Research Article

DIFFERENT SEED RATE OF FORAGE MAIZE WITH A FIXED STAND OF COWPEA AFFECTS PROXIMATE COMPOSITION OF BOTH SPECIES

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ABSTRACT

Mixed cultivation of fodder maize (*Zea mays*) and cowpea (*Vigna unguiculata*) is popular due to their fast-growing, high biomass yielding, high palatable, and mutualistic growing behavior. Evaluation of status of chemical composition of these mixed stands grown with different seed rates of maize, but with a fixed stand of cowpea would suggest the best period of forage harvesting and also the appropriate seed rate. Accordingly an experiment was done by following standard agronomic practices to grow maize-cowpea at Agriculture and Forestry University (AFU) Rampur, Nepal during May to September 2016. The experiment was done by using randomized complete block design (RCBD) consisting of 4 treatments, T_1 (40kg/ha maize seed), T_2 (50kg/ha maize seed), T_3 (30kg/ha maize seed) and T_4 (40kg/ha maize seed + weeding) along with 20 kg/ha of cowpea seed for each treatment, and 5 replications, under a similar rate of chemical fertilizer. Samples were tested for proximate analysis at Animal Nutrition laboratory of AFU. A highly significant result was obtained among different treatments for crude fibre, crude protein, and ash content while ether extract content was statistically similar among the treatments in both the harvests. Maximum ash (10.94%) and crude fibre (31.24%) content were obtained in T_1 on maize stem, and higher crude protein (CP) (28.09%) content was obtained in T_3 on cowpea that was similar with T_2 on cowpea for CP content at 45 days after sowing. At 75 days after sowing, higher crude fibre (CF) (35.87%) content was obtained for treatment T_4 on maize stem. Research results suggested that harvesting of maize is suitable at 45 days after sowing (DAS) if higher ash and crude fibre requirement for balanced feed is expected to meet by using 40 kg seed rate of maize/ha whereas harvesting of cowpea at 75 DAS would be more appropriate if highest crude protein content is expected to harvest, but it would be possible to attain at the cost of higher crude fiber content. Nevertheless results clearly indicated that inclusion of fodder cowpea as a legume component in a fodder stand, such as maize could be helpful for a persistent nutritive value during later stage of harvesting.

Key words: Harvesting, Intercropping, Maize-Cowpea, chemical composition

INTRODUCTION

The indigenous forages remain the primary feed stuff for ruminants as other forage crops are also being used as an important feed source in Nepal (Dhakal et al., 2019; Singh and Singh, 2019). In the case of commercial livestock rearing, their feed and nutrient plays a vital role in growth performance to make a farm profitable in economic concern. In recent decades, forages maize (*Zea mays* L.) mixed cropping with legumes is being an important source of forage/fodder for most of the ruminants in the regions. Maize is the third most important cereal crop in the world which is used as dual-purpose, in human diet, and animal feed (Romney et al., 2003; Klopfenstein et al., 2013). It has the potential to supply a large amount of energy-rich diet as forage/fodder and feed for animals with its safe feeding regime (Shiferaw et al., 2013). Forage maize inclusion in diets of dairy cow improves the intake of forage, increases animal production, and also reduces the cost of production so it has become a major constituent of ruminant rations in recent years (Anil et al., 2000; Cusicanqui & Lauer, 1999).

The cultivation of two or more crops simultaneously in the same field at a time is known as intercropping, or mixed cropping. Cereal-legume mixed cropping plays an important role, especially in the situations of limited water resources in subsistence food production in both developing and developed countries (Tsubo et al., 2005).The dry matter yield and crude protein yield of forages were found increased when intercropped with different legumes than that when compared with maize mono-culture (Javanmard et al., 2009).

