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Original Research Article

Studies on Integrated Nutrient Supply and Intercropping on Quality of Winter Fodder Maize + Legumes in Inceptisols

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A B S T R A C T

A field experiment was condcuted during the winter seasons of 2008 -09 and 2009-10 at Raipur Chhattishgrah, to find out the effect of integrated nutrient supply and legumes intercropping on quality of fodder Maize + legumes in inceptisols. The results of experiment revealed that significantly maximum crude protein content in maize alone *viz*., 6.92% and 7.01% crude protein content in legume intercrop *viz*., 18.90% and 19.33% and total crude protein content in maize + legumes *viz*., 25.82% and 26.34% during first and second year, respectively were recorded from maize + lucerne, 1:1 intercropping, (I_4) over other treatments but in case of crude protein content in maize alone, it was found comparable with maize + cowpea 1:1, (I_2) and maize + berseem 1:1, (I_3) during both the years similarly the intercropping of maize + lucerne 1:1, (I_4) also recorded significantly maximum crude protein yield of maize alone *viz*., 6.21 and 6.51 q $ha^{-1,}$ crude protein yield of legume intercrop *viz*., 7.57 and 8.15 q ha^{-1} and total crude protein yield of maize + legumes *viz*., 13.78 and 14.67 q ha^{-1} during first year and second year, respectively which was significantly higher over rest of the treatments, but in case of crude protein yield of maize alone it was found at par with maize + berseem 1:1, (I_3). The trend was similar during both the year of investigations. Application of 50% RFD + 10 tonnes FYM + $ZnSO_4$, (N_4), observed significantly maximum value of crude protein content in maize alone *viz*., 7.11% and 7.18%, crude protein content of legume intercrop *viz*., 11.87% and 12.22% and total crude protein content in maize + legumes *viz*., 18.98% and 19.40% during first year and second year, respectively. but it was found comparable with treatment N_1, N_2, N_3 and N_5 in case of maize alone, and N_2 and N_5 in case of legume intercrops and maize + legumes during both the years of experimentation similarly significantly, higher crude protein yield of maize alone *viz*., 6.87 and 7.12q ha^{-1}, crude protein yield of legume intercrop *viz*., 4.81 and 5.22 q ha^{-1} and total crude protein yield of maize + legumes *viz*., 11.68 and 12.34 q ha^{-1} during first and second year, respectively were recorded when crop was fertilized with 50% RFD + 10 tonnes FYM + $ZnSO_4$, (N_4) over rest of the treatments, however, it was found comparable with application of 50% RFD + 10 tonnes MSC + $ZnSO_4$, (N_5) in both the years of experiment.

Keywords

Integrated nutrient supply, winter fodder Maize + legume intercropping, crude protein content and crude protein yield

Introduction

Livestock is an integral part of Indian Agriculture and plays a vital role in rural economy. India has a huge livestock population however the production of milk and other livestock products are lowest in the world because there is huge gap between demand and supply as well as poor quality of all kinds of feed and fodders. Intercropping of forage cereals and legumes appears to be technically feasible and

economically viable approaches to increase quality herbage yield, utilization of land more efficiently and providing stability of production (Tripathi, 1989) as well as combined use of inorganic fertilizers and organic manures supplied sufficient plant nutrients to the forage maize + legumes crops during the entire crop growth period increases the availability of macro and micro nutrients, which is not only provide the higher yield but also improves fodder quality because of increasing the nitrogen uptake resulted in higher nitrogen and protein content in plant as well as higher crude protein yield due to increase in dry matter yield under this fertility and physical condition of soil. Therefore, the present experiment was conducted to study on "effect of integrated nutrient supply and legumes intercropping on quality of winter fodder Maize + legumes in inceptisols".

