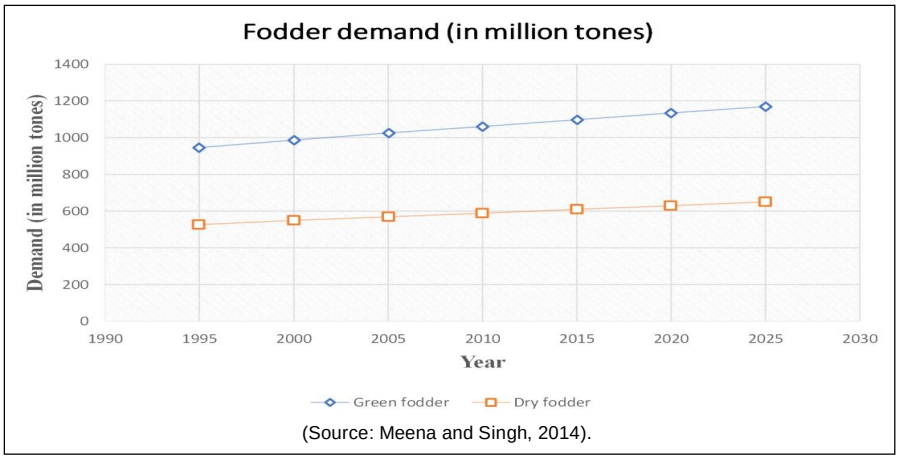
Effect of nitrogenous fertilizers on the growth and development of cereal fodder crops

Management of nitrogenous fertilizers is the primary factor for sustainability, productivity and profitability of the production of fodder crops (Massignam *et al.*, 2009). Scharf *et al.* (2005), Chakwizira *et al.* (2015) and Teuber *et al.* (2020) stated that to obtain adequate NUE (Nitrogen Use Efficiency), supply nitrogen on the basis of crop needs or demand, therefore, a deficient supply of nitrogen leads to poor or inferior quality yields. Moreover, the leaching of nitrate occurred due to the excessive use of nitrogen and also polluted the environment (Di and Cameron, 2002). An adequate supply of nitrogen to different cropping systems and crops (fodder crops, food grain crops *etc*), *via* nitrogenous fertilizers leads to judicious food production to fulfil the need for food for the growing population both humans and livestock (Maheswari *et al.*, 2017). Massignam *et al.* (2009) expressed that leaf area index (LAI) and specific leaf N (SLN) increase by increasing the supply of nitrogen and therefore, RUE (radiation use efficiency), radiation interception and dry matter or biomass yield of maize and sunflower increases. Kwon *et al.* (2019) stated that the application of nitrogen fertilizers to fodder maize enlarges the height of the plant as nitrogen enhances the growth of the plant and increases internodes length and internode numbers which may lead to the promotion of plant height. Demirbas *et al.* (2017) reported that nitrogen application at the rate of 140 kg/ha *via* fertigation to the fodder maize ensured maximum stem circumference, LAI (leaf area index), LAD (leaf area duration), total dry biomass, nitrogen content, green forage yield, nitrogen uptake and a greater number of leaves per plant *i.e*., 6.86 cm, 15.57, 201 days, 8.90 tons/ha, 1.35%, 91.25 tons/ha, 120.42 kg/ha and 15.1, respectively. The application of nitrogenous fertilizers to the legumes fodder is not necessary, however, in order to enhance both yield and quality of the cereal forage crops nitrogen fertilizer plays a vital role. Due to nitrogenous fertilizers crude protein content of cereal fodder markedly increases, but the available energy concentration is reduced slightly (Singh *et al.*, 2011). Mohan *et al.* (2015) stated that nitrogen applications to the cereal forage crops involving fodder maize, pearl millet, sorghum and Sudan/elephant grass resulted in the enhancement of crude protein content, digestible dry biomass yields and ether extract. Kanwal *et al.* (2022) reported that the acid and neutral detergent fibre content of fodder crops is inversely proportional to the levels of nitrogen and nitrogen application has an advantageous impact on forage oat in terms of increasing protein content. Crawford *et al.* (2018) opined that yield of fodder crops in respect of dry and green forage yield, crude fibre and crude protein content accelerated remarkably with an increment



(Source: Meena and Singh, 2014).

Fig 2: Year wise supply of green and dry fodder.



(Source: Meena and Singh, 2014).

