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RESEARCH PAPER

Influence of integrated organic nutrient management practices on soil physico-chemical properties, available nutrients and their uptake by chickpea grown on vertisol of northern dry zone of Karnataka

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Abstract : Field trials were conducted on Vertisols at Agricultural Research Station, Annigeri, UAS, Dharwad during *Rabi* season of 2009-10 and 2010-11 to study the influence of various organics on soil physico- chemical properties, available nutrients in soil and their uptake by chickpea (*Cicer aeritinum* L.) grown under Vertisol of northern dry zone of Karnataka. Soil application of various organic manures and foliar spray of liquid organic manures at flower initiation and 15 days after flowering (DAF) significantly improved the soil physico-chemical properties, available nutrients in the soil and their uptake by chickpea. Among the treatment combinations, application of enriched compost (EC) (1/3) + vermicompost (VC) (1/3) + glyricidia leaf manure (GLM) (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 lower bulk density (1.28 g/cc), higher soil organic carbon (0.56 %), higher available N, P_2O_5, K_2O in soil (245 kg N, 25.18 kg P_2O_5, 357 kg K_2O/ha), higher nutrient uptake by chickpea (128.34 kg N, 16.41 kg P, 76.96 kg K/ha) 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. Integrated application of EC + VC + GLM and liquid organic manures (panchagavya) foliar application individually and their combinations produced higher net returns (Rs. 41677, 42237 and 48344/ha, respectively) and B:C ratio (3.34, 3.31 and 3.69, respectively).

Key Words : Organic, Chickpea, Enriched compost, Liquid organic manures, Physico-chemical properties, Uptake of nutrients

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INTRODUCTION

Maintaining favourable soil physical, chemical and biological condition is a need of the hour. Various forms of degradation causing decline in soil fertility and productivity of crops. Deficiency of macro and micronutrients due to inadequate and superior nutrient management practices and use of straight fertilizers is rampant today.

Further, higher temperature and intensive microbial activity, the soils in tropics and subtropics are poor in soil organic matter content. It has been estimated that the soil organic carbon content in India has drastically reduce from 1.2 per cent to 0.60 per cent in 2000 (Devsenapathy, 2008.) and its declining further. Hence, the maintenance of soil structural

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status, fertility and productivity through soil organic matter management assumes a greater significance.

Long term manurial experiments conducted in India (1885- 2005) had clearly showed a declining trend in productivity with continuous application of inorganic fertilizers (N, P and K) alone. While higher productivity was sustained with the supply of nutrients through organic manures (Anonymous, 2007). The studies have clearly indicated that the decline in crop productivity has been attributed to deficiency of secondary and micronutrients, deterioration in the soil physical and chemical properties. Organic manures had been primarily valued for imparting favourable soil structure apart from supply of major nutrients (N P K) and a potential source of micronutrients (Katyal, 1985).

Chickpea is an important pulse crop extensively grown in India during *Rabi* season. Being leguminous crop, biological nitrogen fixation greatly helps to meet its nitrogen requirement, and thus, occupies an important place in crop rotation in different region of the country. The results of large number of manorial experiments conducted across the country revealed that neither chemical fertilizers nor organic sources alone can sustain the soil productivity under intensive cropping systems (Singh and Yadav, 1992). Therefore, under rain fed situations with lower cropping intensity, use of organic manures, bio-fertilizers, rock phosphate with PSB and liquid manurial sources have potential to improve soil fertility on sustainable basis. The integrated organic practices provide balanced nutrition to crops increases nutrient use efficiency of crops and improve the soil physico-chemical properties. With this background, field trials were conducted to study the effect of various organic nutrient management practices on soil physico- chemical properties, nutrient uptake and yield of chickpea under rain fed conditions on Vertisols of northern dry zone (zone 3) of Karnataka.

MATERIALS AND METHODS

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 of 1.27 g/cc, alkaline in reaction (pH 7.9), low in organic carbon (0.51%), low in available nitrogen (202 kg/ha), and phosphorus (18.90 kg/ha) and medium in available potassium (347 kg/ha).