In a mixed cropping of maize and cowpea, it was observed that more digestible dry matter and crude protein (CP) content was produced than in sole cropping of maize (Dahmardeh et al., 2009). Legumes fix atmospheric nitrogen, which may be utilized by the host plant, or may be excreted from the nodules into the soil, and can also be used by the companion crop in the same field (Willy, 1979). The fixed N is transferred to intercropped cereals during their growing period, and this N is an important source for the cereals (Shen & Chu, 2004). However, the changes in chemical composition in maize and cowpea in a mixed cropping, with respect to the quality concern of ruminant feeding is not much known. This study was done to analyze the proximate composition of maize and cowpea at two harvesting regimes in the tropical condition of inner terai Nepal when grown in a mixed cropping fashion.

MATERIAL AND METHODS

The mixed crop

An experiment was conducted at Agriculture and Forestry University, Rampur, Nepal during May to September 2016.The research design was set as Completely Randomized Block Design (RCBD); comprised of 4 treatments, each replicated five times.

The treatments were: T_1 (40kg/ha maize seed), T_2 (50kg/ha maize seed), T_3 (30kg/ha maize seed), and T_4 (40kg/ha maize seed + weeding) along with 20 kg/ha of cowpea mixed in all treatments.

An individual net plot size of 4×4 square meter was maintained. Standard agronomical practices were followed to manage maize-cowpea mixed crop. Broadcasting of maize and cowpea seeds was done, and three times hand weeding was done in weeding requiring treatment (T4), whereas others plots were left without weeding. All plots were fertilized with the same amount of fertilizer before sowing, containing 100 kg N ha-1, 60 kg P_2O_5 ha-1and 40 kg of K_2O ha-1; with half dose of N in basal and remaining at top dressing at 35 days after sowing (DAS). Maize and cowpea were manually harvested simultaneously from each plot in a total area of a one m2at two levels of maturity stages (at 45 DAS, and 75 DAS).

Determination of nutrient composition

Both the fodder/forage species were manually harvested and chopped into 3 to 4 cm in length, and kept in a separate envelope to take the respective sample. Samples were dried at 80 ˚C for 48 hrs and ground to pass through a 2 mm screen. The ground samples were subjected to proximate analysis in the laboratoryof AFU to determine crude protein, crude fibre, ether extract, and ash, or mineral content by following the AOAC guidelines (Chemist and Horwitz, 1990). The crude protein (CP) content was determined as N × 6.25, through the Kjeldahl Analyzing procedure. Ether extract (EE) was analyzed by a standard ether extraction method using Goldfish fat extraction method. The crude fibre was extracted with acid and alkali treatment in succession after removal of fat and water. Ash content was determined by keeping the sample in a crucible and by complete combustion in a furnace at 650^0 C.

Statistical analysis

All the collected data were analyzed by one-way analysis of variance (ANOVA, GenStat® Version15) whilst the means were compared by the Least Significant Difference (LSD) method at p=0.05.For the analysis of proximate parameters, the one way ANOVA model was used:

$$Y_{ijk} = \mu+\sigma_i+\epsilon_{ij} \text{..(eq.1)}.$$

Where,

Y_{ijk} = Output of individual observation for parameter
M = Over all mean for parameter Y
Σ = Fixed effect of the parameter
ϵ_{ij} = Residual error

RESULTS

Proximate composition at 45 DAS

Results of the proximate composition of intercropped maize and cowpea at 45 DAS are shown in Table (1). The different seed rate of intercropped forages was highly significant on ash content, CP and CF content ($p<0.001$). The ash content (10.94%) was highest for the treatment, 40 Kgha^{-1} seed rate of maize in maize stem, while minimum ash content was for the treatment with 30 Kgha^{-1} seed rate of maize (7.78%) in the maize stem. It was noticed that maximum CF content was obtained with treatment, 40 Kgha^{-1} seed rate of maize (31.24%) in maize stem which was highly significant ($p<0.001$) to the cowpea and maize leaf in treatment, 40 Kgha^{-1} seed rate of maize and 50 Kgha^{-1} seed rate of maize, and all samples in 30 Kg ha^{-1} seed rate of maize and 40 Kg ha^{-1} seed rate of maize + weeding treatment (Table 1).

