



Impact of Nutrient Management on the Quality of Different Varieties of Ryegrass (*Lolium perenne* L.) in Central Plain of Punjab

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ABSTRACT

Background: Ryegrass (*Lolium perenne* L.) is widely grown as green fodder crop and mostly cultivated for animal feed because it is the most nutrient-rich, multi-cut, succulent and palatable grass among others. Seaweed extracts and nano fertilizers has better source of nutrients that increases the nutrient use efficiency of the crop. The present experiment was carried out to investigate the impact of nutrient management on the quality of ryegrass varieties. The experimental trial was held on sandy clay loam soil of the central plain of Punjab.

Methods: The present study was conducted at department of agronomy, school of agriculture, lovely professional university, Jalandhar, Punjab during *Rabi* season in the year 2022-23. This experimental trial was conducted in the split plot design with three replications which consisted of 14 treatment combinations. Treatment combinations comprises of two ryegrass varieties in main plots and seven nutrient management treatments in sub plots.

Result: This experiment revealed that better quality fodder yield was achieved by the combined application 75% RDF + 10% seaweed extract + 1 nano spray (T₇) in the Punjab Ryegrass 2 (V₁) variety which showed the best treatment combination over others.

Key words: Fibre content, Nano-fertilizers, Quality, Ryegrass, Seaweed extract.

INTRODUCTION

Livestock, crops, fisheries and aquaculture comprise the agricultural allied sector in India. Livestock supplies 26.1% of the agricultural GDP and 4.03% of the national GDP, while crops alone account for 9.63% of the national GDP and 60.2% of the GDP of the entire agricultural sector (World Bank, 2024). Since the last 4 decades, fodder crops occupied only 4% land of the whole cultivated land area in India, to produce feed products for livestock. Currently, the net shortage that farmers confront is 11% for dry fodder and 36% for green fodder (Tokas *et al.*, 2019). Therefore, to minimize the net shortage of green forage, it is necessary to grow annually at the rate of 1.7% which can be obtained by adopting high-yielding varieties of fodder crops, increasing the production of fodder and enhancing protection technologies (Koli and Bhardwaj, 2018).

Ryegrass (*Lolium perenne* L.), one of the many fodder crops under the family of *Gramineae*, mostly known as makkhan grass, is crucial for meeting animals' nutritional needs (Beltran-Barriga *et al.*, 2022). It contains 13-18% crude protein (CP), 30-35% acid detergent fibre (ADF), 48-52% neutral detergent fibre (NDF), 2.0-2.5% ether extract (EE), 7-8% total ash and frequently more than 10-13% dry matter (DM), this green grass yields palatable and digestible fodder. These qualities allow grazing animals to sustain remarkably high amounts of dry matter intake, which contributes to their extraordinary performance (Kumar *et al.*, 2023). Ryegrass is grown as an annual and perennial

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grass fodder crop. It is mostly cultivated in north India as a cereal fodder crop due to its high dry matter production capability and ability to withstand both abiotic and biotic stresses.

However, various researches ensured that the application of conventional urea fertilizers leads to lower nitrogen use efficiency along with higher volatilization and leaching loss of nitrogen which may result in lower crop yields with higher production costs (Yadav *et al.*, 2017). In comparison to conventional fertilizers, nano-fertilizers (urea) ensured efficiency and targeted nutrient release leading to better nitrogen use efficiency and consequently, increase yield and quality of crops (Kumar *et al.*, 2020).

Besides, for effective supplements of fodder to increase animal productivity and improve their nutrition, seaweed extracts act as a major source of various nutrients and bio-stimulants which have been used for longer periods (Handique *et al.*, 2022). An application of seaweed extracts helps the plants in several ways or it has several benefits including enhanced structures of roots, development of leaves, increased crop yields and an increase in the capability of plants to tolerate diseases and climatic abnormalities or stresses involving drought or cold (Craigie, 2011).

However, utilization of nano-urea fertilization and seaweed extracts in ryegrass forage crops is limited yet, despite their dynamic benefits of crop production. Therefore, it is needed to further research on the use of better sources and combinations of nitrogenous fertilizers and seaweed extracts for the improvement of the quality of fodder ryegrass. Hence, the current investigation was conducted to determine the effect of different nutrient management on quality of ryegrass (*Lolium perenne* L.) varieties in central plain of Punjab.