The experiment was laid out in RCBD with three replications. There were 18 treatment combinations consisting of four main factors mainly soil application of four organic manures OM_1: Farmyard manure (FYM) ($1/3^{rd}$) + vermicompost (VC) ($1/3^{rd}$) + glyricidia leaf manure (GLM) ($1/3^{rd}$) equivalent to 100 per cent RDN, OM_2: EC ($1/3^{rd}$) + VC ($1/3^{rd}$) + GLM ($1/3^{rd}$) equivalent to 100 per cent RDN, OM_3: FYM ($1/3^{rd}$) + VC ($1/3^{rd}$) + neem cake (NC) ($1/3^{rd}$) equivalent to 100 per cent RDN, OM_4: EC ($1/3^{rd}$) + VC ($1/3^{rd}$) + NC ($1/3^{rd}$) equivalent to 100 per cent RDN and sub-factors consisting of foliar spray of four liquid manures mainly 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 to two control treatments RDF and absolute control (water spray).

The crop was sown on 10-10-2009 and 13- 10- 2010 with a spacing of 30 cm × 10 cm. The recommended dose of nutrients for chickpea were supplemented through different combination of organic manures on nutrient equivalent bases and additional 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.

Soil samples were collected from 0-30 cm depth just after harvest of crop from each treatment of the experimental plot and analyzed for available nitrogen, phosphorus and potassium contents using alkaline permanganate method (Subbiah and Asija, 1956), Olsen's method (Jackson, 1967) and flame photometer method (Muhr *et al.*, 1965), respectively. The soil organic carbon content was determined by Walkley and Blacks wet oxidation method as described by Jackson (1973). Soil pH measurement was made in soil and water solution of 1:2.5 ratio using pH meter as described by Piper (1966). Total porosity was calculated using formula of Black (1965).

RESULTS AND DISCUSSION

Two years pooled results of the present investigation (2009-10 and 2010-11), the influence of organic manure practices on soil organic carbon, pH, bulk density and porosity after harvest of chickpea are presented in Table 1.

In the present investigation, two years pooled data showed that the bulk density was significantly reduced with application of EC + VC + GLM $1/3^{rd}$ each (1.29 g/cc) as compared to OM_3 (1.32g/cc). Similarly, panchagavya spray (1.28g/cc) noticed significantly lower bulk density over LM_2 (1.31 g/cc). The interactions of organic manures and liquid manure treatments had a positive influence with lower bulk density. The combination of OM_2LM_1 indicated significantly lower bulk density followed by OM_1LM_1, OM_2LM_4 and OM_4LM_1. The reduction in bulk density was mainly with increase in the porosity of the soil due to addition of organic matter. These results are in accordance with the findings of Chapale *et al.* (1990); Patil *et al.* (2003); Patidar and Mali (2004) and Halemani *et al.* (2004).

Soil organic carbon content was significantly higher with OM_2 (0.60%) over other organic manurial combinations. Interaction of organic and liquid organic manures with the combination of OM_2LM_1 resulted in higher organic carbon content (0.56%) followed by OM_2LM_3, OM_2LM_4 and OM_1LM_1 over RDF and water spray. Higher organic carbon content has been owing to addition of enriched compost, vermicompost and glyricidia leaf manure with high volume and as a result of higher biological activity which was brought about by panchagavya spray in combination with above organic manures. These results are in conformity with the findings of Malewar *et al.* (2000), Pathak and Ram (2002) and Bhuyan and Gaur (2009).

The integrated application of organic manures EC (1/3),

Table 1 : Influence of integrated organic nutrient management practices on soil physico-chemical properties (Pooled data of 2009-10 and 2010-11)