Materials and Methods

The field experiment was carried out at Instructional farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, during rabi season 2008-09 and 2009-10. The soil of the experimental field was sandy clay loam in texture, locally known as *Inceptisols*. The soil was neutral in reaction and had low nitrogen, low phosphorus and high potassium contents. Experiment was laid out in Split Plot Design with 3 replications. There were two factor, factor A is intercropping had 4 levels *viz*., I_1 - sole maize, I_2 - maize + cowpea (1:1), I_3 - maize + berseem (1:1), I_4 and maize + lucerne 1:1 assigned in main plot. Factor B had 5 level of integrated nutrient supply *viz.*, N_0 - Control, N_1 – RFD, N_2 - 50% RFD + 10 tonnes FYM, N_3 - 50% RFD + 10 tonnes MSC, N_4 - 50% RFD + 10 tonnes FYM + $ZnSO_4$, N_5 - 50% RFD + 10 tonnes MSC + $ZnSO_4$ kept in sub plot. Crop was sown on 5th December and 6th December during 2008-09 and 2009-10 respectively at row spacing of 40 cm in case of sole maize and one row of legumes were introduced in between two rows of maize in case of maize + legumes intercropping. The organic manures were applied as per treatments in the experimental plots before sowing. The recommended dose of nutrients for fodder maize was 100, 60 and 40 kg of NPK ha^{-1}. The nitrogen, phosphorus and potash were applied in the form of urea (46%), Single super phosphate (16% P_2O_5) and murate of potash (60% K_2O).The nutrients dose applied as per treatments through commercial fertilizers. The full dose of phosphorus and potash and 1/3rd dose of the nitrogen was applied as basal. Remaining 1/3rd nitrogen was applied as top dressing after 20 & 45 days of sowing. In case of legumes the recommended dose of nutrients was 20:50:20 kg of NPK ha^{-1} and the entire amount of nutrients were applied as basal dose through commercial fertilizers as per treatments. Crops were raised adopting their recommended package of practices. Crops were harvested after 65 days manually with a sickle.

Results and Discussion

Crude protein content (%)

Effect of different treatments on crude protein content of maize and total crude protein content of maize + legumes intercropping are presented in Table-1. In general, crude protein content of maize alone, crude protein content of legume intercrops and total crude protein content of maize + legumes were higher in second year as compared to first year. Significantly maximum crude protein content in maize alone *viz*., 6.92% and 7.01% crude protein content in legume intercrop *viz*., 18.90% and 19.33% and total crude protein content in maize + legumes *viz*., 25.82% and 26.34%

during first and second year, respectively were recorded from maize + lucerne, 1:1 intercropping, (I_4) over other treatments but in case of crude protein content in maize alone, it was found comparable with maize + cowpea 1:1, (I_2) and maize + berseem 1:1, (I_3) during both the years. It is quite clear from the Table-1 that crude protein content was also significantly influenced by different integrated nutrient supply combination. Application of 50% RFD + 10 tonnes FYM + $ZnSO_4$, (N_4), observed significantly maximum value of crude protein content in maize alone *viz*., 7.11% and 7.18%, crude protein content of legume intercrop *viz*., 11.87% and 12.22% and total crude protein content in maize + legumes *viz*., 18.98% and 19.40% during first year and second year, respectively were recorded with 50% RFD + 10 tonnes FYM + $ZnSO_4$, (N_4) as compared to other treatments, but it was found comparable with treatment N_1, N_2, N_3 and N_5 in case of maize alone, and N_2, and N_5 in case of legume intercrops and maize + legumes during both the years of experiment.

Crude protein yield (q ha^{-1})

The data recorded on crude protein yield of maize and total crude protein yield of maize + legumes as affected by various treatments are presented in Table-2. Statistical analysis of crude protein yield during both the years reveals that intercropping had a significantly effect on crude protein yield of maize alone, crude protein yield of legume intercrop and total crude protein yield of maize + legumes. The intercropping of maize + lucerne 1:1, (I_4) recorded significantly maximum crude protein yield of maize alone *viz*., 6.21 and 6.51 q ha$^{-1,}$ crude protein yield of legume intercrop *viz*., 7.57 and 8.15 q ha^{-1} and total crude protein yield of maize + legumes *viz*., 13.78 and 14.67 q ha^{-1} during first year and second year, respectively which was significantly higher over rest of the treatments, but in case of crude protein yield of maize alone it was found at par with maize + berseem 1:1, (I_3). The trend was similar during both the year of investigations.

It is evident from the data that an integrated nutrient supply effectively alter the crude protein yield of maize alone, crude protein yield of legume intercrop and total crude protein yield of maize + legumes. Significantly, higher crude protein yield of maize alone *viz*., 6.87 and 7.12q ha^{-1}, crude protein yield of legume intercrop *viz*., 4.81 and 4.87 q ha^{-1} and total crude protein yield of maize + legumes *viz*., 11.68 and 12.34 q ha^{-1} during first and second year, respectively were recorded when crop was fertilized with 50% RFD + 10 tonnes FYM + $ZnSO_4$, (N_4) over rest of the treatments, however, it was found comparable with application of 50% RFD + 10 tonnes MSC + $ZnSO_4$, (N_5) in both the years of experiment. The lower crude protein yield of maize alone *viz*., 2.80, and 3.06, crude protein yield of legume intercrop *viz*., 2.44, and 2.87 and total crude protein yield of maize + legumes *viz*., 5.24 and 5.93 q ha^{-1} were observed under control (N_0) during both the years.