MATERIALS AND METHODS

The current study on "Impact of nutrient management on the quality of different varieties of ryegrass (*Lolium perenne* L.) in central plain of Punjab" was conducted at an experimental field in the Department of Agronomy, School of Agriculture, Lovely Professional University, Jalandhar, Punjab during Rabi 2022-23. The field is located in Punjab's agroclimatic zone of trans-gangetic plain region, at an elevation of roughly 252 metres above sea level. Its geographic coordinates are 31° 26' North latitude and 75° 53' East longitude. The soil tract in the research field is sandy clay loam.

Experimental design

The field experiment was laid out in the Split Plot Design with three replications which consisted of two ryegrass varieties in main plot viz. V₁- Punjab Ryegrass 2, V₂- Punjab Ryegrass 1 and seven nutrient management treatment practiced in sub plots viz. T₁- Control (without fertilizers), T₂- 100% RDF, T₃-75% RDF + 5% seaweed extract, T₄-75% RDF + 10% seaweed extract, T₅- 50% RDF + 5% seaweed extract, T₆-50% RDF + 10% seaweed extract + 2 nano spray and T₇- 75% RDF + 10% seaweed extract + 1 nano spray. Size of the gross plot was 5 m × 4 m. Both the varieties of ryegrass were sown on 21st November, 2022 by broadcasting method using seed rate of 10 kg ha⁻¹ and harvested on 20th January, 2023.

Application of fertilizers was done at the recommended dose of 75:60:40 N:P:K kg ha⁻¹. Full dose of phosphorus and potassium was applied as basal application, whereas nitrogen was applied in two equal splits (1st before sowing and 2nd 30 days after sowing). Seaweed extracts contained *Ascophyllum nodosum* algae were sprayed to the crop at 5% and 10% concentration according to the treatment by

mixed with water after 30 days of sowing. Spraying of nano-urea was done on crop leaves by mixing 3 ml in one litre of water at active tillering stage or 30 days after sowing and subsequent spray was done after 10 days of first spray.

Quality parameters analysis

The fraction of cell wall constituents such as crude fibre (CF) (%), neutral detergent fibre (NDF) (%), acid detergent fibre (ADF) (%) and acid detergent lignin (ADL) (%) were analysed as per the methods of Van Soest *et al.* (1991). However, the secondary quality parameters of ryegrass were calculated by using the following formula (Lithourgidis *et al.*, 2006).

$$\text{Total digestible nutrient (\%)} = (-1.291 \times \text{Acid detergent fibre}) + 101.35$$

$$\text{Dry matter intake (g kg}^{-1}\text{)} = \frac{120}{\text{Neutral detergent fibre}}$$

$$\text{Dry matter digestibility (g kg}^{-1}\text{)} = 88.9 - (0.779 \times \text{Acid detergent fibre})$$

$$\text{Relative feed value (\%)} = \text{Dry matter digestibility} \times \text{Dry matter intake} \times 0.775$$

Statistical analysis

MS Excel 2016 was used to analyze the experimental data by analysis of variance method for split plot design. With the help of R software, the means of all treatments were compared.

RESULTS AND DISCUSSION

Crude fibre (%)

The data presented in Table 1 indicated that the CF% was found the highest in Punjab ryegrass 1 (13.99 %) which is statistically significant over Punjab ryegrass 2 (12.36%). The variation of crude fibre content between the varieties might be due to their inherent genetic differences (Bora *et al.*, 2019 and Singh *et al.*, 2008).

The significantly the highest CF% was recorded in control (without fertilizers) (17.36%) followed by 50% RDF + 5% seaweed extract (15.09 %). However, the significantly lower CF% was recorded in 75% RDF + 10% seaweed extract + 1 nano spray (10.18%). Digestibility of fodder crops is inversely related to the CF%. The decline in fibre content as nitrogen levels rise may be explained by the increased nitrogen supply through seaweed extract and nano urea (Moreno-Reséndez *et al.*, 2017 and Salama and Badry, 2020).