Treatments	Organic carbon (%)	Soil pH	Bulk density (g/cc)	Porosity (%)
Organic manures (OM)				
OM_1 : FYM 1/3rd + VC 1/3rd + GLM 1/3rd equivalent to 100% RDN	0.55	7.80	1.30	50.32
OM_2 : EC 1/3rd + VC 1/3rd + GLM 1/3rd equivalent to 100% RDN	0.56	7.77	1.29	50.54
OM_3 : FYM 1/3rd + VC 1/3rd + NC 1/3rd equivalent to 100% RDN	0.54	7.87	1.32	49.64
OM_4 : EC 1/3rd + VC 1/3rd + NC 1/3rd equivalent to 100% RDN	0.54	7.83	1.30	50.25
S.E.±	0.005	0.03	0.01	0.28
C.D. (P=0.05)	0.013	NS	0.02	NS
Liquid organic manures (LM)				
LM_1: Panchagavya @ 3 % at flower initiation and 15 DAF	0.55	7.78	1.28	50.54
LM_2: Biodigester @ 10% at flower initiation and 15 DAF	0.54	7.86	1.31	49.92
LM_3: Cow Urine @ 10% at flower initiation and 15 DAF	0.54	7.81	1.30	50.12
LM_4: Vermiwash @ 10% at flower initiation and 15 DAF	0.55	7.82	1.30	50.17
S.E.±	0.0045	0.03	0.01	0.28
C.D. (P=0.05)	NS	NS	0.02	NS
Interaction				
OM_1LM_1	0.54	7.76	1.28	50.74
OM_1LM_2	0.55	7.83	1.32	49.91
OM_1LM_3	0.55	7.80	1.30	50.20
OM_1LM_4	0.55	7.80	1.29	50.42
OM_2LM_1	0.56	7.74	1.28	50.67
OM_2LM_2	0.55	7.82	1.29	50.45
OM_2LM_3	0.56	7.78	1.30	50.17
OM_2LM_4	0.56	7.77	1.28	50.87
OM_3LM_1	0.54	7.85	1.30	50.20
OM_3LM_2	0.54	7.91	1.33	49.22
OM_3LM_3	0.54	7.86	1.32	49.75
OM_3LM_4	0.54	7.88	1.32	49.40
OM_4LM_1	0.54	7.79	1.28	50.55
OM_4LM_2	0.54	7.88	1.31	50.10
OM_4LM_3	0.54	7.82	1.29	50.36
OM_4LM_4	0.54	7.84	1.32	49.98
Control				
C_1 – RDF	0.49	7.97	1.34	49.18
C_2 – Water spray	0.47	8.03	1.36	48.45
S.E.±	0.009	0.06	0.01	0.58
C.D. (P=0.05)	0.025	NS	0.03	NS

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

VC (1/3), GLM (1/3) equivalent to RDF had significantly higher available soil phosphorus (22.63 kg/ha) and K_2O (351.33 kg/ha) after harvest of the crop over other organic manures. Among the liquid organic manures, panchagavya spray resulted in significantly higher available P_2O_5 (22.20 kg/ha) over other liquid organic manures. Among interaction effects OM_2LM_1 resulted in significantly higher nitrogen (245.00 kg/ha) and phosphorus (25.18 kg/ha) content over other treatment combinations and also over control (Table 2). Higher soil available N, P_2O_5 and K_2O may be due to higher nutrient efficiency and residues in soil, enhanced soil microbial activity, higher root activity in the rhizosphere and improved soil

Table 2 : Influence of integrated organic nutrient management practices on available nutrients in soil and their uptake by plant at harvest of chickpea grown on Vertisols (Pooled data of 2009-10 and 2010-11)