Effect of legumes intercropping on fodder quality

Crude protein content (%)

A perusal of mean value of Table-1 indicated that the significantly higher protein content (%) was recorded under maize + legumes intercropping as compare to sole maize. The increased protein content (%) in maize plant might be attributed due to the contineous supply of nitrogen in increased quantity under legumes intercropping.

Table.1 Crude protein content in winter fodder maize + legume intercropping as influenced by intercropping and Integrated nutrient supply

Treatment	Crude Protein Content (%)					
	2008			2009		
	Maize	Intercrop	Total	Maize	Intercrop	Total
Intercropping						
I_1 - Maize Sole	6.29	-	6.29	6.49	-	6.49
I_2 - Maize + Cowpea (1:1)	6.70	11.52	18.22	6.81	12.03	18.84
I_3 - Maize + Berseem (1:1)	6.77	14.58	21.35	6.89	15.01	21.90
I_4 - Maize + Lucern (1:1)	6.92	18.90	25.82	7.01	19.33	26.34
SEm	**0.10**	**0.12**	**0.22**	**0.05**	**0.16**	**0.21**
CD (P=0.05)	**0.37**	**0.45**	**0.82**	**0.20**	**0.53**	**0.73**
Integrated Nutrient Supply (kg NPK ha^{-1})						
N_1 - Control	5.42	10.27	15.69	5.72	10.59	16.31
N_2 - RFD	6.91	11.02	17.93	7.01	11.40	18.41
N_3 - 50% RFD + 10 tonnes FYM	6.68	11.43	18.00	6.92	11.78	18.90
I_4 - 50% RFD + 10 tonnes MSC	6.69	11.31	18.06	6.86	11.61	18.46
I_5 - 50% RFD + 10 tonnes FYM + $Znso_4$	7.11	11.87	18.98	7.18	12.22	19.40
I_6 - 50% RFD + 10 tonnes MSC + $Znso_4$	6.98	11.59	18.57	7.09	11.94	19.03
SEm	**0.14**	**0.17**	**0.31**	**0.13**	**0.17**	**0.30**
CD (P=0.05)	**0.42**	**0.49**	**0.91**	**0.39**	**0.48**	**0.87**

Table.2 Crude protein yield of winter fodder maize + legume intercropping as influenced by intercropping and integrated nutrient supply

Treatment	Crude Protein Yield (q/ha)					
	2008			2009		
	Maize	Intercrop	Total	Maize	Intercrop	Total
Intercropping						
I_1 - Maize Sole	5.15	-	5.15	5.52	-	5.52
I_2 - Maize + Cowpea (1:1)	5.74	2.47	8.20	5.95	3.03	8.99
I_3 - Maize + Berseem (1:1)	6.00	5.99	11.98	6.21	6.34	12.55
I_4 - Maize + Lucern (1:1)	6.21	7.57	13.78	6.51	8.15	14.67
SEm	**0.12**	**0.10**	**0.22**	**0.18**	**0.20**	**0.39**
CD (P=0.05)	**0.39**	**0.38**	**0.78**	**0.62**	**0.72**	**1.34**
Integrated Nutrient Supply (kg NPK ha^{-1})						
N_1 - Control	2.80	2.44	5.24	3.06	2.87	5.93
N_2 - RFD	6.16	3.90	10.06	6.42	4.21	10.63
N_3 - 50% RFD + 10 tonnes FYM	6.18	4.31	10.49	6.45	4.69	11.15
I_4 - 50% RFD + 10 tonnes MSC	6.04	4.10	10.14	6.34	4.46	10.81
I_5 - 50% RFD + 10 tonnes FYM + $Znso_4$	6.87	4.81	11.68	7.12	5.22	12.34
I_6 - 50% RFD + 10 tonnes MSC + $Znso_4$	6.61	4.45	11.06	6.90	4.87	11.78
SEm	**0.19**	**0.14**	**0.34**	**0.17**	**0.18**	**0.35**
CD (P=0.05)	**0.56**	**0.42**	**0.97**	**0.48**	**0.52**	**1.00**

The contineous supply of nitrogen in increasing amount increased the N uptake and thereby increased the total nitrogen and protein content (%) in the plants. The increase in protein content with increasing levels of N was also reported by several workers Krishna *et al.,* (1998), Gangwar and Kalra (1988) and Tomar (1976). Since N is an important constituent of plant protein which play an important role in protein synthesis. Intercropping of legumes with maize resulted quality forage production might be due to contineous supply of nitrogen in more quantity to maize, induced by complementary interaction between maize and legumes in intercropping for N consumption reported by Eskandari *et al.,* (2003).

