RESEARCH ARTICLE

STUDIES ON INTEGRATED NUTRIENT SUPPLY ON YIELD OF FODDER MAIZE + LEGUMES INTERCROPPING SYSTEM IN INCEPTISOLS

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Abstract : A field experiment was conducted during the winter seasons of 2008 -09 and 2009-10 at Raipur Chhattishgrah, to find out the effect of integrated nutrient supply on yield of fodder Maize + legumes intercropping system in inceptisols. The results of experiment revealed that maize + ber seem (1:1) produced significantly maximum total green fodder yield (662.52 & 680.10 q ha^{-1}), maize equivalent yield (702.37 & 721.34 q ha^{-1}) & relative yield equivalent ratio (162% & 164%) as compared to other treatments during both the years respectively as well as mean basis whereas, significantly higher total dry matter yield (128.54 & 133.88 q ha^{-1}) were recorded with the treatment of maize + lucerne (1:1) during second year. Among integrated nutrient supply, the application of 50% RFD + 10 tonnes FYM + $ZnSO_4$ was recorded significantly higher value of total green fodder yield (626.96 & 648.66 q ha^{-1}), total dry matter yield (125.91 & 129.75 q ha^{-1}) and maize equivalent yield (650.93 & 670.25 q ha^{-1}) during both the years and mean basis. With respect to interaction effect of intercropping and integrated nutrient supply reveals that treatment combination of maize + berseem (1:1) and application of 50% RFD + 10 tonnes FYM + $ZnSO_4$ were recorded significantly higher total green fodder yield than others except treatment combination of maize + ber seem (1:1) and application of 50% RFD + 10 tones MSC + $ZnSO_4$.

Keywords : Integrated nutrient supply, Fodder maize + legumes intercropping, Fodder yield

INTRODUCTION

Livestock is an integral part of Indian Agriculture and plays a vital role in rural economy. India has a huge livestock population of 527 millions (DAH, Ministry of Agriculture, Gol, 2007) however the production of milk and other livestock products are lowest in the world because there is huge gap between demand and supply of all kinds of feed and fodders and on the other hand, there is only 4.4 per cent area of total cultivable land used for growing of fodder and forage crops, therefore, the heavy livestock pressure on the limited land resources in the country calls for increasing the fodder productivity. 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 (Patel *et al.,* 2002) which is not only provide the higher yield but also improves the soil physico-chemical properties. Therefore, the present experiment was conducted to study on integrated nutrient supply on yield of fodder maize + legumes intercropping system in inceptisol.

MATERIAL AND METHOD

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 muriate 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.

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RESULT AND DISCUSSION

Green fodder yield (q ha^{-1})

The effect of different treatments on green fodder yield (q ha^{-1}) is presented in table 1. a perusal of mean value from table indicate that the intercropping of maize + lucerne 1:1, (I_4) recorded significantly maximum green fodder yield of maize alone *viz*., 443.94 and 452.83 q ha^{-1} during first and second year, respectively over rest of the treatments, but yield was at par with maize + berseem 1:1 (I_3) whereas, among the legume intercrops berseem produced significantly higher green fodder yield viz., 225.80 and 233.71 q ha^{-1} during first and second year, respectively with maize + berseem intercropping 1:1 (I_3) over other treatments and significantly highest total green fodder yield *viz.*, 662.52 and 680.10 q ha^{-1} during first and second year, respectively, was obtained with intercropping of maize + berseem 1:1 (I_3) over rest of the treatments during both the years and mean basis. Singh *et al.* (1983) reported that berseem improves physical conditions of the soil, that helps proper plant growth resulting higher green fodder yield.

Minimum green fodder yield of system was recorded under sole maize (I_1) *viz*., 419.66 and 429.33 q ha^{-1} during first and second year, respectively.

Data in table indicated that application of 50 per cent recommanded dose of fertilizer + 10 tonnes of FYM + $ZnSO_4$, (N_4) recorded significantly maximum green fodder yield of maize alone, green fodder yield of legume intercrops and total green fodder yield of maize + legumes *viz*., 477.00, 149.96 and 626.96 during first year and 489.58, 159.08 and 648.66 q ha^{-1} during second year, respectively over rest of the treatments except 50% RFD + 10 tonnes MSC + $ZnSO_4$, (N_5) during both the years as well as pooled mean basis. This might be due to integration of organic and inorganic source of fertilizer not only made availability of all essential nutrients to the crop plant but also release the nutrients in slow pattern therefore, plant get sufficient quantity of all plant nutrients in time resulted better growth and development ultimately turn in maximum production of green and dry matter yield of crop. Similar results were also reported by various investigators *viz*., Patel and Vihol (1992), Manohar *et al.* (1992).

Dry matter yield (q ha^{-1})

The data on dry matter yield of maize and total dry matter yield of maize + legumes are presented in table 2. It is evident from the results that, in general, the dry matter yield of maize alone and total dry matter yield of maize + legumes were higher when maize intercropped with legumes as compare to sole maize (I_1) and also significant difference among the dry matter yield of legume intercrops in intercropping system during both the years of experimentation and it was also noticed that dry matter yield was higher in second year than first year.

