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EFFECT OF FODDER YIELD AND QUALITY ATTRIBUTES OF MAIZE (*ZEA MAYS* L.) + COWPEA (*VIGNA UNGUICULATA* L.) INTERCROPPING AND DIFFERENT NITROGEN LEVELS

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ABSTRACT

A field experiment was carried out at the demonstration block of Krishi Vigyan Kendra (Porba) under Phek district, Nagaland during the kharif season of 2011 and 2012. The treatments consisted of sole crops of maize and cowpea along with intercropping of maize with cowpea in 1:1, 2:1, and 3:1 row proportions. Altogether twenty treatments were arranged in randomized block design with three replications. Higher values of fresh forage yield and dry matter yield was recorded in sole treatments. Among the different row proportions, 1:1 row ratio recorded the highest total fresh forage yield (48.20 t/ha) and it was statistically at par with 2:1 row ratio (48.13 t/ha). In case of total dry matter yield, the highest (14.29 t/ha) was recorded in 2:1 row ratio followed by 1:1 (13.78 t/ha). Intercropping systems of maize + cowpea in 1:1 row ratio recorded higher crude protein, higher total ash content and higher IVDMD than sole in maize. For cowpea, crude protein and crude fibre content were higher in sole treatment while total ash content and IVDMD were higher in 1:1 row ratio. The quality parameters of both maize and cowpea recorded the highest where nitrogen was applied @ 120kg/ha than the other lower nitrogen doses. Among the different intercropping systems, the maximum cost of cultivation was recorded in 3:1 (` 25742.09) row ratio while the lowest was recorded in sole cowpea (` 24332.09). In the 1st year, the highest gross return (Rs. 63515.00), net return (` 39182.91) and B-C ratio (1.62) was found in sole cowpea closely followed by 1:1 ratio. Highest gross return, net return and B-C ratio was recorded in 1:1 row ratio in the 2nd year of investigation. Nitrogen level @120 kg/ha recorded the highest cost of cultivation. However the maximum B-C ratio was recorded in nitrogen application @40 kg/ha (1.42, 1.45) and it was almost similar with nitrogen application @120 kg/ha (1.40, 1.42) respectively in 1st and 2nd year of experimentation.

KEYWORDS: Maize, Cowpea, Intercrop, Quality Attributes

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Original Article

INTRODUCTION

Fodders as a group of crops differ from food and commercial crops as they are primarily grown for the fresh green vegetative biomass. Cereal forages such as maize, sorghum, oat, barley and millets give higher forage yield but are deficient in protein contents. Forage legumes such as soybean, cowpea, cluster bean etc. are rich sources of protein but their forage yield only half in comparison with cereal forages (Iqbal *et al*., 2015). Maize when grown as fodder, the crop gives huge quantities of green herbage in a short time. 59 per cent of total maize grain produced in the country is utilized in manufacture of concentrate feed for livestock (Raju, 2013). Although maize provides high yield in terms of dry matter, it produces forage with low protein content. Protein is also needed by rumen bacteria which digests much of the feed for ruminant animals (Ghanbari, 2000) which becomes

necessary to provide livestock with protein supplements when forage quality is low. Cowpea an annual legume with high level of protein can be mixed with maize to improve forage protein content in diets and thus cost of high quality forage production can be lowered (Eskandari and Ghanbari, 2009). In India it occupies 0.3 million hectare out of 0.65 million hectare area under different pulse and vegetable cowpea (Raju, 2013).

The concept of intercropping is to get increased total productivity per unit area and time besides equitable and judicious utilization of land resources and farming inputs (Marer *et al*., 2007). Intercropping legumes contribute to increased productivity of other crops when incorporated into cropping systems as intercrops (Giller and Wilson, 1991). Maize-legume intercropping is currently receiving global attention because of its prime importance in world agriculture.

According to Iqbal *et al.* (2014) plant nutrition has a significant effect on forage maize yield, particularly nitrogen supplied either through inorganic or organic means. The requirement of fodder crops for nutrients particularly nitrogen is comparatively higher. This is due to the fact that fodder crops are grown to produce luxuriant and succulent vegetative growth in a short period (Agrawal *et al*., 2008).

