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IMPROVING FODDER QUALITY OF PANICUM GRASS THROUGH INTERCROPPING OF LEGUMES AND THEIR INOCULATION

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ABSTRACT:- A protocol was conducted under rainfed conditions for two years at National Agricultural Research Centre (NARC) Islamabad, Pakistan. Treatments comprising intercropping of Panicum grass with legumes (33%, 50% and 67%) with or without inoculation to investigate its fodder quality. The study clearly indicated that quality of fodder increased significantly both with the legumes and inoculation. The intercropping of Panicum grass with 67% inoculation proved the best combination. The 6-7% higher crude protein (CP) of mixed fodder was recorded from 67% intercropping in comparison to grass alone while inoculation increased it by further 1-2%. Results also suggested that total digestible nutrients (TDN) were increased by 2-4% as compared to other treatments.

Key Words: Fodder Quality; Panicum Grass; Forage Legumes; Intercropping; Inoculation; Crude Protein; Total Digestible Nutrients; Pakistan.

INTRODUCTION

Livestock is considered very important component of agriculture sector in the world. The animal production brings milk, milk products, meat, wool, hides, bones and many associated products like manures etc. for the benefits of mankind. Presently, there are 176.4 million livestock in Pakistan which contributes 12% towards GDP (GoP, 2014) while during 2012-13 169.5 million heads contributed 12% to GDP (GoP, 2013). Thus, there has been an increase of only 0.1% share in GDP in last year that indicates very poor performance of this important sector and also that the vast resource of the country is not being managed on scientific basis. Thus, only 10-50% of their actual potential is being realized (Ali et al., 2001).

One of the major problems hindering expansion of ruminant production in the country is unavailability of good quality fodder in sufficient quantity (Sarwar et al., 2002). Production of quality fodder is of great importance for economical animal production. Both quality and quantity of fodder are influenced due to plant species (Kaiser and Piltz, 2002), stage of growth (Kim et al., 2001) and agronomic practices (Rehman and Khan, 2003). Protein is the most demanded feed ingredient of ruminant ration, required substantially for milk or meat production as well as for reproduction. If the crude protein is below 6-7% in the ration, the microbial activity in the rumen is depressed due to lack of N. Livestock in the country is deficient in CP and

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TDN by 38.1% and 24.0%, respectively. Livestock was receiving 51% of nutrients from green fodder, 38%, crop residues; 3%, grazing (bare lands and post harvest); 6%, cereal by products and 2%, oil cake meals, (Sarwar et al., 2002).

The grass species *Panicum maximum* var. Tanzani is a drought resistant but does not stand long periods of complete desiccation. Its nutritive value is quite high when leafy and young (10% CP) which falls rapidly with increasing maturity. Forage legumes have immense value in animal nutrition because of their higher protein content, vitamins and specific minerals such as P and Ca. Forage legumes are usually lower in fiber and higher in CP than forage grasses at advance maturity stages (Bose and Balakarishnan, 2001).

Vetches (*Vicia* species) are legumes which are well adapted to winter growth in Mediterranean environments throughout the world on various soil types and are used in West Asia and Australia for various purposes as green forage, hay, seed crop or green manure. Vetches have the potential to increase animal feed supply substantially and thus can considerably improve animal productivity (Bose and Balakarishnan, 2001). Cowpea is highly palatable, nutritious and rich in protein, calcium and phosphorus than many other summer legumes. These are also used with diets that are largely consisting of grasses and their protein content often falls below minimum critical level. Therefore, increasing leguminous portion in animal diet not only increase protein content but also enhance voluntary intake and digestibility of entire diet (Parveen et al., 2001).

Low rhizobial population is the main cause of low legume yield in country. The use of inoculation is very low; just below 1-3 % of the total area under legumes which is negligible (Aslam et al., 2000). To ensure optimum rhizobial population in the rhizosphere, seed inoculation of legumes with an efficient rhizobial strain is necessary. This helps to improve N fixation, crop growth and yield of leguminous corps (Zamarud et al., 2006).

Bio fertilizers (inoculation material) are apparently environmental friendly, low cost, non bulky agricultural inputs which could play a significant role in plant nutrition as a supplementary and complementary factor to mineral nutrition (Sahai, 2004).

