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Influence of organic amendments on soil enzyme activities, yield, yield attributes and economics of chickpea (*Cicer arietinum* L.) grown in vertisol

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ABSTRACT

A field experiment was conducted on clayey soil at Agricultural Research Station, Annigeri, UAS, Dharwad during *Rabi* season of 2009-10 and 2010-11 to study the influence of organic amendments on soil biological activities, yield, yield attributes and economics of chickpea (*Cicer arietinum* L.) grown in Vertisol. The soil application of various organic manures and foliar spray of liquid organic manures at flower initiation and 15 days after flowering (DAF) significantly enhanced the soil enzyme (dehydrogenase, phosphatase) activity, yield and yield attributes of chickpea *viz.*, number of pods per plant, 100-seed weight, grain yield and haulm yield. Among various treatment combinations, the application of enriched compost 1/3 + vermicompost 1/3 + glyricidia leaf manure 1/3 equivalent to 100 per cent RDN and foliar spray of panchagavya @ 3 per cent at flower initiation and 15 DAF has recorded significantly higher dehydrogenase (10.12 µg TPF /g soil / day) and phosphatase (22.33 µg PnP /g soil / hr) activity in soil, higher grain yield (2400 kg/ha), haulm yield (3423 kg/ha), number of pods per plant (66.38) and 100-seed weight (20.91 g) compared to other treatment combinations. Significantly higher B:C ratio (3.34) was recorded with OM_2 among organic manures, LM_1 (3.31) among liquid organic manures and OM_2LM_1 (3.69) among combination of both.

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KEY WORDS : Organic chickpea, Enriched compost, Liquid organic manures, Dehydrogenase, Phosphatase enzymes

India is self sufficient in food grain production due to intensive cropping with high doses of chemical fertilizers to tap the potential of high yielding crop varieties in irrigated condition under a constant plant protection umbrella. However, modern chemical based agricultural practices have led to several new challenges, *viz.,* decline in productivity, degradation of soil and water resources, diminishing biodiversity and increase in environmental pollution that inturn influence the economic level of farmers. Under such situation organic nutrient management has a significant role in improving crop productivity as well as soil fertility.

Soil is a living tissue with regular complex biochemical reactions involving enzymes such as urease, dehydrogenase and phosphatase in soil catalyses biochemical reactions, which are responsible for nutrient cycling in soils and are directly concerned with carbon, nitrogen and phosphorus cycle. The dehydrogenase enzyme activity is commonly used as an indicator of biological activity in soils (Burns, 1978). Phosphotases are a broad group of enzymes that are capable of catalyzing hydrolysis of esters and anhydrides of phosphoric acid (Schmidt and Lawoski, 1961). In soil ecosystem, these enzymes are believed to play a critical role in P cycles (Spier and Ross, 1978) as evidence shows that they are correlated to P stress and plant growth.

Pulses form an integral part of the vegetarian diet and the cheaper source of protein for the poor farmers of the Indian subcontinent. Among pulses, chickpea (*Cicer arietisum* L.) is one of the most important pulse crop extensively grown in India during *Rabi* season. Alternative sources of soil fertility build up through use of renewable resources like organic manure, liquid manures, biofertilizers and rock phosphate with phosphorus solublizing bacteria has potential to improve soil fertility and crop yield on sustainable basis. The present study was under taken to know the influence of organic amendments on soil biological activities, yield, yield attributes and economics of chickpea grown in Vertisol.

RESEARCH PROCEDURE

The experiment was carried out at Agricultural Research Station, Annigeri, UAS, Dharwad, Karnataka during *Rabi* season of 2009-10 and 20010-11. The soil of the experimental plot was clayey in texture (64.63% clay, 13.12% sand and 22.25% silt) with bulk density 1.27 g/cc, alkaline in reaction (pH 7.9), low in organic carbon (0.51%), low in available N (202 kg/ha), P_2O_5 (18.90 kg/ha) and medium in available K_2O (347 kg/ha).