Interaction effect

Table 1.1 showed that significant lower CF% was recorded in Punjab ryegrass 2 with the application of 75% RDF + 10% seaweed extract + 1 nano spray (10.05%). However, significant higher CF% of ryegrass was recorded in Punjab ryegrass 1 under control plot (without fertilizers) (17.48%) which is statistically alike with the treatment Punjab ryegrass 2 under control plot (without fertilizers) (17.24%).

Neutral detergent fibre (%)

The data presented in Table 1 indicated that the highest NDF% was observed as 50.40% (Punjab ryegrass 1) and the lowest NDF % was recorded in Punjab ryegrass 2 (49.29%).

The significant highest NDF% was recorded as 52.12% under the treatment control (without fertilizers) followed by 50% RDF + 5% seaweed extract (50.97%). However, lower NDF% was recorded as 47.94% in 75% RDF + 10% seaweed extract + 1 nano spray. Increasing nutrient availability raises the nitrogen content, which causes the crops to become more succulent, experience

less nutrient stress and utilize water and nutrients more effectively, ultimately resulting in a decrease in the NDF% in fodder crops (Godlewska and Ciepiela, 2020 and Payghan, 2016).

Interaction effect

Data presented in Table 1.2 revealed that the significant higher NDF% of ryegrass was recorded as 52.17% under the treatment Punjab ryegrass 1 in control plot (without fertilizers) and lower NDF% of ryegrass was recorded with the application of 75% RDF + 10% seaweed extract + 1 nano spray in Punjab ryegrass 2 (47.81%).

Table 1: Effect of different varieties and nutrient management on crude fibre, neutral detergent fibre, acid detergent fibre and acid detergent lignin content of ryegrass.

Treatments	Crude fibre (%)	Neutral detergent fibre (%)	Acid detergent fibre (%)	Acid detergent lignin (%)
Main plot				
V ₁ : Punjab ryegrass 2	12.36 ^b	49.29 ^b	32.51 ^b	2.90 ^b
V ₂ : Punjab ryegrass 1	13.99 ^a	50.40 ^a	32.82 ^a	3.05 ^a
SEm(±)	0.02	0.07	0.05	0.02
C.D (P=0.05)	0.10	0.45	0.28	0.13
Sub plot				
T ₁ : Control ((without fertilizers)	17.36 ^a	52.12 ^a	35.12 ^a	3.42 ^a
T ₂ : 100% RDF	11.61 ^d	49.19 ^d	31.81 ^e	2.86 ^c
T ₃ : 75% RDF + 5% seaweed extract	14.20 ^c	50.39 ^{bc}	33.49 ^c	3.11 ^b
T ₄ : 75% RDF + 10% seaweed extract	13.47 ^c	49.88 ^{cd}	32.52 ^d	2.94 ^c
T ₅ : 50% RDF + 5% seaweed extract	15.09 ^b	50.97 ^b	33.88 ^b	3.19 ^b
T ₆ : 50% RDF + 10% seaweed extract + 2 nano spray	10.32 ^e	48.43 ^e	31.66 ^e	2.74 ^d
T ₇ : 75% RDF + 10% seaweed extract + 1 nano spray	10.18 ^e	47.94 ^e	30.19 ^f	2.59 ^e
SEm(±)	0.27	0.26	0.13	0.04
C.D (P=0.05)	0.78	0.75	0.37	0.11
Interaction (Main plot × Sub plot)				
SEm(±)	0.38	0.37	0.18	0.05
C.D (P=0.05)	1.10	1.07	0.53	0.16

Table 1.1: Interaction effects of different varieties and nutrient management on crude fibre content (%) of ryegrass.

	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	Mean
V ₁	17.24 ^a	10.11 ^d	13.17 ^c	11.16 ^d	14.69 ^b	10.10 ^{de}	10.05 ^e	12.36 ^b
V ₂	17.48 ^a	13.12 ^c	15.23 ^b	15.78 ^b	15.49 ^b	10.55 ^{de}	10.30 ^{de}	13.99 ^a
Mean	17.36 ^a	11.61 ^d	14.20 ^c	13.47 ^c	15.09 ^b	10.32 ^e	10.18 ^e	
Interaction (V × T)					SEm(±)		C.D (P=0.05)	
T at the same level of V					0.38		1.10	
V at the same or different level of T					0.35		1.02	

Table 1.2: Interaction effect of different varieties and nutrient management on neutral detergent fibre content (%) of ryegrass.

