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EFFECT OF LAND CONFIGURATION AND DIFFERENT ORGANIC SOURCES ON GROWTH, YIELD AND QUALITY OF CARROT UNDER ORGANIC FARMING

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ABSTRACT
A field experiment was conducted at the certified organic farm, Navsari Agricultural University, Navsari during Rabi season of 2017-2018 to study the effect of land configuration, fertilizer level and liquid formulation on growth, yield and quality of carrot under organic farming. The treatments imposed were three levels of land configuration *i.e.* C_1: Flatbed C_2: Ridge and furrow and C_3: Broad bed, three levels of fertilizer *i.e.* F_1: 100% N through vermicompost F_2: 75% N through vermicompost, and F_3: 50% N through vermicompost and two levels of liquid formulation *i.e.* L_1: Jeevamrut and L_2: Amritpani in FRBD which replicated thrice. Overall the growth, yield attributes, yield and quality parameters were significantly highest with individual treatments C_3, F_1 and L_1 in all the cases. Significantly maximum root yield of carrot was achieved when 75% N was supplied in broad bed which was at par with 100% N application in all the treatments of land configuration. However root volume, root girth and root length was also affected significantly with the interaction effect of CxF and FxL. Further CxF interaction was also significant with shoot length while FxL interaction was found significant with quality parameters *i.e.* carotene and TSS content.

INTRODUCTION

Nowadays, the indiscriminate use of inorganic fertilizers are producing very hazardous effect on soil properties as well as crop yield. Therefore, it is essential to utilize various sources of nutrients, particularly under organic farming in order to increase the production of crop by maintaining soil fertility and quality. This can partly be accomplished through the adoption of good management techniques. Among them, land management system involving different methods of seed bed preparation plays a crucial role in enhancing crop production through improving soil-water-plant relationship. Ridge-furrow and bed-furrow land configuration systems emerge as few of the most promising sustainable management technologies which increase input use efficiency and crop production (Yadav *et al*., 2003). Organic manures originate from both livestock waste and crop residues, with the nutrients in them being mineralized by soil microbes and slowly making them available to plants over a long period of time (Lampkin, 2000). Humus added by organic manures adsorbs large quantities of water and makes it available to plants. The organic matter activates the soil ingredients necessary for a plants healthy growth. It has a very complex effect on soil and plant growth as well as it improves the physical, chemical and biological properties of soil. Liquid formulations that are used in organic agriculture are the fermented products which are used as plant growth enhancing substances prepared from farm available material. They are rich sources of beneficial micro flora which support, stimulate the plant growth and helping in getting better vegetative growth and also good quality yield (Devkumar *et al*., 2014). With this view, an experiment was conducted to study the effect of land configuration, fertilizer level and liquid formulation on growth, yield and quality of carrot under organic farming.

MATERIALS AND METHODS

The experiment was laid out on carrot as a test crop in rabi season in Factorial Randomized Block Design with three replication during 2017-18 at Organic Farm, Navsari Agricultural University, Navsari, Gujarat, India. Experimental soil was clayey in texture, non-saline (EC-0.81 dS/m) and slightly alkaline (pH- 8.1) in nature, available nitrogen, phosphorus and potassium was high (284 kg/ha), medium (50 kg/ha) and high (482 kg/ha), respectively. There were total eighteen treatment combinations comprising from three land configuration (C_1- Flat Bed, C_2- Ridges and Furrow and C_3- Broad Bed), three nitrogen level (F_1- 100% N through Vermicompost, F_2- 75% N through Vermicompost and F_3- 50% N through Vermicompost) and application of two liquid formulations (L_1- Jeevamrut @ 600 l/ha and L_2- Amrutpani @ 600 l/ha). Seed was treated with each of 0.5% solution of Trichoderma viride and Pseudomonas fluerosencesas as a precautionary measure to prevent soil borne diseases. For fertilizing the crop 50% nitrogen was applied at basal and

remaining 50% nitrogen was applied at 30 days after sowing (DAS) through vermicompost whereas, liquid formulation was applied at 30, 45 and 60 DAS. The liquid formulations were prepared as per the method suggested by National Centre for Organic Farming, Ghaziabad. Jeevamrut: Mix cow dung 10 kg, cow urine 10 lit, Jaggary 2 kg, pulse grain flour 2 kg and live forest soil 1 kg in 200 lit of water. Ferment for 7 days. Stir the solution regularly three times a day. Amritpani: Mix 10 kg cow dung with 500 gm honey and mix thoroughly to form a creamy paste. Add 250 gm of cow desi ghee and mix at high speed and dilute with 200 lit. of water.