The experiment was laid out in factorial RCBD with three replications. There were 18 treatments consisting of soil application of four organic manures *viz.*, OM_1: Farmyard manure 1/3rd + Vermicompost 1/3rd + Glyricidia leaf manure 1/3rd equivalent to 100 per cent RDN, OM_2: Enriched compost 1/3rd + Vermicompost 1/3rd + Glyricidia leaf manure 1/3rd equivalent to 100 per cent RDN, OM_3: Farmyard manure 1/3rd + Vermicompost 1/3rd + Neem cake 1/3rd equivalent to 100 per cent RDN, OM_4: Enriched compost 1/3rd + Vermicompost 1/3rd + Neem cake 1/3rd equivalent to 100 per cent RDN and foliar spray of four liquid manures *viz.*, LM_1 : Panchagavya @ 3 per cent at flower initiation and 15 days after flower initiation (DAF), LM_2 : Biodigester @ 10 per cent at flower initiation and 15 DAF, LM_3 : cow urine @ 10 per cent at flower initiation and 15 DAF, LM_4 : Vermiwash @ 10 per cent at flower initiation and 15 DAF in addition, two control treatment *viz.,* RDF and absolute control (water spray)

The crop was sown on 10-10-2009 and 13- 10- 2010 with a spacing of 30 cm x 10 cm. The recommended dose of nitrogen for chickpea was supplemented with different combination of organic manures with equal proportions based on their N content. Recommended dose of phosphorus was balanced through application of rock phosphate with PSB. The required quantity of organic manures and rock phosphate with PSB as per treatment was incubated for 30 days before sowing of crop under shade with regular watering and were applied at the time of sowing as per the treatments. For RDF treatments, DAP was applied at the time of sowing.

During grand growth stage of crop for both the seasons soil samples were collected from the rhizosphere of the plant. The dehydrogenase activity in the soil samples was determined by following the procedure described by Casida *et al.* (1964). Similarly, the phosphatase activity in the soil samples was determined by the following the procedure described by Evazi and Tabatabai (1979).

RESEARCH ANALYSIS AND REASONING

The organic manures, liquid organic manures and their combinations influenced significantly on dehydrogenase and phosphatase activity in soil at grand growth stage (Table 1).

The organic manure application N equivalent to 100 per cent recommended dose of enriched compost + vermicompost + glyricidia green leaf manure (OM 2) with equal proportion recorded the maximum degydrogenase (9.45 µg TPF /g soil / day) and phosphatase (21.14 µg PnP /g soil / hr) activity in soil, which was significantly superior over other organic manures.

Similarly, among liquid organic manures, panchagavya spray @ 3 per cent at flower initiation and 15 DAF (LM_1) had recorded higher dehydrogenase (9.28 µg TPF /g soil / day) and phosphatase (21.52 µg PnP /g soil / hr) activity in soil, which was significantly superior than other liquid organic manures.

Even the combination of organic manures and liquid organic manures also resulted in higher enzymatic activity with application of N equivalent of 100 per cent recommended dose with EC 1/3rd + VC 1/3rd + GLM 1/3rd and foliar spray of panchagavya @ 3 per cent at flower initiation and 15 DAF recorded significantly higher dehydrogenase (10.12 µg TPF /g soil / day) and phosphatase (22.33 µg PnP /g soil / hr) activity in soil as compared to rest of the treatments except OM_1LM_1 and OM_2LM_3, while lowest dehydrogenase and phosphatase activity in soil recorded with control treatment of water spray and RDF.

Higher dehydrogenase and phosphatase enzyme activity in soil has resulted in greater availability of organic matter, narrow C:N ratio and favourable soil physical and chemical properties and this leads to greater release of macro and micro- nutrients to chickpea crop. This has influenced in higher uptake of nutrients in above treatments and in combination which ultimately resulted in higher grain yield of chickpea. These results are in confirmation with findings of Kavallappa (1989), Singaram and KamalKumari (1995) and Sriramchandrashakaran *et al.* (1997).