Treatments	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)	Nitrogen uptake (kg/ha)	Phosphorus uptake (kg/ha)	Potassium uptake (kg/ha)
Organic manures (OM)						
OM_1 : FYM 1/3rd + VC 1/3rd + GLM 1/3rd equivalent to 100% RDN	231	20.97	345	99.79	10.81	61.38
OM_2 : EC 1/3rd + VC 1/3rd + GLM 1/3rd equivalent to 100% RDN	238	22.63	351	110.07	13.43	67.25
OM_3 : FYM 1/3rd + VC 1/3rd + NC 1/3rd equivalent to 100% RDN	230	19.49	337	95.64	10.42	60.00
OM_4 : EC 1/3rd + VC 1/3rd + NC 1/3rd equivalent to 100% RDN	231	20.85	340	100.42	10.82	61.92
S.E.±	2.84	0.27	3.45	1.83	0.22	0.62
C.D. (P=0.05)	NS	0.78	9.74	5.17	0.61	1.75
Liquid organic manures (LM)						
LM_1: Panchagavya @ 3 % at flower initiation and 15 DAF	237	22.20	344	112.21	13.18	69.14
LM_2: Biodigester @ 10% at flower initiation and 15 DAF	226	20.27	341	82.62	8.45	52.41
LM_3: Cow Urine @ 10% at flower initiation and 15 DAF	233	21.26	346	110.22	12.73	67.02
LM_4: Vermiwash @ 10% at flower initiation and 15 DAF	233	20.21	343	100.86	11.12	61.99
S.E.±	2.84	0.27	3.45	1.83	0.22	0.62
C.D. (P=0.05)	NS	0.78	9.74	5.17	0.61	1.75
Interaction						
OM_1LM_1	235	21.40	348	113.50	12.60	68.34
OM_1LM_2	225	21.58	342	79.38	8.13	51.66
OM_1LM_3	232	20.38	345	107.33	11.89	65.12
OM_1LM_4	233	20.50	347	98.96	10.64	60.41
OM_2LM_1	245	25.18	357	128.34	16.41	76.96
OM_2LM_2	227	19.75	339	85.59	8.88	54.81
OM_2LM_3	240	23.67	355	116.51	15.08	70.22
OM_2LM_4	238	21.92	355	109.82	13.35	67.02
OM_3LM_1	232	20.70	331	100.70	11.50	64.99
OM_3LM_2	229	19.33	342	81.04	8.33	50.44
OM_3LM_3	229	19.75	342	105.04	11.50	64.85
OM_3LM_4	229	18.17	333	95.78	10.36	59.73
OM_4LM_1	235	21.50	339	106.32	12.22	66.26
OM_4LM_2	225	20.42	341	84.46	8.46	52.72
OM_4LM_3	231	21.25	342	112.01	12.45	67.88
OM_4LM_4	232	20.25	338	98.88	10.14	60.81
Control						
C_1 – RDF	212	15.75	347	84.16	9.62	53.04
C_2 – Water spray	196	13.57	328	61.88	6.65	41.96
S.E.±	5.37	0.54	6.63	3.53	0.42	1.31
C.D. (P=0.05)	15.15	1.52	NS	9.96	1.18	3.69

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

physical and chemical properties. These results are in conformity with finding of Katyal (1985); Chapale *et al.* (1990); Badanur *et al.* (1990) and Kademani *et al.* (2003).

The soil physical properties *viz.*, soil moisture content, bulk density and porosity, which was determined during crop growth and at harvest, have given fair indication of the modification in soil physical properties due to use of organic manures, liquid organic manures and their combinations. Although, there was no significant difference in soil moisture content and porosity determined at different stages and depth of soil.