RESULTS AND DISCUSSION

Growth, yield attributes and yield

Data regarding effect of land configuration, fertilizer level and liquid formulation on plant height, root volume and root girth at harvest are presented in Table 1.

The effect of land configuration did not show any significant effect on the plant height at harvest of carrot (Table 1). Slightly higher height was recorded in the broad bed treatment, but it did not reach to the level of significance. The treatment C_3 (Broad bed) recorded significantly higher root volume and root girth of 83.29 cm3 and 3.25 cm, respectively but it remained at par with the treatment C_2 (Ridges and Furrow) while the lowest root volume and root girth was observed under treatment C_1 (Flatbed). In the broad bed and ridges and furrows system soil remains soft and moist, which ultimately resulted in increased moisture and nutrient availability to the plants compared to the flat bed system (Mengel *et al*., 2001). Lower yield attributes with flat bed may be due to less retention of water resulting in insufficient water level in the root zone during the crop growth period.

Table 1: Effect of land configuration, fertilizer level, liquid formulation and their interaction effect on plant height, root volume and root girth of carrot.

Treatments	Plant height (cm)	Root volume (cm^3)	Root girth (cm)
Land Configuration (C)			
C_1- Flat Bed	74.54	75.46	2.94
C_2- Ridges	76.44	81.24	3.13
C_3- Broad Bed	77.18	83.39	3.25
SEm±	1.31	1.36	0.06
CD at 5%	NS	3.91	0.16
Fertilizer Level (F)			
F_1- 100 % N	78.6	82.56	3.22
F_2- 75 % N	75.72	80.58	3.15
F_3- 50 % N	73.85	76.94	2.95
SEm±	1.32	1.36	0.06
CD at 5%	3.78	3.91	0.16
Liquid Formulation (L)			
L_1- Jeevamrut	77.83	81.83	3.18
L_2- Amritpani	74.28	78.23	3.04
SEm±	1.07	1.1	0.06
CD at 5%	3.09	3.19	0.16
Interaction			
C×F SEm±	2.28	2.35	0.1
CD at 5%	NS	6.77	0.23
C×L SEm±	1.86	1.92	0.08
CD at 5%	NS	NS	NS
F × L SEm±	1.86	1.92	0.08
CD at 5%	NS	5.53	0.23
C×F×L SEm±	3.22	3.33	0.14
CD at 5%	NS	NS	NS
CV (%)	7.3	7.21	7.6

The results on growth and yield attributes revealed that among the different levels of fertilizer, F_1 (100% N through vermicompost) showed significantly higher plant height, root volume and root girth of 78.60 cm, 82.56 cm3 and 3.22 cm, respectively but remained at par with the treatment F2 (75 % N through vermicompost) with value of 80.58 cm3 and 2.95 cm in the case of root volume and root girth at harvest. Significantly lowest value of plant height, root volume and root girth was recorded under the treatment F_3 *i.e.* 50 % vermicompost (Table 1). Addition of vermicompost not only enhanced the nutrients availability by producing gibberellin, cytokine and auxins resulting in uptake of nutrients that may have favoured plant growth and yield, and it also improve the soil structure and maintain moisture availability. Similarly, when chickpea crop was fertilized with 100% N through biocompost:vermicompost:castorcake and additionally foliar application cow urine (2%) received maximum grain and stover yield under south Gujarat condition (Bag *et al*., 2015). According to Arancon *et al*. (2003) vermicompost combination with vermiwash applied at very low rates (2.5 to 5.0 t ha^{-1}) can significantly enhanced the growth parameter such as plant height, yield *etc*. The similar result in carrot was also reported by Kirad *et al*. (2010) and Mazed *et al*. (2015) and, Patel *et al*. (2016) in onion.