The application of various organic manures, liquid organic manures and their combinations had shown significant influence on yield and yield attributes of chickpeas (Table 2).

The application of N equivalent of 100 per cent recommended dose with EC 1/3 + VC 1/3 + GLM 1/3 recorded significantly higher grain yield (2147 kg/ha), haulm yield (3172 kg/ha), number of pods per plant (62.65) and 100-seed weight (20.25 g) compared to other organic manures treatments.

Among liquid organic manures, the foliar spray of panchagavya @ 3 per cent at flower initiation and 15 DAF showed significantly higher grain yield (2189 kg/ha), haulm

Table 1 : Influence of organic amendments on soil biological activity in soil at grand growth of chickpea grown under Vertisol (Pooled data of 2009-10 and 2010-11)

Treatments	Dehydrogenase (µg of TPF/g soil/day)	Phosphatase (µg of pnp/g soil/hr)
Organic manures (OM)		
OM_1 : FYM 1/3rd + VC 1/3rd + GLM 1/3rd equivalent to 100% RDN	8.80	20.27
OM_2 : EC 1/3rd + VC 1/3rd + GLM 1/3rd equivalent to 100% RDN	9.45	21.14
OM_3 : FYM 1/3rd + VC 1/3rd + NC 1/3rd equivalent to 100% RDN	8.53	19.26
OM_4 : EC 1/3rd + VC 1/3rd + NC 1/3rd equivalent to 100% RDN	8.85	20.52
S.E.±	0.08	0.21
C.D. (P=0.05)	0.22	0.59
Liquid organic manures (LM)		
LM_1: Panchagavya @ 3% at flower initiation and 15 DAF	9.28	21.52
LM_2: Biodigester @ 10% at flower initiation and 15 DAF	8.60	19.43
LM_3: Cow urine @ 10% at flower initiation and 15 DAF	8.81	20.65
LM_4: Vermiwash @ 10% at flower initiation and 15 DAF	8.95	19.60
S.E.±	0.08	0.21
C.D. (P=0.05)	0.22	0.59
Interaction		
OM_1LM_1	9.17	21.92
OM_1LM_2	8.50	19.26
OM_1LM_3	8.74	20.83
OM_1LM_4	8.78	19.08
OM_2LM_1	10.12	22.33
OM_2LM_2	8.90	20.27
OM_2LM_3	9.53	21.60
OM_2LM_4	9.23	20.37
OM_3LM_1	8.73	20.35
OM_3LM_2	8.36	18.70
OM_3LM_3	8.29	19.47
OM_3LM_4	8.75	18.53
OM_4LM_1	9.08	21.47
OM_4LM_2	8.63	19.48
OM_4LM_3	8.67	20.72
OM_4LM_4	9.02	20.40
Control		
C_1 – RDF	6.90	15.60
C_2 – Water spray	6.17	13.92
S.E.±	0.15	0.42
C.D. (P=0.05)	0.43	1.17

FYM – Farm yard manure VC – Vermicompost GLM – Glyricidia leaf manure NC – Neem cake
EC – Enriched compost RDN – Recommended dose of nitrogen (25 kg/ha)
RDF – Recommended dose of fertilizer (25:50:0 N:P_2O_5 kg/ha) DAS – Days after sowing
DAF – Days after flower initiation NS – Non-significant TPF - Triphenyl formazon pnp - P-nitrophenol phosphate

yield (3190 kg/ha), number of pods per plant (62.01) and 100-seed weight (20.40 g) as compared to foliar spray of biodigester @ 10 per cent and vermiwash @ 10 per cent at flower initiation and 15 DAF. However, it was at par with the foliar spray of cow urine @ 10 per cent at flower initiation and 15 DAF. The cow dung in panchagavya acts as a medium for the growth of beneficial microbes and cow urine provides nitrogen which is essential for crop growth (De Britto and Girija, 2006).