Considering the limitations and constraints faced by the farmers busy in livestock production, a comprehensive study was conducted to determine forage quality through grass-legumes intercropping and legume seed inoculation.

MATERIALS AND METHODS

The study was conducted under rainfed conditions for two years and completed in 2007 at experimental area of Rangeland Research Programme, National Agricultural Research Centre (NARC) Islamabad, Pakistan. The experimental treatments were:

T_1 = Grass 100 %
T_2 = Legumes of the season (cowpeas in summer and vetch in winter)
T_3 = Grass + 33 % legumes
T_4 = Grass + 50 % legumes
T_5 = Grass + 67 % legumes
T_6 = T_2 + inoculation
T_7 = T_3 + inoculation

T_8 = T_4 + inoculation

T_9 = T_5 + inoculation

The experimental soil has pH 8.4, ECe 0.53 dS m^{-1}, total N 0.037%, available P 4.7 mg kg^{-1}, extractable K 79.6 mg kg^{-1}, OM 0.53% and textural class was sandy clay loam.

Panicum maximum grass was planted as perennial fodder. Winter legume, *Vicia sativa* (commonly known as vetch) and summer legume, *Vigna unguiculata* (commonly known as cowpeas) were sown as inter crops in the established grass. Summer legume followed winter legume in the next year. Seed of legumes was inoculated with *Rhizobium leguminosarum* before sowing to obtain T_6-T_9. The experiment was laid out using randomized complete block designs (RCBD) with four replications (Arshad ullah et al., 2015).

This study was conducted under rainfed conditions and no irrigations and fertilizer were applied. Grass was harvested at panicle stage, whereas legumes were harvested at 100% flowering. The fresh samples were oven dried to a constant temperature at 70 ^{o}C for 72 h. Crude protein percentage was determined by micro-Kjeldhal method (AOAC, 1994). Total digestible nutrients (TDN) was calculated by the following equation (Wardeh, 1981).

$$\% \text{ TDN} = -26.685 + 1.334 (CF) + 6.598 (EF) + 1.423 (NFE) + 0.967 (Pr) - 0.002 (CF)^2 - 0.670(EE)^2 - 0.024 (CF)(NFE) - 0.055 (EF)(NFE) - 0.146 (EF) (Pr)^2 + 0.039 (EE)^2 (Pr)$$

The meteorological data of three years (2005-07) were collected and divided it by 36 months. This data is the overall average of all the months in three years. Monthly average rainfall was 86 mm, 104 mm and 118 mm, wind speed 60 km day^{-1}, 51 km day^{-1} and 46 km day^{-1}, pan evaporation 4 mm day^{-1} each, sunshine 8 h day^{-1}, each; monthly maximum and minimum average temperature 28^{o}C, 3^{o}C, 28^{o}C, 14^{o}C, 28^{o}C, 13^{o}C and average maximum and minimum relative humidity were 83%, 49%, 81%, 51%, 83% and 50% during the study period i.e., 2005, 2006 and 2007, respectively (WRRI, 2007).

All the data were analyzed using one-way analysis of variance with the help of software package of MSTAT-C Microcomputer program, Version 1.3. A least significant difference (LSD) was applied for multiple comparisons (Bicker, 1991).

RESULTS AND DISCUSSION

The balanced nutrition and protein/mineral requirements of people fed on animal products eating quality fodders meeting international standards are also of utmost importance. The chemical analysis of any feed stuff is important for qualitative information regarding nutrients. Thus forage quality evaluation holds the key to economic livestock production. Protein is very important and the most demanded feed ingredient of ruminant rations. Large and highly significant differences were noted in between grass and both the legumes (*Vicia sativa* and *Vigna unguiculata* during the study (Figure 1). CP in grass pure stand was 6% while both the legumes were having about 20%. Intercropping of grass with legumes by vetch or cowpea or inoculate or non inoculated 67% proved better