With respect to the treatment of liquid formulations more plant height (77.83 cm), root volume (81.83 cm3) and root girth (3.18 cm) was observed under L_1 (Jeevamrut) at harvest compared to L_2 (Table 1). The organic formulations activate the biological reactions in the soil and to protect the plants from diseases incidence which also become responsible to enhance the growth and crop yield. Similarly, Gore and Sreenivasa (2011) also reported highest plant growth and root length as well as yield of tomato with the application of RDF + Beejamruth + Jeevamruth + Panchgavya. These also agree with Vinaykumar and Neeraj (2015) and Sankar et al (2009) who used panchgavya as liquid fertilizer in onion crop.

The results revealed that interaction of land configuration, fertilizer level and liquid formulation *viz*., CxF, CxL, FxL and CxFxL were failed to exert any significant effect on plant height. Among the various two factor interactions, interaction between CxL was found non significant, whereas remaining interactions were significant. Interaction of CxF showed significant effect on root volume (Table 2). The combination of C_3F_1 produced significantly higher root volume (89.53 cm3) and root girth (3.47 cm) which was remained at par with treatment combination C_3F_2 (86.22 cm^3 and 3.33 cm of root volume and root girth, respectively). The significantly lower root volume (74.43 cm3) was recorded under combination of C_3F_3 while significantly lower root girth was recorded with the treatment combination C_1F_3 (2.75 cm), which was at par with C_2F_1 combination.

Interaction between FxL also showed a significant effect on the root volume and root girth (Table 2 and 3) of carrot. The combination of F_2L_1 gave significantly higher root volume (85.83 cm^3) but it was remained at par with the treatment

Table 2: Interaction effect of C x F and F x L on root volume (cm^3) of carrot.

Land Configuration (C)	Fertilizer level (F)			Fertilizer Level (F)	Liquid formulation (L)	
	F_1- 100 % N	F_2- 75 % N	F_3- 50 % N		L_1- Jeevamrut	L_2- Amritpani
C_1- Flat Bed	75.13	75.67	75.57	F_1- 100 % N	84.66	80.47
C_2- Ridges	83.02	79.87	80.83	F_2- 75 % N	85.83	75.33
C_3- Broad Bed	89.53	86.22	74.43	F_3- 50 % N	74.99	78.9

Table 3 : Interaction effect of C x F and F x L on root girth (cm) of carrot

Land Configuration (C)	Fertilizer level (F)			Fertilizer Level (F)	Liquid formulation (L)	
	F_1- 100 % N	F_2- 75 % N	F_3- 50 % N		L_1- Jeevamrut	L_2- Amritpani
C_1- Flat Bed	3.17	2.9	2.75	F_1- 100 % N	3.41	3.03
C_2- Ridges	3.02	3.33	3.05	F_2- 75 % N	3.13	3.17
C_3- Broad Bed	3.47	3.23	3.05	F_3- 50 % N	3	2.91

Table 4: Effect of land configuration, fertilizer level, liquid and their interaction effect formulation on root length, shoot length and yield of carrot.

Treatments	Root length (cm)	Shoot length (cm)	Yield (t/ha)
Land Configuration (C)			
C_1- Flat Bed	16.68	76.39	9.92
C_2- Ridges	17.87	80.13	10.74
C_3- Broad Bed	19.85	79.66	11.14
SEm ±	0.42	1.11	0.26
CD at 5%	1.21	3.19	0.74
Fertilizer Level (F)			
F_1- 100 % N	20.41	80.69	11.24
F_2- 75 % N	17.46	79.22	10.61
F_3- 50 % N	16.52	76.26	9.94
SEm ±	0.42	1.11	0.26
CD at 5%	1.21	3.19	0.74
Liquid Formulation (L)			
L_1- Jeevamrut	18.48	78.88	11.19
L_2- Amritpani	17.78	78.57	10.01
SEm ±	0.34	0.9	0.21
CD at 5%	NS	NS	0.6
Interaction			
C×F SEm ±	0.72	1.92	0.45
CD at 5%	2.09	5.53	1.29
C×L SEm ±	0.59	1.57	0.37
CD at 5%	NS	NS	NS
F × L SEm ±	0.59	1.57	0.37
CD at 5%	1.71	NS	1.05
C×F×L SEm ±	1.03	2.72	0.63
CD at 5%	NS	NS	NS
CV (%)	9.8	5.98	10.41