MATERIALS AND METHODS

A field experiment was conducted at the demonstration block at Krishi Vigyan Kendra, Phek district, Porba, Nagaland., *kharif* season of 2011 and 2012 to study the effect of fodder quality of maize (*Zea mays* L.) + cowpea (*Vigna unguiculata* L.) intercropping and different nitrogen levels. The experimental plot lies in sub alpine temperate zone and is situated at an elevation of 1842 metres above mean sea level with the geographical location at 25^{o}62´ North latitude and 95 ^{o} 33´ East longitude. The soil of the experimental field was clayey loam and well drained, acidic (pH > 5.0), with low available N. P and K and medium organic carbon. The experiment was laid out in randomized block design replicated three times with five cropping systems and four N levels. The treatment consisted of C_1- sole maize, C_2- sole cowpea, C_3-maize + cowpea (1:1), C_4- maize + cowpea (2:1), C_5- maize + cowpea (3:1) N_1- 0 N, N_2 – 40 N, N_3- 80 N, N_4 – 120 N kg per hectare. Uniform recommended dose of 40 kg P_2O_5 and 20 kg K_2O per hectare was applied as basal application in all plots after sowing. Nitrogen was applied in two split doses, first dose was applied as basal and remaining half of N was applied after 30 days after sowing (DAS) as per treatment. The mean temperature ranged from 9°C to 31°C during summer and rarely goes below 8°C in winter due to high atmospheric pressure. The rainfall from March to August ranged between 1641 and 836 mm in two years of study.

Maize (cv. Vijay Composite) at seed rate of 50 kg/ha and cowpea (cv. UPC- 1956) at seed rate of 20 kg/ha were sown on 8th April 2011 and 9th April 2012. The plant to plant and row to row spacing for both maize and cowpea was 30 cm x 10 cm respectively. All the plots were given uniform intercultural operations during the entire growth period in both years of study. The crops were harvested for fodder purpose on 17th June 2011 and 20th June 2012. Uniform recommended dose of 40 kg P_2O_5 and 20 kg K_2O per hectare was applied as basal application in all plots after sowing. Nitrogen was applied in two split doses, first dose was applied as basal and remaining half of N was applied after 30 days after sowing (DAS) as per treatment.

RESULTS AND DISCUSSIONS

Total Fresh Forage Yield (t/ha)

Table 1 depicts the total fresh forage and total dry matter yield respectively of the maize and cowpea taken under study. The highest total fresh forage yield in 2011 (49.20 t/ha) was observed in C_4 row ratio followed by C_3 row ratio in

2012 (45.31 t/ha). In 2012, C_3 row ratio produced significantly highest total fresh forage yield (51.09 t/ha). The total fresh forage yield of cowpea did not reach the level of significance. The findings carried by Iqbal *et al*., 2012 revealed that the highest green forage yield of 12.22 t/ha and dry matter yield of 2.039 t/ ha were recorded for cowpea sown in alternate rows with forage maize.

From the data it was evident that the various nitrogen levels showed significant differences in the total fresh forage yield and total dry matter yield of the intercrops in both years of study.

Total Dry Matter Yield (t/ha)

The total dry matter yield of crops was found to be significantly highest (14.94 t/ha) with C_4 row ratio as compared to other cropping systems under study in 2011, while in 2012, C_3 row ratio was observed to produce greater dry matter content (14.07 t/ha) although non-significant with other treatments. A perusal of the data in Table 1 shows that the different nitrogen levels significantly influenced the total fresh and dry matter content of forage crops under study. Adeleke and Haruna (2012) mentioned that pulses are usually intercropped with cereals which enhance land productivity over soil amelioration. Similarly, Safari *et al*. (2014) also reported that dry matter content and forage yield of corn increased with increase in the amount of N application and the highest dry matter content and forage yield was obtained in 150 and 225 kg/ha nitrogen application which was in line with the results obtained in the present investigation.

Crude Protein (%)

Table 2 represents the significant effect of different cropping systems and N levels on per cent crude protein content of maize. In maize, among the cropping systems under study, the highest per cent crude protein content of 12.55, 12.76 and 12.66 % during 2011, 2012 and pool respectively was obtained from C_3 (1:1) and it was statistically superior than all other treatments. The crude protein content of maize may have improved by intercropping with legumes due to availability of more nitrogen fixed by the legumes. This is supported by the findings of Amasaib *et al.* (2012) who found that the crude protein content of *Zea mays* in mixture (22.2 %) with legume was significantly higher than crude protein of *Zea mays* in pure stand (15.7 %). The maximum crude protein was recorded with N_4 treatment in 2011, 2012 and pooled with 12.39, 12.78 and 12.59 % respectively. It may also be attributed that a large proportion of nitrogen was available to non legumes in the mixtures when compared to pure stands. Bhillare (2007) opined that more crude protein content at higher nitrogen levels was because of more uptake of nitrogen which is a constituent of protein, amino acids and amides.