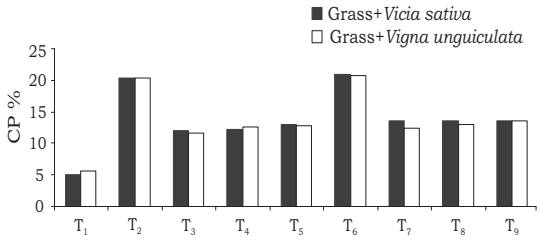

Figure 1. Effect of grass legumes intercropping and inoculation on CP of fodder after two years (n= 4 SD *Vicia sativa* = 0.702 SD *Vigna unguiculata* = 0.663)

and significant in cowpeas in both the years (Figure 2). Intercropping of inoculated legume increased CP of grass by 0.2% and could not produce significant result when compared without inoculation (Figure 3). The grass alone showed decreasing trend due to more maturation (woodiness in stem behavior). The trend of two year investigations was consistent. However, the CP of forage legumes increased after every harvest indicating a gradual effect of growing legumes and increasing effectiveness of inoculation. Kutuzova et al. (2001) described the CP demand in meadow fodder.

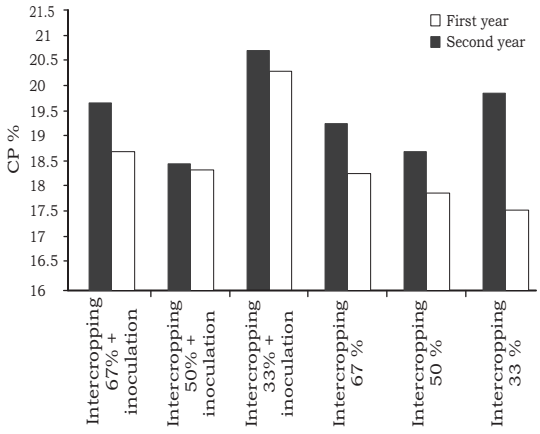

Figure 2. Year wise effect of intercropping and inoculation on CP of legumes (n= 4 SD First year= 0.932 SD Second year= 0.628)

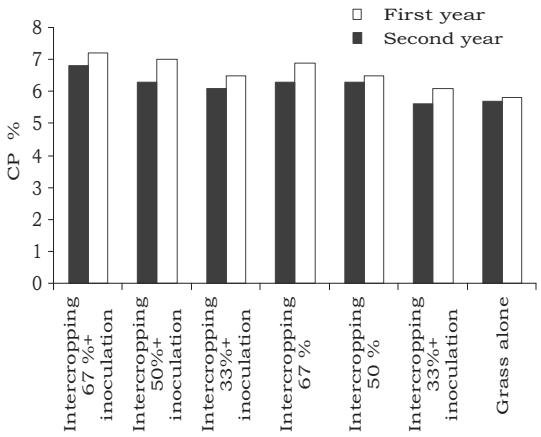

Figure 3. Year wise effect of intercropping and inoculation on CP of grasses (n= 4 SD First year = 0.952 SD Second year = 0.648)

They urged to increase 6-7 mha as legume-grass mixture area to meet increasing CP demand in meadow fodder. Sudesh et al. (2006) noted that mixture of grass and legume produced more CP than grass and cereal mixture. Tamm and Tamm (2005); Hoffmann et al. (2004); Malikov (2004); Trots and Yakovler (2003); Zimkova et al. (2002) and Reynolds and Frame (2005) also observed the increasing trend of CP when different leguminous crops were intercropped with non leguminous crops or grasses. They also noted that CP percentage was increased more by inoculation of legume seeds that was due to fixation of atmospheric nitrogen.

Berdahl et al. (2004) compared nutritive quality of four cool-season grass monocultures and their respective binary grass-alfalfa (*Medicago sativa*) mixtures. Great plains were dependent on maintaining the legume component in the mixture, which increased CP from 71g kg^{-1} for grass monocultures to 109 g kg^{-1} for

grass-alfalfa mixtures when no supplemental nitrogen fertilizer was used. The forage yield and quality of common vetch (*Vicia sativa*), grass pea (*Lathyrus sativus*) and barley grown alone and as mixtures were investigated in field experiments by Karadag (2004). The highest CP yield (1.53 t ha^{-1}) was achieved with the 50% grass pea and 50% barley mixture. The mean relative yield of dry matter and total seed yields were 1.78 and 1.79, respectively.