	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	Mean
V ₁	52.07 ^a	48.60 ^{fg}	49.31 ^{def}	48.84 ^{efg}	50.28 ^{cd}	48.13 ^g	47.81 ^g	49.29 ^b
V ₂	52.17 ^a	49.78 ^{de}	51.48 ^{ab}	50.92 ^{bc}	51.67 ^{ab}	48.72 ^{efg}	48.07 ^g	50.40 ^a
Mean	52.12 ^a	49.19 ^d	50.39 ^{bc}	49.88 ^{cd}	50.97 ^b	48.43 ^e	47.94 ^e	
Interaction (V × T)					SEm(±)		C.D (P=0.05)	
T at the same level of V					0.37		1.07	
V at the same or different level of T					0.35		1.01	

Acid detergent fibre (%)

The data presented in Table 1 indicated that the ADF% was significantly highest in Punjab ryegrass 1 (32.82%) which is statistically significant over Punjab ryegrass 2 (32.51%). The significant highest ADF% was recorded in control (without fertilizers) (35.12%) followed by 50% RDF + 5% seaweed extract (33.88%) and the lowest ADF% was recorded as 30.19% (75% RDF + 10% seaweed extract + 1 nano spray). With combined levels of nutrient application, the ADF% in ryegrass was decreasing, which in turn increased the qualitatively digestible contents of fodder with higher nutrient levels (Bhakar *et al.*, 2020).

Interaction effect

Data delineated in Table 1.3 resulted that the significant higher ADF% of ryegrass was observed as 35.17% by growing Punjab ryegrass 1 in control plot (without fertilizers) and lower ADF% was recorded in Punjab ryegrass 2 with the application of 75% RDF + 10% seaweed extract + 1 nano spray (30.07%).

Acid detergent lignin (%)

The data presented in Table 1 indicated that the ADL% was significantly highest in Punjab ryegrass 1 (3.05%) and 2.90% was the lowest ADL% found in Punjab ryegrass 2. The variation of ADL% between the varieties might be due to their inherent genetic differences (Kumar *et al.*, 2023).

The significant highest ADL% was recorded as 3.42% in control (without fertilizers) followed by 50% RDF + 5% seaweed extract. However, the significant lowest ADL% was recorded as 2.59% in 75% RDF + 10% seaweed extract + 1 nano spray. Seaweed extract and nano urea improved nutrient availability for uptake, boost succulence and lower the plant's dry matter content, which may be the cause of the ryegrass's decreased ADL% (Godlewska and Ciepiela, 2020).

Interaction effect

Table 1.4 revealed that 3.62% was the highest ADL% of ryegrass recorded in Punjab ryegrass 1 under control plot (without fertilizers) followed by growing Punjab Ryegrass 2 in control plot (without fertilizers). However, significantly the lowest ADL% was recorded with the application of 75% RDF + 10% seaweed extract + 1 nano spray in Punjab ryegrass 2.

Total digestible nutrients (%)

The data depicted in Fig 1 indicated the TDN% of ryegrass was found to be significantly highest in Punjab ryegrass 2 (59.38%) and the significantly lowest TDN% was obtained as 58.98% in Punjab ryegrass 1.

The significant highest TDN% was recorded as 62.38% with the treatment 75% RDF + 10% seaweed extract + 1 nano spray followed by 50% RDF + 10% seaweed extract + 2 nano spray. However, the significant lowest TDN% was recorded in control (without fertilizers) (56.02%). In the fodder crop, there is a negative correlation between the TDN% and the ADF%. Higher TDN values can be linked to enhanced nutrient availability, which lowers the ADF% in fodder and raises the TDN% (Kaur and Goyal, 2017).

Interaction effect

The significant higher TDN% was obtained in Punjab Ryegrass 2 using 75% RDF + 10% seaweed extract + 1 nano spray (62.54%). However, the significant lower TDN% was recorded as 55.95% in Punjab ryegrass 1 under control plot (without fertilizers).

Dry matter intake (g kg⁻¹)

A data depicted in Fig 1 indicated that the DMI was significantly highest in Punjab ryegrass 2 with the value 2.44 g kg⁻¹ which is statistically significant over Punjab ryegrass 1 (2.38 g kg⁻¹).