The dry matter yield of maize and total dry matter yield of maize + legumes were significantly influenced due to various intercropping system. The significantly maximum dry matter yield of maize alone *viz.*, 88.62 and 91.83 q ha^{-1} during first and second year, respectively were recorded with maize + lucerne intercropping over sole maize (I_1) but at par with maize + cowpea 1:1 (I_2) and maize + berseem 1:1, (I_3). Whereas, among the legume intercrops berseem produced significantly higher dry matter yield viz., 40.79 and 42.05 q ha^{-1} during first and second year, respectively with maize + berseem intercropping 1:1 (I_3) over other treatments but at with maize + lucerne intercropping 1:1 (I_4) and total dry matter of maize + lucerne *viz.*,128.54 and 133.88 q ha^{-1} were recorded during first and second year, respectively. Which was significantly higher than other treatments but at par with maize + cowpea 1:1 (I_2) and maize + berseem 1:1, (I_3). during both the years as well as mean basis too this might be due to complimentary effect of lucerne through better symbiotic system which increase quantity and availability of nitrogen. Similar, results were observed by Krishna *et al.* (1998)

It is quite clear from the table that the significantly maximum dry matter yield of maize alone *viz*., 96.61 and 98. 99 q ha^{-1} , dry matter yield of legume intercrops *viz*., 29.30 and 30.76 q ha^{-1} and total dry matter yield of maize + legumes *viz*., 125.91 and 129.75 q ha^{-1} during first and second year, respectively was recorded under the treatment which received 50% RFD + 10 tonnes FYM + $ZnSO_4$, (N_4) over rest of the treatments except 50% RFD + 10 tonnes MSC + $ZnSO_4$, (N_5) during both the years and mean basis. This might be due to plant get sufficient quantity of essential nutrients throughout their crop growth period by combine use of organic and inorganic source of fertilizers Similar results were also reported by Patel *et al.* (2002) and Sudhir *et al.* (2002)

Interaction effect

Intercropping and integrated nutrient supply interacted significantly with respect to total green fodder yield of maize + legumes at harvest are presented in table 2. It is quite clear from the table that significantly maximum total green fodder yield of 742.31 q ha^{-1} on pooled mean basis was recorded when maize intercropped with berseem 1:1, (I_3) and supplemented with 50% RFD + 10 tonnes FYM + $ZnSO_4$, (N_4) as compared to other treatment combinations, however, it was remained statistically at par with treatment combination of I_3 N_5 (I_3 - Maize + berseem, 1:1 and N_5 - 50% RFD + 10 tonnes MSC + $ZnSO_4$,) on pooled mean basis.

Maize equivalent yield

The data on maize equivalent yields as affected by different treatments are presented in table2. It is evident from the data in table that, in general, higher maize equivalent yield was recorded in second year as compared to first year. The maize equivalent yield of intercropping recorded significantly higher value with maize + legumes intercropping as compare to sole maize (I_1). Among the intercropping of maize with legumes the maize + berseem 1:1, (I_3) was recorded maximum maize equivalent yield *viz.*, 702.37 and 721.34 q ha^{-1} during first and second year, respectively were significantly higher over rest of the treatments. The minimum maize equivalent yield *viz.*, 419.66 and 429.33 q ha^{-1} was recorded under sole maize, (I_1) during both the years of experimentation. This might be due to additional green fodder yield obtained from legumes under intercropping system and higher price rate of legumes i.e. Rs. 100 q^{-1} as compared to maize Rs. 85 q^{-1}**.** Similarly, Balyan (1997) reported that significantly higher maize equivalent yield in intercropping as compared to sole maize.

It is quite clear from the table that the trend was similar for all the treatments during both the years of investigation. Significantly maximum maize equivalent yield *viz.,* 650.93 and 670.25 q ha^{-1} were recorded with the application of 50% RFD + 10 tonnes FYM + $ZnSO_4$, (N_4) during first and second year respectively over rest of the treatments except 50% RFD + 10 tonnes MSC + $ZnSO_4$, (N_5). The minimum maize equivalent yield *viz.,* 369.81 and 383.24 q ha^{-1} was noticed under control plot (N_0) during both the years. This might be attributed to increased availability of macro and micro nutrients, favorable soil conditions and better nutrition for entire growth period under this integration leading to higher production of fodder yield of both the crops. Similar results were reported by Skekinath *et al.* (2004) and Deshmukh *et al.* (2009).

Relative yield equivalent ratio

It is quite clear from the table 3 that the maize + legumes intercropping significantly influenced the relative yield equivalent ratio. In general second year of investigation recorded higher relative yield equivalent ratio as compared to first year. The maize + berseem 1:1, (I_3) recorded significantly higher relative yield equivalent ratio *viz.,* 162 (%) and 164 (%) as compared to rest of the treatments during both the years, respectively. This might be due to the compensated yields and best economical usage of land as evidenced by Elexander and Genter *et al.* (1962).

