

Original Research Article

<https://doi.org/10.20546/ijcmas.2019.810.116>

Correlation Studies of Quality Traits and Yields of Fodder Obtained from Intercropping Systems under Tarai Region of Uttarakhand, India

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ABSTRACT

The experiment was conducted during *rabi* season of 2016-17 at Fodder Agronomy block of Instructional Dairy Farm (IDF), Nagla of the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand, India to correlation study between quality traits and yields of fodder obtained from intercropping systems. Randomized block design was used with four replications consisting of 10 treatments as detailed in materials and methods. The analysis of data indicated that dry matter content was positively correlated with cell wall contents. All cell wall structural components (NDF/ADF/hemicellulose) showed positive correlation with each other. There existed negative association with RFV, TDN, cell content, crude protein content (CP) and dry matter intake (DMI). N content, CP content and DMI showed significant negative correlation with NDF and hemicellulose but positive association with DMD and RFV. The cell content showed significant negative correlation with cell wall components and positive association with N content, CP content and DMI. DMD was non significantly and positively associated with RFV, N content, CP content and DMI while significantly and positively association with TDN. DM content was positively correlated with all yields (GFY, DFY, DDMY, CPY) and this association was significant. NDF was positively associated with GFY, DFY and DDMY but significantly negative with CPY.

Keywords

Correlation, Crude protein content, Digestible dry matter content, Hemicellulose

Article Info

Accepted:

10 September 2019

Available Online:

10 October 2019

Introduction

Fodder plays a crucial role in the health and nutrition of the large population of livestock in India, which is having 11.6 per cent livestock population of the world (Ahmad *et al.*, 2019), whereas milk production of the country is about 165.4 million tonnes in 2016-17. At present, the country faces a net deficit of 63 % green fodder, 24 % dry crop residues and 64%

feeds, respectively (Choudhary *et al.*, 2014). The available cool season forages are poor in quality, being deficient in available energy, protein and minerals. Therefore to compensate the low productivity of the livestock, farmers maintain a large herd of animals. Hence the milk production in country can be increased by providing nutritive fodder having good quality. Fodder yield and quality of crops are a complex cause of several effects and

influenced by many component traits. Thus, study of correlation provides an opportunity to assess the magnitude and direction of association between yield and quality with its direct and indirect components, which are essential for formulating an effective and efficient crop improvement scheme (Chandra *et al.*, 2012). To improve the quality and yield of fodder crops, it is imperative to know the association of different quality traits with the yield traits of fodder crops. In this view, the present study was undertaken to identify inter-relationship of quality traits and their association with the yield and quality traits of fodder.

Materials and Methods

The experiment was conducted during *rabi* season of 2016-17 at Fodder Agronomy block of Instructional Dairy Farm (IDF), Nagla of the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand, India. The Instructional Dairy Farm is situated in the *Tarai* belt of Shivalik range of Himalayas with humid sub-tropical type of climate at latitude of 29°N and longitude of 79.3°E and situated at an altitude of 243.84 m above the mean sea level. The soil of experiment site was silty clay loam neutral in reaction (7.58 pH) with 0.79 % organic carbon, 281.45, 21.64 and 231.74 kg/ha available N, P and K respectively. The experiment was laid out in randomized block design with four replications and comprising ten treatments *i.e.* sole ryegrass, sole oat, sole barley, sole berseem, ryegrass+berseem (1:1), ryegrass+berseem (2:2), oat+berseem (1:1), oat+berseem (2:2), barley+berseem(1:1) and barley+berseem(2:2). The recommended fertilizers viz. 120:60:40 Kg N:P₂O₅:K₂O/ha for sole ryegrass, oat and barley, 20:60:40 Kg N:P₂O₅:K₂O/ha for sole berseem and 80:60:40 Kg N:P₂O₅:K₂O/ha for intercropping systems, respectively were applied. In basal

application, half nitrogen was applied in sole ryegrass, oat, barley and intercropping system crops. Remaining nitrogen was top dressed in two equal splits after first and second cuttings. In legume crops, whole nitrogen was applied as basal. Total amount of recommended phosphorus (*i.e.* 60 Kg P₂O₅/ha) and potassium (*i.e.* 40 Kg K₂O/ha) were applied at the time of sowing in all crops. The harvested herbage was weighted immediately for green fodder yield and 500 g fresh sample from each net plot was taken to determine dry matter content. The samples were dried at 70° C ± 2 in hot air oven for moisture loss, grounded with a Wiley mill to pass through 1 mm screen and analyzed for quality components. Total N was determined using the CHNS analyzer and crude protein was calculated by multiplying nitrogen per cent with 6.25 (AOAC, 1965). Total digestible nutrients (TDN), digestible dry matter (DDM), dry matter intake (DMI) and relative feed value (RFV) were estimated according to the following equations adapted from Horrocks and Vallentine (1999): TDN= (-1.291 X ADF) + 101.35, DMI= 120/% NDF dry matter basis, DDM=88.9-(0.779 X % ADF, dry matter basis), RFV= % DDM X % DMI X 0.775. The data was subjected for correlation study as per procedure given by Cochran and Snedecor (1994).