In conclusion, the mixture comprising 25% common vetch or grass pea and 75% barley was recommended for green forage, dry matter and seed yield. The 50% grass pea and 50% barley mixture produced the highest CP yield and therefore, were recommended to be grown for improving quality of fodder in respect of CP. A clear and significant difference was observed in grass and legumes for TDN content indicating that latter have more potential for supplying digestible nutrients to animals (Figure 4). There was a marked difference of TDN of both legumes within two study years, showing a decrease of almost 5%. Three planting geometries (33%, 50%

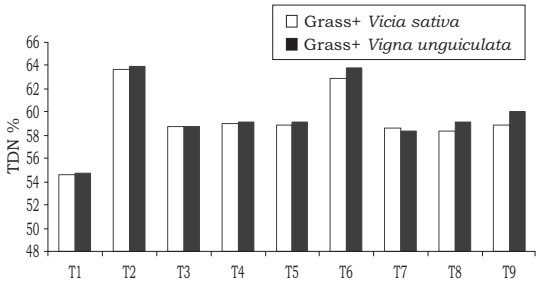

Figure 4. Improvement of total digestible nutrients of fodder due to intercropping and inoculation (n=4 SD *Vicia sativa* = 0.709 SD *Vigna unguiculata*= 0.961)

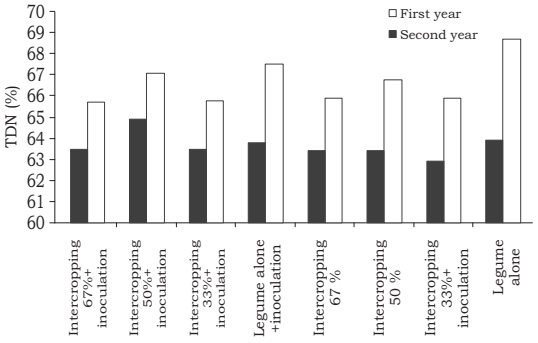

Figure 5. Year wise effect of intercropping (grass + legumes) on TDN of legumes (n=4 SD First year= 1.467 SD Second year= 0.835)

and 67%) did not affect significantly TDN composition of either grass or legumes. As far as inoculation was concerned, it increased TDN of grass that was assessed significant statistically only with intercropping of 67% with inoculated legumes (Figure 5 & 6). TDN decrease in legumes in the second year may be due to more hardiness of biomass or maturation as was also argued by Likhachev et al. (2003) who investigated the efficiency of grain forage production in legume companion crop. The legume (Lupin)

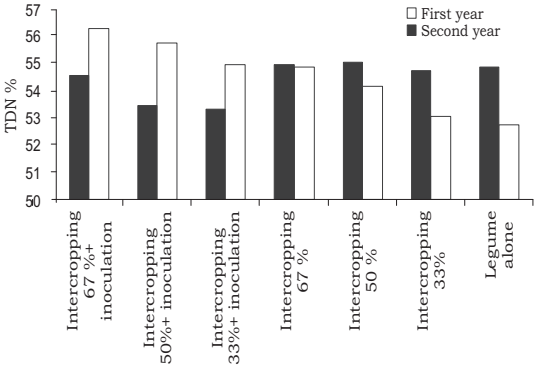

Figure 6. Year wise effect of intercropping (grass + legumes) on TDN of grass (n= 4 SD First year = 1.352 SD Second year = 0.945)

and wheat and oats mixture attained higher forage nutritive value in this study. Nutritive value is main factor of digestibility. Xiao-Yan et al. (2006) reported that inoculation of appropriate strain of Rhizobium improved nitrogen fixation of legume crops that ultimately increased the digestibility of livestock feed. Azim et al. (2000) observed that digestibility of NDF and hemicellulose declined non-linearly with increasing maturing stage. They also reported that legumes had higher digestibility than grasses, therefore corn + cowpeas silage DM increased TDN.

It is thus concluded that intercropping and inoculation technique improved quality of forages through a positive effect on quality parameters (CP and TDN). Inoculation of legume seeds had significant effect on the quality parameters of grass and forage legumes resulting in increase in CP and digestible nutrients.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

S. No	Author Name	Contribution to the paper
1.	Dr. Muhammad Arshad Ullah	Conceived the idea, write abstract, Introduction and Methodology, Did Statistical analysis, Results and Discussion.
2.	Dr. Nazir Hussain	Conceived the idea, Data entry in Statistical analysis
3.	Dr. Helge Schmeisky	Table, Figure and Statistical interpretation
4.	Dr. Muhammad Rasheed	Results and Discussion, References

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