Fig 3: Year wise fodder demands.

in the application dose of nitrogen fertilizer and farm yard manure (FYM). Jat and Kaushik (2018) observed that higher crude fibre (9.99%), digestible crude protein (15.89%), free nitrogen extract (10.87%), extract of ether (14.99%), total digestible nutrient (11.23%) and mineral substance (14.45%) are obtained by 90 kg/ha nitrogen application to the cereal fodder oat over the treatment of 70 kg/ha nitrogen application. Aditi *et al.* (2019) at Karnataka suggested that 50 percent application of the prescribed doses of nutrients via inorganic fertilizers with 50 percent nitrogen in the form of FYM ensured higher NUE (Nutrient use efficiency) and maximum green forage yield in fodder crop (sorghum). Cinar *et al*. (2020) stated that to obtain the maximum yield of fodder ryegrass, the appropriate nitrogen application rate is 250 kg/ha. Acid detergent fibre and neutral detergent fibre rates are not affected by the increment of nitrogen doses. Moreover, with nitrogen application at the rate of 300 kg/ha, the yield will be decreased but the crude protein content of ryegrass will be increased. Pavinato *et al.* (2014) concluded that nitrogen fertilization at the rate of 120 kg/ha flourishes linearly and significantly enhances the yield of dry matter and helps to aggregate the crude protein content in ryegrass. Witkowska *et al.* (2008) suggested that the concentration of fatty acid in the ryegrass will be higher if nitrogen fertilizer is applied at higher rates and harvesting of ryegrass is done after a shorter regrowth period. Bora *et al.* (2019) described that nitrogen fertilizer at the rate of 90 kg/ha will significantly increase the crude fibre concentrate, crude protein concentrate and crude fat contented in ryegrass. Sarma *et al.* (2020) also investigated the dry matter yield of ryegrass with economic revenues will be higher if the nitrogen fertilizer is applied at the rate of 90 kg/ha in 3 split doses (40% as basal application, after 1st cut 30% and after 2nd cut 30%). Sidhu *et al.* (2020) expressed that dry matter of forage crop ryegrass will be increased if the rate of nitrogen fertilizer is increased up to 160 kg/ha. Moreover, it has been also recorded that at these doses, crude protein contended and the yield of crude protein is also maximum. Satpal *et al.* (2022) stated that obtaining maximum ryegrass fodder yield is possible in the semi-arid ecoregion if the basal dose is done by applying nitrogen at the rate of 80 kg/ha and phosphorous at the rate of 40 kg/ha followed by

a top dressing of nitrogen is done at the rate of 20 kg/ha after 3 weeks of sowing and after every cut applies nitrogen 40 kg/ha. Tan *et al.* (2021) pointed out that nitrogen fertilizer is important for the growth of ryegrass but overdoses application of nitrogen results in over-nitrate accumulation in plants that may lead to fatal for ruminants. Sidhu *et al.* (2021) concluded that ryegrass provides maximum dry matter and green foliage yields if it is sown in mid-October *i.e.*, it imparts ` 98937.30/- per ha net returns and 2.97 benefits: cost ratio. In addition to that, they also opined that higher net returns will be obtained if the ryegrass is applied with nitrogen at the rate of 160 kg/ha. Moreover, the application of nitrogen 120 kg/ha also confirmed a profitable B: C ratio. Iqbal *et al.* (2014) described that a higher B: C ratio (2.52) will be obtained if the forage crops are supplied with 75% nitrogen from urea and 25% nitrogen from the manure of poultry rather than the use of 100% nitrogen from urea. Patel *et al.* (2022) reviewed that the variety of oats with the supply of nitrogen at the rate of 120 kg/ha provide superior quality and maximum crude protein, dry matter and green fodder yields. Moreover, at that dose fodder oat variety provides a higher monetary price and confirms the 2.87 B: C ratio of that particular oat cultivar. Dar *et al.* (2014) observed that if the forage maize or other fodder crops are applied with nitrogen at the rate of 180 kg/ha, it provides a maximum yield of dry fodder and green fodder *i.e.*, 6.66 ton/ha and 32.3 ton/ha. Thereby, Rs. 155900 net returns per ha and a 2.21 B: C ratio is recorded which is considered as maximum than other doses or treatments.