In treatment combinations, the application of equivalent of 100 per cent recommended dose with EC 1/3 + VC 1/3 + GLM 1/3 N and foliar spray of panchagavya @ 3 per cent at flower initiation and 15 DAF has recorded significantly higher grain yield (2400 kg/ha), haulm yield

Table 2 : Influence of organics amendments on yield and yield components of chickpea grown under Vertisol (Pooled data of 2009-10 and 2010-11)

Treatments	No. of pods per plant at harvest	100-seed weight (g)	Grain yield (kg/ha)	Haulm yield (kg/ha)
Organic manures (OM)				
OM_1 : FYM 1/3rd + VC 1/3rd + GLM 1/3rd equivalent to 100% RDN	58.67	19.25	1972	2989
OM_2 : EC 1/3rd + VC 1/3rd + GLM 1/3rd equivalent to 100% RDN	62.65	20.25	2147	3172
OM_3 : FYM 1/3rd + VC 1/3rd + NC 1/3rd equivalent to 100% RDN	57.52	18.80	1927	2887
OM_4 : EC 1/3rd + VC 1/3rd + NC 1/3rd equivalent to 100% RDN	57.44	19.35	1996	2958
S.E.±	1.31	0.23	49	70
C.D. (P=0.05)	3.70	0.66	138	199
Liquid organic manures (LM)				
LM_1: *Panchagavya* @ 3% at flower initiation and 15 DAF	62.01	20.40	2189	3190
LM_2: *Biodigester* @ 10% at flower initiation and 15 DAF	55.77	18.69	1734	2689
LM_3: Cow urine @ 10% at flower initiation and 15 DAF	60.86	19.49	2114	3204
LM_4: Vermiwash @ 10% at flower initiation and 15 DAF	57.64	19.08	2005	2924
S.E.±	1.31	0.23	49	70
C.D. (P=0.05)	3.70	0.66	138	199
Interaction				
OM_1LM_1	63.11	20.51	2171	3183
OM_1LM_2	54.58	18.20	1712	2662
OM_1LM_3	61.07	19.48	2039	3154
OM_1LM_4	55.92	18.80	1966	2958
OM_2LM_1	66.38	20.91	2400	3423
OM_2LM_2	58.07	19.70	1802	2758
OM_2LM_3	64.36	20.15	2229	3357
OM_2LM_4	61.77	20.24	2155	3149
OM_3LM_1	59.66	19.63	2060	3099
OM_3LM_2	54.83	18.38	1687	2615
OM_3LM_3	59.13	18.80	2057	3144
OM_3LM_4	56.48	18.40	1906	2691
OM_4LM_1	58.89	20.53	2123	3054
OM_4LM_2	55.59	18.48	1736	2719
OM_4LM_3	58.90	19.51	2131	3160
OM_4LM_4	56.39	18.89	1995	2897
Control				
C_1 – RDF	50.66	18.72	1804	2731
C_2 – Water spray	43.91	18.18	1446	2376
S.E.±	2.49	0.45	94	135
C.D. (P=0.05)	7.03	1.26	264	381

FYM – Farm yard manure VC – Vermicompost GLM – Glyricidia leaf manure
NC – Neem cake EC – Enriched compost RDN – Recommended dose of nitrogen (25 kg/ha)
RDF – Recommended dose of fertilizer (25:50:0 N:P_2O_5 kg/ha) DAS – Days after sowing
DAF – Days after flower initiation NS – Non-significant

(3423 kg/ha), number of pods per plant (66.38) and 100-seed weight (20.91 g) as compared to other treatment combinations except OM_1LM_1, OM_2LM_3 and OM_2LM_4, while lowest grain yield (1446 kg/ha), haulm yield (2376 kg/ha), number of pods per plant (43.91) and 100-seed weight (18.18 g) were recorded in control treatment (water spray - C_2). Rajendran *et al.* (2006) reported that application of vermicompost @ 5 t per ha with foliar spray of 3 per cent panchagavya at 10 DAS could be recommended to enhance the yield and quality of grain amaranthus cv. CO3. Similar results were also reported by Nekar *et al.* (2009) in groundnut and Yadav and Vijayakumari (2003) in chilli.