The highest per cent crude protein in cowpea cropping system was obtained from sole cowpea (C_2) compared to different row proportions in both the years and their pooled (17.21, 18.13 and 17.68 % respectively) (Table 3). Muhammad *et al*. (2006) and Sebetha *et al*. (2010) reported that cowpea in sole plots had higher crude protein content than in the intercropped plots. In 2011, 2012 and pooled, among the different nitrogen levels the maximum per cent crude protein content was obtained from N_4 treatments (16.90, 17.78 and 17.34 % respectively) and it was at par with N_3 (16.81, 17.63 and 17.18 % respectively).

Crude Fibre (%)

Different cropping systems showed significant variation on the per cent crude fibre content of maize during 2011 and pool of two years (Table 2). In both these observations, the sole crop of maize (24.67 and 24.18 % respectively) recorded significantly higher value than any of the intercropping treatments. Higher crude fibre percentage in sole maize could be attributed to less availability of nitrogen as compared to maize sown in mixture with legumes. Crude fibre content

in different row ratios were all statistically at par with each other and crude fibre decreased with decrease in the proportion of cowpea in the cropping systems. Similar observations have been made by Ibrahim *et al*. (2006) for maize – cowpea mixtures. Reza *et al*. (2012) from their study also observed the highest amount of crude fibre in pure stand of forage sorghum with 41.22 per cent and the lowest in the proportion of 25 per cent Sorghum: 75 per cent Limabean with 35.77 per cent. Differing to the effect of nitrogen on crude protein, the increase in levels of nitrogen lowered the crude fibre content. Significantly higher crude fibre content was recorded in treatment where nitrogen was not applied (N_1) and the lowest was in treatment where nitrogen was applied @ 120 kg/ha (N_4) in the analysis of two years data. Nitrogen application increased the protein synthesis and decreased pectin, cellulose and hemicellulose contents, which are major constituents of crude fibre (Tiwana *et al.*, 2003)

Data on the per cent crude fibre content of cowpea (Table 3) revealed that different cropping systems showed significant difference among themselves in the per cent crude fibre content of cowpea in 2011, 2012 and pooled data. Sole cowpea - C_2 (22.79, 22.73 and 22.76 %) recorded the highest per cent crude fibre followed by C_3 (22.14, 22.09 and 22.12 %).

For cowpea also the effect of different levels of nitrogen did not show any significant on crude fibre content during 2011 and 2012; however their pooled analysis was found to be significant.

Total ash Content (%)

Increase in total ash content was observed in the different intercropping systems as compared to its sole treatment only during 2012 and pool of two years data. Such increase by growing maize in mixture with legumes has been reported by Ibrahim *et al.* (2006). Further, maize in 1:1 row ratio (C_3) recorded the highest value, followed by 3:1 (C_4) and sole (C_1) row ratio which might be due to the increase in seed rate or proportion of legume in C_3 row ratio as compared to other cropping systems. The different nitrogen levels affected per cent total ash content significantly in both years of study and in the pooled data. There was progressive increase in the per cent total ash content with increase in the N levels.

The different cropping systems significantly influenced the per cent total ash content in forage in both years of study and the pooled data. The maximum total ash was obtained in sole crop of cowpea (C_2) in both the years. A close scrutiny of the data shows that the various nitrogen treatments significantly influenced per cent total ash content in cowpea. There was progressive increase in per cent ash content in with increase in nitrogen levels where N_4 treatment recorded 8.88, 8.68 and 8.78 per cent in 2011, 2012 and pooled data respectively.