combinations of F_1L_1 (84.66 cm3) and F_1L_2 (80.47 cm^3). The significantly lower root volume (74.99 cm3) was recorded under combination F_3L_1 however; it remained at par with F_3L_2 and F_1L_2 treatment combinations. The higher order interaction was found non significant. In the case with root girth F_1L_1 resulted in significantly higher value (3.41 cm) but it remained at par with F_2L_1 (3.13 cm) and F_3L_1 (3.00 cm). The significantly lower root girth (2.91 cm) was recorded with combination of F_3L_2 which was statistically similar to F_2L_1 combination.

The results were also in agreement with Shwetha and Babalad (2008) and Chandrakala (2008) when they have applied organic manures in combination with fermented organics *viz*., Beejamrut, Jeevamrut, Panchgavya to soybean-wheat cropping system and observed significantly higher leaf area index, plant height, number of branches, dry matter accumulation, seed yield and yield parameters like number of pods per plant over organics alone application.

Data regarding effect of land configuration, fertilizer level and liquid formulation on root length, shoot length and yield at harvest are presented in Table 4.

The mean root length was significantly affected due to land configuration. The treatment C_3 (Broad bed) recorded significantly superior root length (19.85 cm) whereas the lowest root length of 16.68 cm was recorded with the treatment C_1 (Flat bed), but the values under C_1 and C_2 were at par. Sowing carrot on ridges (C_2) enhanced the shoot length (80.13 cm) followed by C_3- broad bed (79.65 cm). Flat bed (C_1) type of configuration recorded smaller shoot length. The results of land configuration significantly affected on root weight of carrot and maximum root yield (11.14 t/ha) was observed under C_3 (Broad bed) treatment. It was significantly higher than C_1 (Flat bed) treatment (9.92 t/ha) but was similar (10.74 t/ha) to C_2 (Ridges and furrow). The increase in yield attributes with broad bed over ridges and furrows could be attributed to loose friable soil, improved physical properties such as lower bulk density, better aeration and lower penetration resistance. (Mengel *et al*., 2001).

The different treatment of vermicompost application was found significant on the root length, shoot length and carrot yield (Table 4). The fertilizer level F_1- 100% N through vermicompost recorded significantly highest root length (20.41 cm) as compared to other levels. It was found significantly superior over other treatments. The lowest root length (16.52 cm) was obtained with F_3 (50% N through vermicompost) however, it was at par with F_2 (50% N through vermicompost). The different levels of vermicompost application also exerted significant effect on the shoot length of carrot. The significantly highest shoot length (80.69 cm) was recorded with the treatment F_1 but remain at par with the treatment F_2 and lowest shoot length (76.26 cm) was recorded with the treatment F_3. Application of N through vermicompost at different rates was affected significantly on the root yield of carrot. The values of root yield obtained at 100%, 75% and 50% N application through vermicompost were 11.24, 10.61 and 9.94 t/ha respectively. Among which values of F_1 and F_2 were at par. The ability of organic manure to improve the chemical properties of soil as well as it release its nutrient in to the soil, which make it an ideal input for good carrot crop yield. Ahmed *et al*. (2014) found the similar result in carrot, Kirad *et al*. (2010) in carrot, Mazed *et al*. (2015) in carrot. Similar results were also obtained by Gadelrab and ELAmin (2013) when they have applied

Table 5: Interaction effect of C x F and F X L on root length (cm) of carrot.

Land Configuration (C)	Fertilizer level (F)			Fertilizer Level (F)	Liquid formulation (L)	
	F_1- 100 % N	F_2- 75 % N	F_3- 50 % N		L_1- Jeevamrut	L_2- Amritpani
C_1- Flat Bed	17.11	16.28	16.63	F_1- 100 % N	20.94	19.87
C_2- Ridges	21.57	16.43	15.6	F_2- 75 % N	19.46	15.45
C_3- Broad Bed	22.54	19.67	17.34	F_3- 50 % N	15.04	18.01

Table 6: Interaction effect of C x F on shoot length (cm) of carrot.