The soil application of bulky organic manures and liquid

Table 3 : Influence of integrated organic nutrient management practices on yield and yield components and economics of chickpea grown on Vertisols under rainfed conditions (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)	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	58.67	19.25	1972	2989	36884	3.06
OM_2: EC 1/3rd + VC 1/3rd + GLM 1/3rd equivalent to 100% RDN	62.65	20.25	2147	3172	41677	3.34
OM_3: FYM 1/3rd + VC 1/3rd + NC 1/3rd equivalent to 100% RDN	57.52	18.80	1927	2887	34882	2.88
OM_4: EC 1/3rd + VC 1/3rd + NC 1/3rd equivalent to 100% RDN	57.44	19.35	1996	2958	36855	3.00
S.E.±	1.31	0.23	49	70	1258	0.07
C.D. (P=0.05)	3.70	0.66	138	199	3557	0.20
Liquid organic manures (LM)						
LM_1: *Panchagavya* @ 3 % at flower initiation and 15 DAF	62.01	20.40	2189	3190	42237	3.31
LM_2: *Biodigester* @ 10% at flower initiation and 15 DAF	55.77	18.69	1734	2689	30089	2.66
LM_3: Cow Urine @ 10% at flower initiation and 15 DAF	60.86	19.49	2114	3204	40623	3.25
LM_4: Vermiwash @ 10% at flower initiation and 15 DAF	57.64	19.08	2005	2924	37348	3.07
S.E.±	1.31	0.23	49	70	1258	0.07
C.D. (P=0.05)	3.70	0.66	138	199	3557	0.20
Interaction						
OM_1LM_1	63.11	20.51	2171	3183	42089	3.34
OM_1LM_2	54.58	18.20	1712	2662	29778	2.67
OM_1LM_3	61.07	19.48	2039	3154	38936	3.19
OM_1LM_4	55.92	18.80	1966	2958	36732	3.06
OM_2LM_1	66.38	20.91	2400	3423	48344	3.69
OM_2LM_2	58.07	19.70	1802	2758	32281	2.82
OM_2LM_3	64.36	20.15	2229	3357	44172	3.49
OM_2LM_4	61.77	20.24	2155	3149	41910	3.36
OM_3LM_1	59.66	19.63	2060	3099	38461	3.06
OM_3LM_2	54.83	18.38	1687	2615	28373	2.53
OM_3LM_3	59.13	18.80	2057	3144	38693	3.09
OM_3LM_4	56.48	18.40	1906	2691	33999	2.84
OM_4LM_1	58.89	20.53	2123	3054	40053	3.15
OM_4LM_2	55.59	18.48	1736	2719	29925	2.63
OM_4LM_3	58.90	19.51	2131	3160	40690	3.21
OM_4LM_4	56.39	18.89	1995	2897	36752	3.00
Control						
C_1 – RDF	50.66	18.72	1804	2731	33283	2.99
C_2 – Water spray	43.91	18.18	1446	2376	24805	2.59
S.E.±	2.49	0.45	94	135	2421	0.13
C.D. (P=0.05)	7.03	1.26	264	381	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

organic manures had significant influence on soil physical and chemical properties and available nutrients in soil as well as uptake of nutrients by chickpea. As it is evidenced from the data, uptake of major nutrients, N (110.07 kg/ha), P (13.43 kg/ha) and K (67.25 kg/ha) was significantly higher with the application of EC + VC + GLM in equal proportion (OM_2) over other organic manures. Similarly, panchagavya spray (LM_1) has resulted in significantly higher uptake of N (112.21 kg/ha), P (13.18 kg/ha) and K (69.14 kg/ha) over other liquid organic manures. The interaction effect of OM_2LM_1 has resulted in higher uptake of NPK over other treatments (Table 2). Higher uptake of major nutrients in the above treatments was due to favourable soil physical and chemical conditions, this has further influenced the manifestation of yield attributing characters and subsequent yield of chickpea. Similar results were also observed by Sanjutha *et al.* (2008) and Tolanur (2008).

Application of various organic manures, liquid organic manures and their combinations had shown significant influence on yield and yield attributes of chickpeas (Table 3). Application of EC (1/3) + VC (1/3) + GLM (1/3) equivalent of 100 per cent recommended dose of nutrients 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 manurial treatments.

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

The combined application of EC (1/3) + VC (1/3) + GLM (1/3) along with rock phosphate + PSB to meet the phosphorus requirement equivalent of 100 per cent recommended dose of nutrients and foliar spray of panchagavya @ 3 per cent at flower initiation and 15 DAF recorded significantly 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) 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. CO-3. Similar results were also reported by Nekar *et al.* (2009) in groundnut and Yadav and Vijayakumari (2003) in chilli.

Significantly higher net returns (Rs. 41677/ha) and B:C ratio (3.34) were recorded (Table 3) 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 DAF over other liquid organic manures except cow urine 10 per cent spray which 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. Similar results were also reported by Yadav and Lourduraj (2006) and Anonymous (2009).

The present investigation clearly showed that application of enriched compost + vermicompost + glyricidia leaf manure equivalent to 100 per cent recommended dose of nutrients and foliar spray of panchagavya @ 3 per cent or cow urine @ 10 per cent at flower initiation and 15 DAF improved soil physico-chemical properties, available NPK content in soil and their uptake by chickpea as well as yield and yield attributing characters. These practices helped in accomplishing the nutrient requirement of chickpea apart from maintaining soil health and reduce the dependence on chemical fertilizers.

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