IVDMD (*in vitro* Dry Matter Digestibility) (%)

The effect of different cropping system on maize *in vitro* dry matter digestibility did not show any significant variations due to cropping systems. However, in general, the highest IVDMD was recorded in C_3 row ratio with 64.14 and 64.00 per cent in 2011 and 2012 respectively. The positive effect of intercropping on dry matter digestibility was observed among the cropping systems. The highest IVDMD was recorded in C_3 row ratio followed by C_4 (2:1) and C_5 (3:1) treatment and the lowest in C_1 (sole). These results could be attributed to higher protein concentration for *Zea mays* when sown in mixtures with cowpea. The present findings were in line with Javanmard *et al.* (2009) who reported that intercropping of legumes with *Zea mays* significantly increased digestibility of the forages. The different levels of nitrogen treatment did not show any significant differences among the N treatments on the IVDMD. In general, N_4 recorded the maximum IVDMD with 63.92 and 64.25 per cent in 2011 and 2012 respectively. The IVDMD values were also observed to increase

with increase in nitrogen rate. Such an increase in IVDMD values with the addition of nitrogen might be due to cumulative effect of increase in crude protein content, ash content and decrease in crude fibre. Similar results was reported by Kalra and Sharma (2015) in maize IVDMD where the values increased with increased addition of nitrogen from 0 to 120 kg/ha.

In cowpea the maximum IVDMD (62.63 per cent and 62.18 per cent) was obtained in C_3 in both the years. In general, higher IVDMD values were associated with mixtures of maize and cowpea than that of sole. Verma *et al*. (1997) and Pal *et al.* (2014) opined that the digestible dry matter yield of cowpea was recorded significantly highest under sorghum + cowpea (100%) followed by sole cowpea. The different nitrogen treatments showed significant variations only in 2011 and pooled data. N_4 treatment recorded the highest IVDMD (63.33 per cent) which was significantly highest over all the other treatments. In the second year N_4 treatment showed 61.72 per cent content of IVDMD and pooled analysis was found to contain 62.52 per cent in cowpea. These findings were in line with earlier studies of Sindhu *et al*. (2006) who reported that application of nitrogen levels significantly affected the IVDMD per cent of fodder maize and the increase in IVDMD content might be due to increase in leaf: stem ratio, LAI, etc. as the leaves contained more protein and soluble carbohydrates than stem and increase in nitrogen application increased the IVDMD over control.

CONCLUSIONS

It may be concluded that the planting geometry of 1:1 row cropping of maize and legume (cowpea) was found suitable for higher yield and also producing better quality forage crops. The highest dose of nitrogen (120 kg/ha) under the present study gave better results in terms of higher forage production and with better quality. There is need for more studies on the nutrient requirement for specific forage crops in order to suggest a recommendation. However, from the present investigation, 120 kg N may be applied in the intercropping system for higher yield of forage crops.

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APPENDICES

Table 1: Effect of Different Cropping System and N Levels on Total Fresh Forage Yield and Total Dry Matter Yield (t/ha)

Treatments	Total Fresh Forage Yield (t/ha)			Total Dry Matter Yield (t/ha)		
	2011	2012	Pooled	2011	2012	Pooled
Cropping System (C)						
C_1 + C_2	44.35	44.68	44.51	12.46	12.83	12.65
C_3: Maize + cowpea (1:1)	45.31	51.09	48.20	13.46	14.07	13.78
C_4: Maize + cowpea (2:1)	49.20	47.06	48.13	14.94	13.64	14.29
C_5: Maize + cowpea (3:1)	44.02	42.91	43.46	13.56	13.21	13.39
SEm±	1.46	1.40	1.12	0.42	0.43	0.31
CD (P=0.05)	NS	4.04	3.23	1.21	NS	0.90
Nitrogen Levels (N-kg/ha)						
N_1: 0	34.13	34.56	34.35	10.00	9.61	9.81
N_2: 40	46.05	46.51	46.28	13.90	12.95	13.42
N_3: 80	48.36	49.91	49.94	14.45	15.18	14.82
N_4: 120	54.33	54.75	54.54	16.11	16.01	16.07
SEm±	1.46	1.40	1.12	0.42	0.43	0.31
CD (P=0.05)	4.22	4.04	3.23	1.21	1.24	0.90
C x N						
SEm±	2.92	2.80	2.24	0.83	0.86	0.63
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Table 2: Effect of Different Cropping System and N Levels on Percent Crude Protein, Crude Fibre, Total ash and IVDMD Content of Maize