The data on gross returns, net returns and B:C ratio

Table 3 : Influence of organic amendments on gross returns, net returns and B:C ratio of chickpea grown under Vertisol (Pooled data of 2009-10 and 2010-11)

Treatments	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
Organic manures (OM)			
OM_1 : FYM 1/3rd + VC 1/3rd + GLM 1/3rd equivalent to 100% RDN	54743	36884	3.06
OM_2 : EC 1/3rd + VC 1/3rd + GLM 1/3rd equivalent to 100% RDN	59474	41677	3.34
OM_3 : FYM 1/3rd + VC 1/3rd + NC 1/3rd equivalent to 100% RDN	53428	34882	2.88
OM_4 : EC 1/3rd + VC 1/3rd + NC 1/3rd equivalent to 100% RDN	55290	36855	3.00
S.E.±	1258	1258	0.07
C.D. (P=0.05)	3557	3557	0.20
Liquid organic manures (LM)			
LM_1: Panchagavya @ 3% at flower initiation and 15 DAF	60559	42237	3.31
LM_2: Biodigester @ 10% at flower initiation and 15 DAF	48200	30089	2.66
LM_3: Cow urine @ 10% at flower initiation and 15 DAF	58725	40623	3.25
LM_4: Vermiwash @ 10% at flower initiation and 15 DAF	55451	37348	3.07
S.E.±	1258	1258	0.07
C.D. (P=0.05)	3557	3557	0.20
Interaction			
OM_1LM_1	60111	42089	3.34
OM_1LM_2	47588	29778	2.67
OM_1LM_3	56738	38936	3.19
OM_1LM_4	54534	36732	3.06
OM_2LM_1	66304	48344	3.69
OM_2LM_2	50029	32281	2.82
OM_2LM_3	61912	44172	3.49
OM_2LM_4	59650	41910	3.36
OM_3LM_1	57171	38461	3.06
OM_3LM_2	46871	28373	2.53
OM_3LM_3	57183	38693	3.09
OM_3LM_4	52489	33999	2.84
OM_4LM_1	58652	40053	3.15
OM_4LM_2	48311	29925	2.63
OM_4LM_3	59068	40690	3.21
OM_4LM_4	55131	36752	3.00
Control			
C_1 – RDF	50022	33283	2.99
C_2 – Water spray	40368	24805	2.59
S.E.±	2421	2421	0.13
C.D. (P=0.05)	6827	6827	0.38

FYM – Farm yard manure VC – Vermicompost GLM – Glyricidia leaf manure
NC – Neem cake EC – Enriched compost RDN – Recommended dose of nitrogen (25 kg/ha)
RDF – Recommended dose of fertilizer (25:50:0 N:P_2O_5 kg/ha)
DAS – Days after sowing DAF – Days after flower initiation NS – Non-significant

are provided in Table 3. Significantly higher net returns (Rs. 41677/ha) and B:C ratio (3.34) were recorded with OM_2 followed by OM_1 with corresponding values of Rs. 36884 per ha and 3.06. Among liquid organic manures, significantly higher net returns (Rs. 42237/ha) and B:C ratio (3.31) were recorded with panchagavya @ 3 per cent spray at flower initiation and 15 days after flower initiation over other liquid organic manures except cow urine 10 per cent spray with which it was at par. With the interaction of organic manures and liquid organic manures, significantly higher net returns (Rs. 48344/ha) and B:C ratio (3.69) were recorded with OM_2LM_1 over all other combinations except OM_2LM_3 and OM_2LM_4.

The results of the present investigation clearly brought

out that soil application of N equivalent to 100 per cent recommended dose with enriched compost + vermicompost + glyricidia leaf manure and foliar spray of panchagavya @ 3 per cent or cow urine 10 per cent at flower initiation and 15 DAF improved the soil biological activity, yield and yield attributing characters of chickpea. This will help in accomplishing the nutrient demand of chickpea through various organic nutrient sources and reduce the dependence in chemical fertilizers.

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