Among the legume intercrops significantly higher crude protein content (%) in lucerne was recorded as compared to other intercrops in maize + lucerne (1:1) intercropping system. This might be due to large quantity of nitrogen added in soil by lucerne through symbiotic nitrogen fixation reported by Sharma (2002), which resulted in higher uptake and accumulation of N increased higher crude protein content in lucerne.

Significantly higher total crude protein content (%) of maize + lucerne was recorded under maize with lucerne (1:1) followed by maize + berseem (1:1) as compare to others. Increase in the quantity and contineous availability and uptake of nitrogen due to augmentation of higher N fixation resulted increased protein content (%) under these treatments. Similarly, higher crude protein content from mixture of non-legume and legume have been also reported by Reddy *et al.,* (1986). Higher crude protein might be due to inclusion of cowpea as mixed crop or intercrop. Similar results were also reported by Rao *et al.,* (1976) and Tiwari *et al.,* (1978). Toniolo *et al.,* (1987) they too reported significantly higher crude protein content (%) of maize-soybean intercropping than that of monocropped maize. Forage quality of maize was higher in intercrops as compared to sole crop reported by Eskandari *et al.,* (2003). Dahmardeh *et al.,* (2009) also concluded that intercropping of maize and cowpea resulted in more digestible dry matter and also crude protein content (%) than maize sole cropping.

Crude protein yield (q ha^{-1})

A perusal of mean value from the Table-2 indicated that the results of crude protein yield follow the similar trend to that of protein content (%) and dry matter yield. Fodder maize gown with legumes as intercropping significantly increased the protein yield over sole maize. This might be due to more supply of nitrogen and N uptake by biological N fixation through legume crops. Sudhakar *et al.,* (1996) also reported the pronounced effect of intercropping of forage legumes with cereals on crude protein yield. Javanmard *et al.,* (2009), worked on intercropping of maize with different legumes indicated that crude protein yield of forage were increased by all intercropping compositions as compared with the monoculture.

Among the legume intercrops significantly higher crude protein yield of lucerne was recorded as compared to other intercrops in maize + lucerne (1:1) intercropping system. This might be due to N fixation capacity of lucerne is high as compared to other intercrops reported by (Sharma, 2002) resulting higher availability and uptake of N ultimately produced higher crude protein yield.

Among the intercropping combinations, maize + lucerne (1:1) recorded significantly

higher total crude protein yield of maize + legumes as compare to other treatments. This might be attributed due to higher availability and uptake of N, because lucerne have capacity to fix more N as compared to other legumes, resulted in higher total crude protein yield.

Effect of integrated nutrient supply on fodder quality

Crude protein content (%)

Crude protein content (%) is an important quality factor in forage crop which increase significantly with integration of inorganic and organic source of fertilizer. Table-1 indicated that crude protein content (%) and crude protein yield of maize alone and total crude protein content (%) and total crude protein yield of maize + legumes were significantly higher with the application of 50 % RFD + 10 tonnes FYM + $ZnSO_4$ (N_4) over other treatments except 50 % RFD + 10 tonnes MSC + $ZnSO_4$ (N_5). This might be due to increased availability of nitrogen with integration of inorganic and organic manure which increased the nitrogen uptake resulted in higher nitrogen and protein content

Crude protein yield (q ha^{-1})

It is evident from the data that an integrated nutrient supply effectively alter the crude protein yield of maize alone, crude protein yield of legume intercrop and total crude protein yield of maize + legumes. Significantly, higher crude protein yield of maize alone *viz*., 6.87 and 7.12q ha^{-1}, crude protein yield of legume intercrop *viz*., 4.81 and 4.87 q ha^{-1} and total crude protein yield of maize + legumes *viz*., 11.68 and 12.34 q ha^{-1} during first and second year, respectively were recorded when crop was fertilized with 50% RFD + 10 tonnes FYM + $ZnSO_4$, (N_4) over rest of the treatments, however, it was found comparable with application of 50% RFD + 10 tonnes MSC + $ZnSO_4$, (N_5) in both the years of experiment. This might be due to increase in dry matter yield under this fertility and physical condition of soil. Similar, results was reported by Yadav *et al.,* (2005) that the treatment having 75 kg N through urea + 25 kg N ha^{-1} through FYM and 75 kg N through urea + 25 kg N ha^{-1} through caster cake were recorded higher crude protein yield in sorghum as compared with 100 kg N ha^{-1} through Urea. These results confirm the findings of Sandhu *et al.,* (1990).The lower crude protein yield of maize alone *viz*., 2.80, and 3.06, crude protein yield of legume intercrop *viz*., 2.44, and 2.87 and total crude protein yield of maize + legumes *viz*., 5.24 and 5.93 q ha^{-1} were observed under control (N_0) during both the years.

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