Treatments	Crude Protein (%)			Crude Fibre (%)			Total ash (%)			IVDMD (%)		
	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled
Cropping System (C)												
C_1: Sole maize	10.36	10.95	10.66	24.67	23.69	24.18	7.18	7.33	7.26	62.99	63.58	63.29
C_2: Sole cowpea	--	--	--	--	--	--	--	--	--	--	--	--
C_3: Maize + cowpea (1:1)	12.55	12.76	12.66	22.62	21.18	21.90	7.56	7.78	7.67	64.14	64.00	64.07
C_4: Maize + cowpea (2:1)	11.51	11.57	11.54	21.53	20.66	21.09	7.32	7.58	7.45	63.64	63.75	63.69
C_5: Maize + cowpea (3:1)	11.12	11.26	11.19	21.35	19.81	20.58	7.30	7.45	7.38	63.62	63.90	63.76
SEm±	0.34	0.34	0.25	0.65	1.36	0.69	0.10	0.08	0.06	0.38	0.35	0.25
CD (P=0.05)	0.98	0.99	0.72	1.87	NS	1.99	NS	0.22	0.18	NS	NS	NS
Nitrogen Levels (N-kg/ha)												
N_1: 0	10.60	9.97	10.29	24.14	24.41	24.28	7.14	7.16	7.15	62.98	63.55	63.27
N_2: 40	11.19	11.47	11.33	22.31	21.69	22.00	7.21	7.38	7.30	63.69	63.62	63.65
N_3: 80	11.38	12.30	11.84	21.90	20.05	20.98	7.36	7.68	7.52	63.80	63.82	63.81
N_4: 120	12.39	12.78	12.59	21.81	19.21	20.51	7.65	7.92	7.79	63.92	64.25	64.08
SEm±	0.34	0.34	0.25	0.65	1.36	0.69	0.10	0.08	0.06	0.38	0.35	0.25
CD (P=0.05)	0.98	0.99	0.72	NS	NS	1.99	0.28	0.22	0.18	NS	NS	NS
C x N												
SEm±	0.68	0.69	0.50	1.30	2.73	1.38	0.19	0.15	0.12	0.76	0.70	0.49
CD (P=0.05)	1.96	1.99	1.44	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Effect of Different Cropping System and N Levels on Percent Crude Protein, Crude Fibre, Total ash and IVDMD Content of Cowpea

Treatments	Crude Protein (%)			Crude Fibre (%)			Total ash (%)			IVDMD (%)		
	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled
Cropping system (C)												
C_1: Sole maize	--	--	--	--	--	--	--	--	--	--	--	--
C_2: Sole cowpea	17.21	18.13	17.68	22.79	22.73	22.76	9.04	8.88	8.96	61.41	60.28	60.85
C_3: Maize + cowpea (1:1)	16.80	17.71	17.26	22.14	22.09	22.12	8.63	8.40	8.51	62.63	62.18	62.41
C_4: Maize + cowpea (2:1)	16.40	17.32	16.86	20.41	20.49	20.45	8.49	8.24	8.37	62.28	61.35	61.82
C_5: Maize + cowpea (3:1)	16.15	16.98	16.57	20.17	20.16	20.17	8.18	7.98	8.08	62.33	61.28	61.81
SEm±	0.08	0.10	0.07	0.07	0.11	0.05	0.06	0.05	0.04	0.33	0.48	0.30
CD (P=0.05)	0.24	0.29	0.19	0.21	0.31	0.16	0.18	0.15	0.12	NS	NS	NS
Nitrogen levels (N-kg/ha)												
N_1: 0	16.32	17.24	16.86	21.48	21.50	21.49	8.28	8.11	8.20	60.99	60.93	60.96
N_2: 40	16.61	17.48	16.98	21.44	21.41	21.43	8.50	8.27	8.38	61.53	61.22	61.37
N_3: 80	16.81	17.63	17.18	21.38	21.31	21.35	8.68	8.44	8.56	62.80	61.23	61.55
N_4: 120	16.90	17.78	17.34	21.21	21.25	21.23	8.88	8.68	8.78	63.33	61.72	62.52
SEm±	0.08	0.10	0.07	0.07	0.11	0.05	0.06	0.05	0.04	0.33	0.48	0.30
CD (P=0.05)	0.24	0.29	0.19	NS	NS	0.16	0.18	0.15	0.12	0.96	NS	0.87
C x N												
SEm±	0.17	0.20	0.13	0.15	0.21	0.11	0.12	0.10	0.08	0.66	0.96	0.60
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS