RESEARCH ARTICLE

EFFECT OF INTEGRATED NUTRIENT SUPPLY AND INTERCROPPING OF FODDER CROPS ON PHYSICAL PROPERTIES OF SOIL IN FODDER MAIZE + LEGUMES INTERCROPPING SYSTEM

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Abstract : A field experiment was conducted during the winter seasons of 2008 -09 and 2009-10 at Raipur Chhattisgarh, to find out the effect of integrated nutrient supply and intercropping of fodder crops on physical properties of soil in fodder maize + legumes intercropping system. Integrated nutrient supply with application of 50 % RFD + 10 tonnes FYM + $ZnSO_4$ was recorded significantly lowest value of soil bulk density and higher value of total porosity and water holding capacity. Intercropping of maize + lucerne (1:1) proved most efficient system resulting significantly lower value of bulk density but at par with Maize + Berseem (1:1) and higher value of total porosity and water holding capacity as compared to other intercropping system.

Keywords: Integrated nutrient supply, Maize + fodder legumes, Water holding capacity

INTRODUCTION

India has a huge gap between demand and supply of all kinds of feed and fodders. Therefore, intercropping of forage cereals and legumes appears to be technically feasible and economically viable approaches to increase quality green fodder yield. Maize (*Zea mays* L.) + fodder legumes intercropping system not only increase the productivity of green fodder crops but also maintain the soil fertility status and improves the soil physical properties by adding organic matter in soil after decomposition of their living roots. It has been reported that continuous use of inorganic sources of nutrients leads to deterioration of soil health resulting yield stagnation. Continuous application of high amount of only inorganic fertilizers had deleterious effect leading to decline in productivity due to limitation of one or more of micro-nutrients (Nambiar and Abrol, 1989). Therefore, there is urgent need to integrated use of organic and inorganic source of nutrients which will improves the soil physical properties. Organic manure is the component of integrated nutrient supply system and when it apply adequate manner with proper management then it improves soil physical properties due to increase of soil organic carbon, soil water retention and transmission and improvement in other physical properties of soil like bulk density, penetration resistance and aggregation (Zebarth *et al*., 1999). Therefore, the present study was conducted to study the effect of integrated nutrient supply and intercropping of fodder crops on soil physical properties in fodder Maize + legumes intercropping system.

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 laidout 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 recommanded 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 recommanded 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. Data on Bulk density, Particle density, Porosity and Water holding capacity were estimated with the standard procedures and the

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formulae are given by Bodman (1942), Black and Hertge (1986) and Piper (1950) respectively.

RESULT AND DISCUSSION

Bulk density (gcc^{-1})

The data on bulk density as affected by various treatments are presented in table 1 indicates that maize + legumes intercropping did not influenced significantly the soil bulk density during both the years except after harvesting during second year. Significantly lower bulk density was recorded with maize + lucerne 1:1, (I_4) as compare to others but at par with maize + berseem 1:1, (I_3). This might be due to addition of organic matter in soil after decomposition of their living root by in legumes intercropping system. Since, lucerne have deep and fibrus roots therefore, it add more amount of organic matter in soil from their roots as compare to other fodder legumes reported by Singh (1983).Therefore, it decreased the soil bulk density. Among integrated nutrient supply significantly variation was not found at initially duing first year. Significantly lowest value of soil bulk density was recorded with application of 50% RFD + 10 tonnes FYM + $ZnSo_4$ (N_4) over rest of the treatments but these values are at par with repect to obtained from 50% RFD + 10 tonnes FYM (N_2) and 50% RFD + 10 tonnes MSC + $ZnSo_4$ (N_5) at initial time duing second year and after havesting during both the years of intestigation. Prasad *et al.* (1983) have also reported that the decomposition products of organic materials helped in the granulation of the particles and in turn in increased porosity, which leads to the decrease in the soil bulk density.

Particle density (gcc^{-1})

The data recorded on soil particle density as affected by various treatments are presented in table 1 reveals that the maize + legumes intercropping did not influence significantly soil particle density during both the years but lower value of soil particle density was recorded with maize + lucerne 1:1, (I_4) over rest of the treatments. This might be attributed due to increase of organic matter in soil after decomposition of living roots which decreased the particle density. Similar trend was also reported by Cheng & Coleman (1990) and Khurshid *et al.* (2006).

It is quite clear from the table that integrated nutrient supply did not differ significantly with respect to particle density during both the years. But minimum value of soil particle density was recorded under the treatment of 50% RFD + 10 tonnes FYM + $ZnSO_4$, (N_4) as compared to other treatments.

Total porosity (%)

The data showing the effect of different treatments on total porosity (%) of soil at initial and after harvesting are presented in table 2 showed that the maize + legumes intercropping did not significantly influence the total porosity in soil during both the years except after harvesting during second year. Significantly higher value of total porosity in soil was recorded with application of maize + lucerne 1:1, (I_4) as compared to sole maize (I_1) but these values are at par with respect to obtained from maize + cowpea 1:1, (I_2) and maize + berseem 1:1, (I_3) after harvesting during second year. Fan *et al.* (2006) also reported increase in soil porosity after intercropping due to increased root biomass. Integrated nutrient supply did not significantly influence the results of total porosity of soil at all the stages of observation except after harvesting during second year. Significantly maximum value of total porosity of soil was recorded with the treatment of 50% RFD + 10 tonnes FYM + $ZnSO_4$, (N_4) as compared to others but at par with 50% RFD + 10 tonnes FYM (N_2), 50% RFD + 10 tonnes MSC (N_3) and 50% RFD + 10 tonnes MSC + $ZnSO_4$, (N_5), after harvesting during second year might be due to decomposition products of organic materials helped in the granulation of the particles and in turn in increased porosity, reported by Prasad *et al.* (1983) The increased porosity is probably due to aggregation of the soil particles by the action of microorganisms which produce polysaccharides providing a cementing action between the soil particles (Six *et al.*, 1998).

Water holding capacity (%)

The data recorded on water holding capacity as affected by various treatments are presented in table 2 reveals that the maize + legumes intercropping did not influence significantly water holding capacity during both the years except after harvesting during second year. Significantly maximum water holding capacity was recorded with maize + lucerne 1:1, (I_4) over other treatments except maize + cowpea 1:1, (I_2) and maize + berseem 1:1, (I_3) after harvesting during second year. This might be due to accumulation of organic matter through decomposition of living roots by microbial activities increased water holding capacity of soil. The results are in conformity with the findings of Gumaste (1981) and Balyan (1997). Integrated nutrient supply significantly variation was not found at initially during first year. Significantly maximum water holding capacity was recorded under the treatment of 50% RFD + 10 tonnes FYM + $ZnSO_4$, (N_4), over other treatments except 50% RFD + 10 tonnes FYM (N_2), 50% RFD + 10 tonnes MSC (N_3) and 50% RFD + 10 tonnes MSC + $ZnSO_4$, (N_5), at all stages during both the years except at initially during first year. While minimum water holding capacity was recorded under the treatment of 100% RFD (N_1) at all the stages during both the years. Parashuram chandravanshi *et al.* (1999) also reported increased in the water holding capacity of the soil due to increased capillary porosity brought about the positive interaction between clay and humus.

Table 1. Effect of integrated nutrient management and intercropping of fodder crops on bulk density and particle density of soil at before sowing and after harvesting in fodder maize + legumes intercropping system.