Table 1. Effect of the different seed rate of maize in proximate content of a different proportion of maize plant and cowpea at 45 DAS, grown at AFU, Rampur, Nepal

Maize seed rate	SAMPLE	ASH	CF	CP	EE
T1(40 kgha^{-1})	Cowpea	9.78^{ab}	27.76^{b}	21.81^{b}	3.08
	Maize leaf	8.92^{bc}	28.1^{b}	13.29^{cde}	2.88
	Maize stem	10.94^{a}	31.24^{a}	12.07^{def}	1.68
Mean		9.88	29.09	15.72	2.55
T2 (50Kgha^{-1})	Cowpea	9.08^{abc}	28.07^{b}	20.55^{b}	2.98
	Maize leaf	8.36^{bc}	28.32^{b}	11^{ef}	2.96
	Maize stem	8.36^{bc}	30.55^{a}	10.31^{f}	1.56
Mean		8.6	28.98	13.95	2.5
T3 (30Kgha^{-1})	Cowpea	8.88^{bc}	23.56^{c}	28.09^{a}	2.98
	Maize leaf	8.3^{bc}	28^{b}	13.99^{cd}	2.92
	Maize stem	7.78^{c}	28.39^{b}	14.79^{c}	1.58
Mean		8.32	26.65	18.96	2.49
T4(40Kgha^{-1}+Weeding	Cowpea	9.28^{abc}	24.3^{c}	26.17^{a}	2.98
	Maize leaf	8.74^{bc}	28.22^{b}	13.63^{cd}	2.78
	Maize stem	9.77^{ab}	28.35^{b}	15.37^{c}	1.52
	Mean	9.26	26.96	18.39	2.43
Sem(±)		0.39	0.35	0.49	0.06
LSD(0.05)		1.121*	1.003**	1.398**	0.1696

Note: *= significant at p=0.05, **= highly significant at p=0.01, NS= no significant effect at p<0.05
Different superscripts in the same column indicated significant difference at p=0.05.
Sem= Standard error of mean.

The higher CP content was found in cowpea (28.09%) when grown with 30 Kgha^{-1} seed rate of maize (T3) which was, however, statistically similar (26.17%) with cowpea @ 40 kg maize/ha and once weeding(T4). CP content in cowpea with treatment 30 Kgha^{-1} seed rate of maize differ significantly with all samples of 40 Kgha^{-1} seed rate of maize and 50 Kgha^{-1} seed rate of maize, as well as the maize leaf, and maize stem of treatments 40 Kgha^{-1} seed rate of maize, and 50 Kgha^{-1} seed rate of maize. (Table 2).

Table 2. Effect of the different seed rate of maize in the proximate content of maize leaf and stem and whole cowpea at 75 DAS, grown at AFU, Rampur, Nepal

Maize seed rate	Sample	ASH	CF	CP	EE
40 Kgha^{-1}	Cowpea	9.5	31.89^{cd}	19.33^{a}	2.68
	Maize leaf	6.82	34.17^{abc}	9.34^{bc}	2.66
	Maize stem	8.86	34.84^{ab}	7.28^{d}	1.82
Mean		8.39	33.63	11.98	2.39
50 Kgha^{-1}	Cowpea	9.4	32.07^{cd}	20.93^{a}	2.8
	Maize leaf	7.28	31.17^{d}	8.75^{bcd}	2.7
	Maize stem	8.4	31.72^{d}	10.04^{b}	1.66
Mean		8.36	31.63	13.24	2.39
30 Kgha^{-1}	Cowpea	10.24	31.97^{cd}	19.62^{a}	2.72
	Maize leaf	7.16	31^{d}	10.6^{b}	2.76
	Maize stem	8.4	32.63^{bcd}	9.33^{bc}	1.54
Mean		8.6	31.87	13.18	2.34
40Kgha^{-1} +Weeding	Cowpea	10.2	30.77^{cd}	19.71^{a}	2.84
	Maize leaf	6.82	34.79^{ab}	9.77^{b}	2.9
	Maize stem	8.72	35.87^{a}	7.67^{cd}	1.57
	Mean	8.58	33.81	12.38	2.44
Sem(±)		0.36	0.50	0.40	0.12
LSD		1.031NS	1.417**	1.15**	0.3513NS

Note: *= significant at p=0.05, **= highly significant at p=0.01, NS= no significant effect at p<0.05.
Different superscripts in the same column indicated significant difference at p=0.05.
Sem= Standard error of mean.