Table 1.3: Interaction effect of different varieties and nutrient management on acid detergent fibre content (%) of ryegrass.

	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	Mean
V ₁	35.07 ^a	31.78 ^f	33.67 ^c	32.92 ^{de}	33.48 ^c	30.60 ^g	30.07 ^h	32.51 ^b
V ₂	35.17 ^a	31.84 ^f	33.31 ^{cd}	32.13 ^f	34.28 ^b	32.72 ^e	30.31 ^{gh}	32.82 ^a
Mean	35.12 ^a	31.81 ^e	33.49 ^c	32.52 ^d	33.88 ^b	31.66 ^e	30.19 ^f	
Interaction (V × T)					SEm(±)	C.D (P=0.05)		
T at the same level of V					0.18	0.53		
V at the same or different level of T					0.17	0.51		

Table 1.4: Interaction effect of different varieties and nutrient management on acid detergent lignin content (%) of ryegrass.

	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	Mean
V ₁	3.22 ^b	2.76 ^{ef}	3.11 ^{bc}	2.88 ^{de}	3.18 ^b	2.72 ^f	2.48 ^g	2.90 ^b
V ₂	3.62 ^a	2.96 ^{cd}	3.11 ^{bc}	2.99 ^{cd}	3.21 ^b	2.77 ^{ef}	2.71 ^f	3.05 ^a
Mean	3.42 ^a	2.86 ^c	3.11 ^b	2.94 ^c	3.19 ^b	2.74 ^d	2.59 ^e	
Interaction (V × T)					SEm(±)	C.D (P=0.05)		
T at the same level of V					0.05	0.16		
V at the same or different level of T					0.05	0.16		

The significant higher DMI of ryegrass was recorded as 2.50 g kg^{-1} with the treatment 75% RDF + 10% seaweed extract + 1 nano spray. However, the significant lowest DMI was recorded in control (without fertilizers) (2.30 g kg^{-1}). In the fodder crop, there is a negative correlation between the DMI and the NDF%. The higher DMI values can be linked to enhanced nutrient availability, which lowers the NDF% in fodder that may leads to increase DMI (Kaur and Goyal, 2017).

Interaction effect

The significant higher DMI was recorded with 75% RDF + 10% seaweed extract + 1 nano spray in Punjab ryegrass 2 (2.51 g kg^{-1}). However, the significant lower DMI was obtained as 2.30 g kg^{-1} in Punjab ryegrass 1 under control condition (without fertilizers).

Dry matter digestibility (g kg^{-1})

A data depicted in Fig 1 indicated that the DMD of ryegrass was significantly highest in Punjab ryegrass 2 (63.57 g kg^{-1}) and lowest in Punjab ryegrass 1 (63.33 g kg^{-1}).

The significant highest DMD of ryegrass was recorded as 65.38 g kg^{-1} with the treatment 75% RDF + 10% seaweed extract + 1 nano spray. However, the significant lowest DMD was recorded in control (without fertilizers) (61.55 g kg^{-1}). There is also a negative correlation between the DMD and the ADF% in the fodder crops (Kaur and Goyal, 2017).

Interaction effect

The significant higher DMD of ryegrass was obtained as 65.48 g kg^{-1} in Punjab ryegrass 2 with the application of 75% RDF + 10% seaweed extract + 1 nano spray. However, the lower DMD was recorded with Punjab ryegrass 1 in control plot (without fertilizers).

Relative feed value (%)

A data depicted in Fig 1 indicated that the RFV was found to be significantly highest in Punjab ryegrass 1 (120.12%). The significant lowest RFV was obtained as 117.03% under the treatment Punjab ryegrass 2.

The highest RFV of ryegrass was recorded in 75% RDF + 10% seaweed extract + 1 nano spray (126.86%) followed by 50% RDF + 10% seaweed extract + 2 nano spray (123.38%). However, the significant lowest RFV was recorded in control (without fertilizers) (109.86%). Higher RFV may be attributed to increased availability of the nutrients which increases the crude protein content, ether extract (%) total ash (%) and also lowers the values of fibre fractions in plants resulting in proper growth and development of ryegrass (Jahansouz *et al.*, 2014 and Kumar *et al.*, 2016).