Relative yield equivalent ratio did not significant influence with the treatments of integrated nutrient supply. But maximum relative yield equivalent ratio was recorded with application of 50 % RFD + 10 tonnes FYM + $ZnSO_4$ (N_4).

Table 1. Total green fodder and dry matter yield of fodder maize + legume intercrops as influenced by intercropping and integrated nutrient supply.

Treatment	Total Green Fodder Yield (q/ha)			Total Dry Matter Yield (q/ha)		
	2008-09	2009-10	Mean	2008-09	2009-10	Mean
Intercropping						
I1 - Maize Sole	419.66	429.33	424.50	80.49	83.94	82.21
I2 - Maize + Cowpea (1:1)	544.70	568.86	556.28	106.12	111.45	108.78
I3 - Maize + Berseem (1:1)	662.52	680.10	671.31	128.07	131.09	129.58
I4 - Maize + Lucerm (1:1)	637.56	656.44	647.00	128.54	133.88	131.21
SEm	**3.80**	**4.07**	**3-93**	**1.90**	**2.56**	**2.23**
CD (P=0.05)	**13.16**	**14.13**	**13.64**	**6.58**	**8.87**	**7.73**
Integrated Nutrient Supply (NPK kg ha^{-1})						
N0 - Control						
N1 - RFD	335.36	367.52	341.44	68.53	73.10	70.82
N2 - 50% RFD + 10 tonnes FYM	583.18	602.61	592.90	114.38	118.40	116.39
N3 - 50% RFD + 10 tonnes MSC	608.69	627.16	617.93	117.89	122.48	120.19
N4 - 50% RFD + 10 tonnes FYM + Znso4	603.94	622.92	613.85	115.50	120.09	117.79
N5 - 50% RFD + 10 tonnes MSC + Znso4	626.96	648.66	635.82	125.91	129.75	127.84
SEm	617.69	638.72	626.71	122.60	126.70	124.65
CD (P=0.05)	**3.97**	**4.03**	**3.99**	**1.67**	**1.75**	**1.71**
Interation (I* N)	**11.34**	**11.50**	**11.42**	**4.78**	**5.0**	**4.89**
	S	**S**	**S**			

Table 2. Interaction effect of integrated nutrient supply and intercropping on total green fodder yield of fodder maize + legumes intercropping system.

Intercropping / Integrated Nutrient Supply	Pooled mean of Total Green fodder yield (q ha^{-1})			
	I1	I2	I3	I4
N0	270.00	357.08	423.30	395.40
N1	440.00	568.78	693.71	669.10
N2	454.50	597.97	720.88	698.38
N3	451.33	592.79	717.37	693.90
N4	469.16	614.73	742.31	717.07
N5	462.00	606.34	730.29	708.29
Interaction (I×N)	N at same level of I		N at same level of I	
SEm	6.64		6.99	
CD (P=0.05)	18.98		21.27	

Table 3. Maize equivalent yield and Relative yield equivalent ratio of fodder maize + legume intercrops as influenced by intercropping and integrated nutrient supply.

Treatment	Maize equivalent yield			Relative yield equivalent ratio		
	2008-09	2009-10	Mean	2008-09	2009-10	Mean
Intercropping						
I1 - Maize Sole	419.66	429.33	424.50	100.00	100.00	100.00
I2 - Maize + Cowpea (1:1)	564.84	590.22	577.53	135.00	137.00	136.00
I3 - Maize + Berseem (1:1)	702.37	721.34	711.86	162.00	164.00	163.00
I4 - Maize + Lucerm (1:1)	671.74	692.38	682.05	154.00	155.00	154.00
SEm	**4.14**	**4.19**	**4.19**	**0.70**		**0.80**
CD (P=0.05)	**13.35**	**13.72**	**13.53**	**0.70**		
Integrated Nutrient Supply (NPK kg ha^{-1})				**2.30**	**3.00**	**2.70**
N0 - Control						
N1 - RFD	369.81	383.24	376.53			
N2 - 50% RFD + 10 tonnes FYM	607.68	628.34	618.00	136.00	137.00	137.00
N3 - 50% RFD + 10 tonnes MSC	631.24	651.07	641.15	138.00	139.00	139.00
N4 - 50% RFD + 10 tonnes FYM + Znso4	627.13	646.43	636.78	138.00	139.00	138.00
N5 - 50% RFD + 10 tonnes MSC + Znso4	650.93	670.25	660.58	138.00	138.00	138.00
SEm	641.12	660.58	650.85	139.00	140.00	140.00
CD (P=0.05)	**4.25**	**4.47**	**4.36**	138.00	139.00	139.00
	12.15	**12.79**	**12.46**	**1.4**	**1.3**	**1.3**
				NS	**NS**	**NS**

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