Results and Discussion

Correlation among quality parameters

NDF had significant positive association with ADF, hemicellulose and dry matter content. However non significant positive association with DM content was noticed. It was negatively correlated with DDM, RFV, TDN, cell content, nitrogen, CP content and DMI. This was significant for cell content, nitrogen, CP content and DMI (Table 1). ADF had significant negative correlation with DDM, TDN, cell content and DMI. This might be due to the fact that the accumulated cell wall

contents are always less digestible than cell soluble and also cell wall contents simply act as physical barrier to microbial enzymes reacting their target polysaccharides (Chesson, 1993). Thus digestibility, cell content and intake are reduced with the presence of cell wall components and negative correlation existed (Prajapati *et al.*, 2017). Hemicellulose had non significant positive correlation with DDM indicating better digestibility of hemicelluloses than ADF/NDF. Hemicellulose had significant negative association with cell content, nitrogen content, CP content and DMI. RFV was non significantly and negatively associated with cell wall components (ADF, NDF and hemicellulose) and for other parameters it had non significant positive association. A significant positive correlation of TDN with DDM and significant negative correlation with ADF was noticed. Inverse relationship between TDN and ADF was reported by Lithourgidis *et al.*, (2006). Cell content showed significant negative correlation with cell wall contents (NDF/ADF/Hemicellulose). The cell wall is formed by the transport of cell contents viz. sugar matrix components from the golgibodies that are the sugar donors for cell wall component viz. hemicellulose, cellulose, fibers, lignin etc (Taiz and Zeiger, 2002). Thus if cell wall contents increases, the cell content decreases showing a negative correlation between cell wall and cell contents. Nitrogen content had significant positive association with CP content, DMI and cell content. There existed negative correlation between ADF, NDF, hemicellulose and TDN but it was significant for NDF and hemicellulose. Association between nitrogen content and cell content, CP content, DMI was significant and positive. Chandra *et al.*, (2012) also reported positive association between N content and CP content. DMI was significantly and positively associated with cell content, nitrogen content, CP content while significantly and negatively associated with ADF, NDF and hemicellulose.

Earlier workers have also observed negative association between DMI and cell wall components (Ayan *et al.*, 2012).

Quality parameters and yield

The correlation between quality parameters and yield as presented in (Table 2) indicated that DM content was positively correlated with all yields (GFY, DFY, DDMY, CPY) and this association was significant. Enhancement in dry fodder yield is due to accumulation of dry matter in various plants parts which increases the weight. This factor might have led significant positive correlation with green /dry forage yield (Chandra *et al.*, 2012). The DDMY also had significant positive correlation with dry matter content which might be due to higher values of dry matter and digestible dry matter. The association between CPY and dry matter content was positive but non significant. Crude protein content was negatively associated with GFY, DFY and DDMY and this association was non significant. Crop yielding higher dry matter has been reported to have lower crude protein (Fageria and Baligar, 2005; Ibrahim *et al.*, 2006) this might be a reason for negative correlation between CPY and total fodder yields. However, crude protein content had significant positive association with crude protein yield. Higher values of crude protein content and DFY lead to enhancement in CP yield. Similar was the association between nitrogen content and various yields since CPY is a function of nitrogen content in the plants and thus positive correlation was observed. A positive association between CP content, DMY and CPY in cereal-legume intercropping has been noticed by (Ram and Singh, 2003). A non significant positive association between TDN and yields was noticed. This suggests that accumulation of digestible nutrients was more with increase in green /dry fodder yield and there by more DDMY and CPY.

Table.1 Correlation study between different quality parameters.