Proximate composition of forage at 75 DAS

Table (2) represents the results of nutrient composition of intercropped/mixed cropped maize and cowpea forage at 75 DAS. The different seed rates of intercropped forages were statistically significant ($p<0.001$) for CP and CF content. The maximum CP content was obtained in cowpea with treatment, 50 Kg ha^{-1} seed rate of maize (20.93%), but it was statistically at par to the cowpea with 40 Kg ha^{-1} seed rate of maize treatment, 30 Kg ha^{-1} seed rate of maize treatment, and 40 Kg ha^{-1} seed rate of maize + weeding treatments (Table 2).. Likewise, maximum CF content was obtained in the treatment,40 Kg ha^{-1} seed rate of maize + weeding (35.87%) in maize stem which was highly significant ($p<0.001$) compared to the cowpea and maize leaf in the treatment sown with 50 Kg ha^{-1} seed rate of maize and 30 Kg ha^{-1} seed rate of maize (Table 2).

DISCUSSION

The ash content of maize stem, leaf and cowpea differed significantly at 45 DAS, but were non-significant ($p>0.05$) at 75 DAS. In a similar research, Azim et al., (1989) reported that there existed a variation in the mineral composition of different fractions of plant; the results were non-significant, and also the stage of maturity had a little effect on the mineral composition of maize. In this experiment, crop sown with 40 Kgha^{-1} seed rate of maize, while analyzing chemical constituent of maize stem had higher CF at 45 DAS while same seed rate but weeded treatment had maximum CF content, but at the later stage (75 DAS) The similar trend of CF accumulation in later stage of harvest in mixed forages had been repeatedly reported in the previous experiments e.g. in wheat-bean mixture (Ghanbari and Lee, 2003) and maize-cowpea mixture (Dangi et al., 2020) respectively.

The crude protein content of maize and cowpea (grown with varied seed rate of maize) differ significantly ($p<0.001$) with different treatments (refer tables here). Dawo et al. (2007), reported that CP content increased 22 % in the mixture of legume forage when seed rate of maize in the mixture decreased by 50 %. The results are in agreement with our studies where legumes also increased CP concentration when the seed rate of maize is lower i.e. at 30 Kgha^{-1}. Azim et al. (1989) reported that the crude protein content of maize reduced to about 30% at the age of two months whereas 66% reduction occurs at three months that is also supported by the findings of this study. Cusicanqui & Lauer (1999) reported that crude protein contents of forage maize decreased with increased plant density. The non-significant result was obtained in EE content in different samples with different seed rates of maize. Jiang-bo (2016) reported that non-significant difference ($p> 0.05$) was found in ether extract (EE) and Ash content among the treatments, and different times of harvest, which was similar to the findings of this research.

CONCLUSION

In maize-cowpea intercropping/mixed cropping, maize with lower seed rate (30 kg /ha) could provide higher CP content at earlier vegetative growth period but it declines with increasing days of maturity in the case of both maize and cowpea whereas CF content increases with maturity. Thus, the mixed forage cultivation of maize and cowpea could be harvested as per the requirements of CP and CF; either at earlier (45 DAS), or later stage (75 DAS), to meet the need of animal's balanced diet. The study also revealed the fact that the introduction of legume is, such as cowpea as a fodder with cereal fodder such as maize, could be a good strategy to promote the nutritive composition of forage maize, especially for the later stage of harvesting.

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REFERENCES

Anil, L., Park, J., and Phipps, R.H. (2000). The potential of forage-maize intercrops in ruminant nutrition. *Anim. Feed Sci. Technol. 86,* 157-164.