Interaction effect

The significant higher RFV of ryegrass was recorded as 127.37% with 75% RDF + 10% seaweed extract + 1 nano

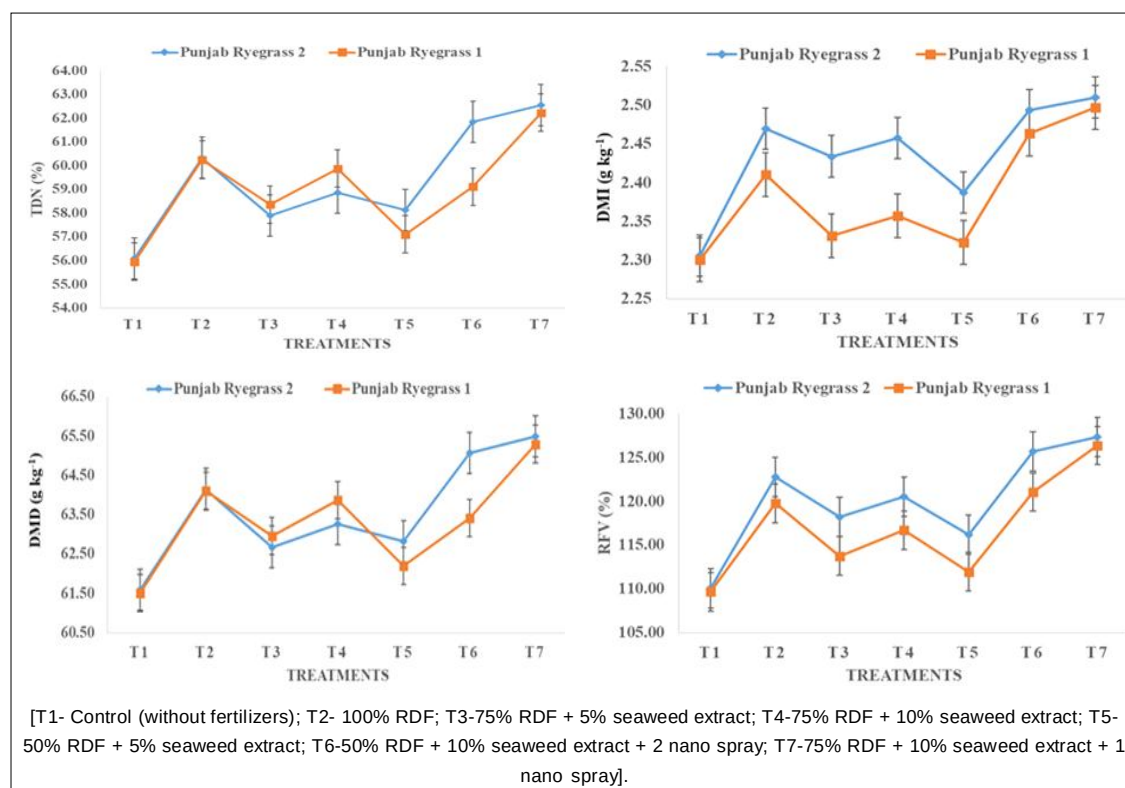


Fig 1: Effect of different varieties and nutrient management on total digestible nutrients (TDN) (%), dry matter intake (DMI) (g kg^{-1}), dry matter digestibility (DMD) (g kg^{-1}) and relative feed value (RFV) (%) of ryegrass during 2022-2023.

spray in Punjab ryegrass 2. However, the significant lower relative feed value of ryegrass was recorded in Punjab ryegrass 1 under control plot (without fertilizers) (109.66%).

CONCLUSION

Cell wall constituents (CF, NDF, ADF and ADL%) indicates the quality of the fodder crops. The digestibility and palatability of fodder crops are indicated by these factors. Increases in protein lead to increases in palatability and digestibility, while increases in fibre content cause declines in these properties.

From one year experiment, it is concluded that application of 75% RDF + 10% seaweed extract + single spray of nano urea in the Punjab Ryegrass 2 variety (V_1T_7) to obtain higher fodder yield with better quality fodder of ryegrass in central plain of Punjab.

Conflict of interest

The authors in this article declare that there is no conflict of interest.

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