| Quality Parameters | NDF | ADF | DDM | Hemicellulose | RFV | TDN | Cell content | Nitrogen | CP | DM |
|--------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| ADF | 0.680* | | | | | | | | | |
| DDM | -0.598 ^{NS} | -0.941** | | | | | | | | |
| Hemicellulose | 0.685* | 0.055 ^{NS} | 0.095 ^{NS} | | | | | | | |
| RFV | -0.484 ^{NS} | -0.544 ^{NS} | 0.364 ^{NS} | -0.336 ^{NS} | | | | | | |
| TDN | -0.236 ^{NS} | -0.702* | 0.809** | 0.546 ^{NS} | 0.102 ^{NS} | | | | | |
| Cell content | -1.000** | -0.681* | 0.595 ^{NS} | -0.689* | 0.487 ^{NS} | 0.230 ^{NS} | | | | |
| Nitrogen | -0.872** | -0.309 ^{NS} | 0.204 ^{NS} | -0.935** | 0.452 ^{NS} | -0.245 ^{NS} | 0.873** | | | |
| CP | -0.881** | -0.310 ^{NS} | 0.216 ^{NS} | -0.923** | 0.415 ^{NS} | -0.218 ^{NS} | 0.882** | 0.998** | | |
| DM | 0.408 ^{NS} | 0.067 ^{NS} | -0.053 ^{NS} | 0.515 ^{NS} | -0.055 ^{NS} | 0.225 ^{NS} | -0.404 ^{NS} | -0.527 ^{NS} | -0.519 ^{NS} | |
| Dry matter intake | -0.967** | -0.651* | 0.565 ^{NS} | -0.657* | 0.385 ^{NS} | 0.238 ^{NS} | 0.968** | 0.837** | 0.851** | -0.481 ^{NS} |

NDF= Neutral detergent fiber, ADF= Acid detergent fiber, DDM= Digestible dry matter, RFV= Relative feed value, TDN= Total digestible nutrient, CP= Crude protein, DM= Dry matter, DMI= Dry matter intake; * and ** Significant at 5 % and 1 % level, respectively

Table.2 Correlation study between quality parameters and yields

| Quality Parameters | Yield (q/ha) | | | |
|----------------------|----------------------|----------------------|----------------------|----------------------|
| | GFY | DFY | DDMY | CPY |
| NDF | 0.396 ^{NS} | 0.342 ^{NS} | 0.400 ^{NS} | -0.669* |
| ADF | -0.010 ^{NS} | -0.043 ^{NS} | 0.047 ^{NS} | -0.395 ^{NS} |
| DDM | -0.018 ^{NS} | 0.013 ^{NS} | 0.048 ^{NS} | 0.273 ^{NS} |
| Hemicellulose | 0.442 ^{NS} | 0.414 ^{NS} | 0.550 ^{NS} | -0.568 ^{NS} |
| RFV | -0.078 ^{NS} | -0.029 ^{NS} | 0.156 ^{NS} | 0.445 ^{NS} |
| TDN | 0.140 ^{NS} | 0.165 ^{NS} | 0.285 ^{NS} | 0.018 ^{NS} |
| Cell content | -0.387 ^{NS} | -0.333 ^{NS} | -0.393 ^{NS} | 0.676* |
| Nitrogen | -0.486 ^{NS} | -0.441 ^{NS} | -0.545 ^{NS} | 0.659* |
| CP | -0.481 ^{NS} | -0.435 ^{NS} | -0.526 ^{NS} | 0.671* |
| DM | 0.921** | 0.930** | 0.924** | 0.263 ^{NS} |
| DMI | -0.423 ^{NS} | -0.370 ^{NS} | -0.392 ^{NS} | 0.601 ^{NS} |

NDF= Neutral detergent fiber, ADF= Acid detergent fiber, DDM= Digestible dry matter, RFV= Relative feed value, TDN= Total digestible nutrient, CP= Crude protein, DM= Dry matter, DMI= Dry matter intake, GFY=Green fodder yield, DFY=Dry fodder yield, DDMY= Digestible dry matter yield, CPY= Crude protein yield; * and ** Significant at 5 % and 1 % level, respectively.

RFV was positively correlated with CPY and DDMY however, negative association with GFY and DFY. RFV is a function of DDMY and DMI (Albayrak *et al.*, 2011). NDF was positively associated with GFY, DFY and DDMY but significantly negative with CPY. ADF was negatively correlated with all the yields except DDMY. Hemicellulose content was negatively associated with CPY but positively with GFY, DFY and DDMY. Significant negative association between NDF/ADF and CP has been reported earlier too.

On the basis of the present investigation, it is concluded that all cell wall structural components (NDF/ADF/hemicellulose) showed positive correlation with each other. There existed negative association with RFV, TDN, cell content, crude protein content (CP) and dry matter intake (DMI). DMD was positive correlation with RFV, TDN, cell content, N content, crude protein content (CP) and dry matter intake (DMI). Hence, associated effects between cereals and legumes may improve quality traits of fodder and their relation with yields.

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How to cite this article:

Sapana Tiwari, Brajkishor Prajapati and Kewalanand. 2019. Correlation Studies of Quality Traits and Yields of Fodder Obtained from Intercropping Systems under Tarai Region of Uttarakhand, India. *Int.J.Curr.Microbiol.App.Sci*. 8(10): 997-1002.

doi: <https://doi.org/10.20546/ijcmas.2019.810.116>