Land Configuration (C)	Fertilizer Level (F)		
	F_1- 100 % N	F_2- 75 % N	F_3- 50 % N
C_1- Flat Bed	78.7	74.34	76.13
C_2- Ridges	81.03	79.97	79.38
C_3- Broad Bed	82.33	83.37	73.28

Table 7: Interaction effect of C x F and F x L on carrot yield (t/ha).

Land Configuration (C)	Fertilizer level (F)			Fertilizer Level (F)	Liquid formulation (L)	
	F_1- 100 % N	F_2- 75 % N	F3- 50 % N		L_1- Jeevamrut	L_2- Amritpani
C_1- Flat Bed	10.9	9.47	9.4	F_1- 100 % N	12.54	9.95
C_2- Ridges	11.56	10.24	10.41	F_2- 75 % N	10.85	10.37
C_3- Broad Bed	11.28	12.12	10.01	F_3- 50 % N	10.16	9.71

Table 8: Effect of land configuration, fertilizer level, liquid formulation and their interaction effect on carotene, TSS and carbohydrate content of carrot.

Treatments	Carotene (mg/100 g)	TSS (°brix)	Carbohydrate (%)
Land Configuration (C)			
C_1- Flat Bed	5.04	14.03	8.16
C_2- Ridges	5.05	14.04	8.18
C_3- Broad Bed	5.07	14.11	8.21
SEm±	0.05	0.05	0.03
CD at 5%	NS	NS	NS
Fertilizer Level (F)			
F_1- 100 % N	5.13	14.15	8.2
F_2- 75 % N	5.09	14.1	8.19
F_3- 50 % N	4.93	13.93	8.16
SEm±	0.05	0.05	0.03
CD at 5%	0.14	0.14	NS
Liquid Formulation (L)			
L_1- Jeevamrut	5.11	14.12	8.19
L_2- Amritpani	4.99	14	8.18
SEm±	0.03	0.04	0.03
CD at 5%	0.11	0.11	NS
Interaction			
C×F SEm±	0.08	0.07	0.06
CD at 5%	NS	NS	NS
C×L SEm±	0.07	0.07	0.05
CD at 5%	NS	NS	NS
F × L SEm±	0.07	0.08	0.05
CD at 5%	0.2	0.24	NS
C×F×L SEm±	0.12	0.12	0.08
CD at 5%	NS	NS	NS
CV (%)	4.1	1.51	1.7

compost Elshomokh and compost Alkhaseeb on onion.

The effect of liquid formulation was found non-significant and the maximum root length (18.48 cm) of carrot was observed with L_1 (Jeevamrut) and minimum (17.78 cm) with L_2 (Amritpani). However the different liquid formulation did not showed any significant response on root length. In case with root yield the significantly maximum yield (11.19 t/ha) was obtained with L_1 (Jeevamrut) treatment whereas L_2 (Amritpani) yielded 10.01 t/ha of carrot yield (Table 4). The increase in yield might be due to application of microorganisms enriched organic sources which may create maximum nutrient availability to plant. Patil *et al*. (2012) also found highest grain and straw yield of soybean when they have applied 100 per cent RDN through vermicompost + jeevamrut which was statistically at par with the application of 100 per cent RDN through FYM + jeevamrut.

The interaction effect of land configuration and fertilizer level (CxF) as well as fertilizer level x land configuration (FxL) resulted significant effect on root length (Table 5). The treatment combination C_3F_1 registered significantly higher root length (22.54 cm) but did not differ statistically with C_2F_1. The lowest root length was recorded with C_2F_3 combination (15.60 cm). Another second order interaction of FxL was also showed significant effect on root length (Table 5). From interaction point of view the combinations F_1L_1, F_1L_2 and F_2L_1 maintain their superiority in root length while, the lowest value of 15.04 cm of root length was recorded with combination of F_3L_1. It was at par with F_2L_2 combination.