Azim, A., Naseer, Z., and Ali, A. (1989). Nutritional evaluation of maize fodder at two different vegetative stages. *Asian-Aust. J. Anim. Sci., 2 (1),* 27-34.

Chemists, A.A., and Horwitz, W. 1990. Official Methods of Analysis. Association of Analytical Chemists (15th Edn.). Vol. 1, AOAC, Arlington, VA., Pages: 489.

Cusicanqui, A., and Lauer, J.G. (1999). Plant density and hybrid influenced on corn forage yield and quality. *Agron. J., 91,* 911-915.

Dahmardeh, M., Ghanbari, A., Syasar, B., and Ramroudi, M. (2009). Effect of intercropping maize (*Zea mays*L.) with cow pea (Vigna unguiculata L.) on green forage yield and quality evaluation. *Asian J. Plant Sci., 8 (3),* 235.

Dangi, S., Barsila, S.R., Sapkota, B., Devkota, B., Devkota, N.R., and Ayaşan,T. (2020). Herbage Mass Productivity and Composition of Weeds in the Mixed Forage Maize-cowpea Field. *Asian J. Crop Sci., 12, 57-62.*

Dawo, M.L, Wikinson, J.M., Sanders, F.E.T., and Pilbeam, D.J. (2007). The yield and quality of fresh and ensiled plant material from intercropping maize (*Zea mays*) and beans (*Phaseolus vulgaris). J. Sci. Food Agric., 87,* 1391-1399.

Dhakal, B., Subedi,S., Khanal, B., and Devkota, N.R. (2019). Assessment of major feed resources and its utilization in Manaslu Conservation Area (MCA), Nepal. J. Agric. Forestry Uni., 3, 133-143.

Ghanbari Bonjar, A., and Lee, H.C. (2003). Intercropped wheat (*Triticum aestivum* L.) and bean (*Vicia faba* L.) as a whole□crop forage: effect of harvest time on forage yield and quality. Grass Forage Sci., 58, 28-36.

Javanmard, A., Nasab, A. D., Javanshir, A., Moghaddam, M., and Janmohammadi, H. (2009). Forage yield and quality in intercropping of maize with different legumes as double-cropped. *J. Food Agric. Environ*. *7(1),* 163-166.

Jiang-bo. H. (2016). Effect of intercropping maize with soybean on green forage yield, and quality evaluation. ISOR J. Agric. *Vet. Sci, .9,* 59-63.

Klopfenstein, T. J., Erickson, G. E., and Berger, L. L. (2013). Maize is a critically important source of food, feed, energy and forage in the USA. *Field Crops Res.*, *153*, 5-11.

Romney, D. L., Thorne, P., Lukuyu, B., and Thornton, P. K. (2003). Maize as food and feed in intensive smallholder systems: management options for improved integration in mixed farming systems of east and southern Africa. *Field Crops Res.*, *84*(1-2), 159-168.

Shen, Q.R., and Chu, G.X. (2004). Bi-directional nitrogen transfer in an intercropping system of peanut with rice cultivated in aerobic soil. *Biol. Fertil. Soils., 40,* 81-87.

Shiferaw, B., Prasanna, B. M., Hellin, J., and Bänziger, M. (2013). Crops that feed the world 6. Past successes and future challenges to the role played by maize in global food security. *Food Secur.*, *3*(3), 307.

Singh, S.B., and Singh, N. (2019). Nepal livestock feed balance and strategies to address the feed deficit. J. Agric. Forestry Uni., 3, 159-171.

Tsubo, M., Walker S., and Ogindo, H.O. (2005). A simulation model of cereal legume intercropping systems for semi-arid regions. Department of Soil, Crop and Climate Sciences, University of the Free State. *Field Crops Res*., *93(1).*

Willy, R. W. (1979). Intercropping-its importance and research needs. *Competition and yield advantages. Field Crop Abst.*, *32*, 1-10.