Treatment	Bulk density (gcc^{-1})				Particle density (gcc^{-1})			
	2008-09		2009-10		2008-09		2009-10	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Intercropping								
I_1 - Maize Sole	1.49	1.43	1.42	1.34	2.55	2.51	2.50	2.44
I_2 - Maize + Cowpea (1:1)	1.48	1.40	1.38	1.28	2.54	2.50	2.48	2.41
I_3 - Maize + Berseem (1:1)	1.50	1.40	1.37	1.26	2.55	2.48	2.47	2.39
I_4 - Maize + Lucerne (1:1)	1.49	1.39	1.36	1.24	2.54	2.46	2.45	2.37
SEm	**0.01**	**0.02**	**0.02**	**0.03**	**0.02**	**0.03**	**0.03**	**0.04**
CD (P=0.05)	**NS**	**NS**	**NS**	**0.09**	**NS**	**NS**	**NS**	**0.14**
Integrated Nutrient Supply (NPK kg ha^{-1})								
N_0 - Control	1.50	1.48	1.47	1.36	2.55	2.53	2.52	2.46
N_1 - RFD	1.51	1.49	1.48	1.38	2.56	2.54	2.53	2.47
N_2 - 50% RFD + 10 tonnes FYM	1.48	1.35	1.33	1.22	2.55	2.47	2.46	2.36
N_3 - 50% RFD + 10 tonnes MSC	1.48	1.38	1.36	1.26	2.56	2.48	2.47	2.38
N_4 - 50% RFD + 10 tonnes FYM + $Znso_4$	1.47	1.33	1.31	1.21	2.56	2.46	2.45	2.36
N_5 - 50% RFD + 10 tonnes MSC + $Znso_4$	1.49	1.36	1.34	1.23	2.53	2.47	2.46	2.37
SEm	**0.02**	**0.03**	**0.04**	**0.04**	**0.04**	**0.03**	**0.04**	**0.05**
CD (P=0.05)	**NS**	**0.09**	**0.12**	**0.12**	**NS**	**NS**	**NS**	**0.15**

Table 2. Effect of integrated nutrient management and intercropping of fodder crops on total porosity and water holding density of soil at before sowing and after harvesting in fodder maize + legumes intercropping system.

Treatment	Total porosity (%)				Water holding density (%)			
	2008-09		2009-10		2008-09		2009-10	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Intercropping								
I_1 - Maize Sole	41.84	42.90	43.03	44.35	32.05	33.50	33.78	35.83
I_2 - Maize + Cowpea (1:1)	41.90	43.77	44.23	46.83	33.27	35.06	35.83	39.67
I_3 - Maize + Berseem (1:1)	41.22	43.64	44.39	47.32	33.11	36.00	37.00	41.05
I_4 - Maize + Lucerne (1:1)	41.19	44.10	45.00	48.57	32.39	37.56	38.07	44.05
SEm	**0.81**	**1.20**	**1.39**	**1.13**	**0.87**	**1.08**	**1.24**	**1.44**
CD (P=0.05)	**NS**	**NS**	**NS**	**3.00**	**NS**	**NS**	**NS**	**5.02**
Integrated Nutrient Supply (NPK kg ha^{-1})								
N_0 - Control	41.28	41.43	41.56	44.11	33.17	33.25	34.00	34.50
N_1 - RFD	41.17	41.01	41.53	43.62	32.34	32.92	32.98	31.25
N_2 - 50% RFD + 10 tonnes FYM	42.01	45.12	45.67	47.79	32.42	36.08	37.00	44.00
N_3- 50% RFD + 10 tonnes MSC	42.07	44.24	44.86	46.99	32.67	34.83	35.58	42.00
N_4 - 50% RFD + 10 tonnes FYM + $Znso_4$	42.73	45.57	46.13	49.92	32.50	38.83	39.98	45.09
N_5- 50% RFD + 10 tonnes MSC + $Znso_4$	40.97	44.74	45.11	47.72	33.17	37.08	37.83	43.83
SEm	**1.53**	**1.50**	**2.11**	**2.05**	**1.78**	**1.87**	**2.05**	**2.23**
CD (P=0.05)	**NS**	**NS**	**NS**	**5.73**	**NS**	**5.36**	**5.87**	**6.39**

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