Effect of biofertilizers on the growth and development of cereal fodder crops

Biofertilizers are an organic source of fertilizers comprising stain of particular microbial organisms accomplished from roots or root zones of plants and help to increase plants yield by 10 to 40% (Nosheen *et al.,* 2021). These inoculant micro-organisms colonialize the root zones and plant interior, enhancing the growth of plants while given to the surface of the plants, soil, or seed (Singh *et al.,* 2022). Moreover, Mahmud *et al.* (2021) also expressed that biofertilizers have an immense role in enhancing the fertility of the soil and increasing plant yield. Biofertilizers take part in the cycling of nutrients when applied over the soil and enhance the structure of the soil, thereby, the productivity of crops improved (Mishra *et al.,* 2013 and Malusà *et al.,* 2016). Bioinoculants increase the root system's accrual, prolonged its longevity or life, raised the seedling's survival, promote the degradation of detrimental material and diminish the flowering time (Mahanty *et al.,* 2017). Biofertilizers dissolve the major nutrients resulting in the availability of nutrients to the crops increasing. They help to root hair development and thereby, the uptake of water by the plants enhanced (Bhardwaj *et al.,* 2014; Ma and Ludewig, 2021). Inoculation of AM (arbuscular mycorrhizal fungi) and *Azospirrilum* in the fodder crop *Panicum maximum* leads to improvement in forage growth, improve quality and productivity and enhance germination percentages. Blended inoculation of these biofertilizers over a single one gives superior results, as it utilizes microorganisms most efficiently (Rajendran and Devraj, 2004). Mahato and Neupane (2017) investigated that a single application of *Azotobacter* to the fodder maize provides the best output even though together an application with farm yard manure exhibits suitable growth of the crop. Kumar and Sharma (2002) discovered that fodder crops (sorghum) yield in terms of dry and green fodder increases positively with the *azosprirllum inoculation,* but crude figre and crude protien content remained unchanged in foragr sorghum. Mallikarjun *et al*. (2018) opined that the combined supply of biofertilizer inoculation and nitrogen (100%) application accomplished better results in comparison to any other different level of nitrogenous treatments which may lead to higher quqlity attributes or measures such as cell contents, total carbohydrates, extract of ether, dry matter yield, total carbohydrates content and crude protein. Paul and singh (2010) in Gujarat pointed out that combined application of inorganic fertilizers of nitrogen @75 kg/ha and organic nitrogenous fertilizers @ 25 kg/ha in the form of cake of castor or FYM together with inoculation of *Azospirillum lipoferum* and *Azotobacter chroococcum* remarkably maximize the crude protein (CP) content and green fodder yield of cereal fodder sorghum. Rasool *et al.* (2015) studied that the fodder yield of maize (dry biomass, green forage and cob yield) is higher by the combined application of FYM @4.5 tons/ha and 75% of the recommended dose of NPK along with bio-fertilizers including PSB and *Azotobacter*. Jadhav *et al.* (2018) at Gujarat expressed that amalgamate application of the bio-fertilizers involving Phosphate solubilizing bacteria and *Azotobacter* in addition to 100 per cent RDF accomplished better results by observing 52.63% and 58.23% maximum dry biomass and green fodder yield of fodder crop (maize) in comparison to any other treatment under a different agro-climatic situation. Samruthi *et al.* (2020) reported that combined application of FYM with bio-fertilizers to cereal fodder such as pearl millet resulted in a remarkable increment of growth attributes or parameters including height of the plant, tiller number per plant, leaves number per plant which leads to a significant increase in green forage yield in composites cultivars and hybrids of pearl millet against control. At Gujarat, Yadav *et al.* (2019) investigated that growth attributes such as the height of the plant and tillers number per plant of the fodder crop (pearl millet) increased by the combined application of RDF and FYM at the rate of 2.5 tons/ha along seed treatment with *Azotobacter* and PSB which leads to maximum dry forage yield (7492 kg/ha). Patil *et al.* (2018) stated that united application of 2 tons poultry manure/ha, 75% of the recommended dose of fertilizers along with bio-fertilizers such as *Azosprillum*at the rate of 5 kg/ha and 5 kg PSB per ha generate higher yield parameters which include

earheads number per m^2, grain weight per earheads, test weight and earheadlength and also increases yield (stover and grain yield, harvest index) and carbohydrate and protein content of fodder pearl millet. Randhawa *et al.* (2020) concluded that integrating application of FYM @ 5 tons/ha + 75% NPK + biofertilizers ensured higher yield attributes which include numerous active shoots, length of the spike, spikelets number per spike, fertile spikelets per spike, grains number per spike, grains weight per spike, test weight, grain and stover yield of cereal fodder such as barley. Jat *et al.* (2021) reported that the amalgamate application of FYM@5 tons/ha and biofertilizers together with a recommended dose of fertilizers provides a remarkable enhancement in the length of ear, grains per ear, active shoots, 1000 seed weight, biological and economical yields of fodder barley. Ramamurthy (2002) stated that inoculation of the strain of *Azospirillum* to the forage crops such as *Pennisetum sp* provides maximum benefits: cost ratio (2.35) rather than using nitrogen 25 kg/ha and 75 kg/ha which provides 2.07 and 2.09 B: C ratio, respectively.

CONCLUSION

Livestock plays an important role in the development of the Indian economy. Therefore, the production of judicious quantities and superior-quality fodder crops is necessary for feeding the livestock population in the country. Moreover, the forage quality of the crops can be determined by their crude protein and fibre content. These parameters indicate the digestibility and palatability of fodder crops. Digestibility and palatability increase with the increment of protein and carbohydrate but decreases with the increment of fibre. Nitrogen is the most essential nutrient for cereal fodder crops as it controls the crude protein and fibre content in the plant. Nitrogen application to the crops increases carbohydrate and crude protein content but decreases fibre content of the plants, thereby, improving the forage quality. Furthermore, excess application of nitrogen hinders the carbohydrate content, therefore, supply of optimum doses of nitrogenous fertilizers (doses vary depending upon fodder crops) not only secures the adequate amount of carbohydrate content but increases green fodder and dry matter yield also. However, the application of suitable biofertilizers with nitrogenous fertilizers at the proper time contributes to a tremendous increase in the growth and development of fodder crops that lead to the production of superior quality and quantity of yield and thereby, a higher net return can be obtained. Moreover, biofertilizers act as an organic fertilizer that is environmentally friendly (reduces pollution risk) or by continuous application of these fertilizers for several years improves the soil fertility status for a longer period of time without degradation.

Conflict of interest

There is no conflict of interest in manuscript and manuscript had not submitted to other journal.

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