The interaction of land configuration and fertilizer level (CxF) recorded significant effect on shoot length (Table 6) and the treatment combination of C_3F_2 recorded significantly higher shoot length (83.36 cm), but remained at par with C_2F_1, C_3F_1, C_2F_2 and C_2F_3. The other interactions CxL, FxL and CxFxL on shoot length were failed to reach the level of significance.

Similar to root length of carrot, the interaction effect of CxF and FxL were also found significant with root yield of carrot. The result presented in Table 7 reflected that the C_3F_2 combination yielded significantly highest (12.12 t/ha) carrot yield which remained at par with C_2F_1 and C_3F_1. The lowest yield (9.40 t/ha) was obtained with C_1F_3 however, it was statistically at par with combination of C_1F2, C_2F_2 and C_2F_3 with value of 9.47, 10.24 and 10.41 t/ha, respectively. Interaction of FxL significantly yielded highest (12.54 t/ha) carrot root under combination of F_1L_1 which was significantly superior over other combinations as remaining combinations yielded significantly lower root and showing no difference between them.

Table 9: Interaction effect of F x L on carotene and TSS content of carrot.

Fertilizer Level (F)	Carotene content (mg/100 g)		TSS (°brix)	
	L_1- Jeevamrut	L_2- Amritpani	L_1- Jeevamrut	L_2- Amritpani
F_1- 100 % N	5.16	5.1	14.19	14.1
F_2- 75 % N	5.08	5.1	14.08	14.11
F_3- 50 % N	5.09	4.77	14.09	13.77

Quality Parameters

Generally, chemical composition of plant reflects on quality of product. Inorganic elements, which are mostly supplied through fertilizer naturally, react with organic elements during metabolism process in the plant body and as a result new organic compound is formed. In the present study carotene, TSS and carbohydrate compounds present in carrot root were quantitatively determined. Its results are described in Table 8. The results indicated that treatments of different land configuration, fertilizer level, liquid formulation and their interaction produced non-significant effect on carbohydrate content in carrot. All the treatments showed almost similar carbohydrate content.

Results regarding carotene and TSS content did not influenced due to land configuration indicating land configuration has no effect on quality parameters of carrot. Numerically higher value of carotene and TSS content of 5.07 mg/100g and 14.11 Obrix, respectively was noted in broad bed method (Table 8). The results are in proximity with Desai (1989) who reported non-significant effect of land configurations on quality parameters of groundnut at Rahuri. Balwinder Kumar and Gill (2009) while growing turmeric on Flat and Ridges concluded that planting method did not influence the quality characters of turmeric.

A perusal of the data presented in Table 8 indicated that the different treatment of fertilizer level significantly affected the carotene and TSS content of the carrot. Both the parameters were significantly highest (5.13 mg/100g of carotene and 14.15 °brix of TSS) in the F_1 treatment (100% N through vermicompost) but the values were at par with the treatment F_2 treatment (75% N through vermicompost) and that of lowest in treatment F_3 treatment (50% N through vermicompost). Vermicompost which is produced by earthworms is a rich source of both micro and macro nutrients, vitamins, growth hormones and enzymes increase organic carbon content of soil and improve soil physical properties. This results to better availability and uptake of nitrogen and other nutrients in combination of manures which might have lead to the balance C:N ratio and increased activity of plant metabolism which lead to increase in carotene content and TSS in carrot. Ahmed *et al*. (2014), Chatterjee *et al*. (2014) and Kirad *et al*. (2010) found similar result in carrot. Contrary with the carbohydrate content in this case it was found non significant but with the case of greater yam under organic farming having 100% N application it was found significant (Kaswala *et al*., 2013).

The different liquid formulations induced significant effect on carotene and TSS content of carrot (Table 8). Application of Jeevamrut showed its superiority and synthesized more carotene (5.11 mg/100 g) and TSS (14.12 °brix) than the application of Amritpani which contained 4.99 mg/100g of carotene and 14.00 °brix of TSS. The organic liquid are eco-friendly organic preparations made from cow products and contain nutrients, vitamins, amino acids, growth promoting substances like IAA, GA and beneficial microorganisms which can be responsible for quality improvement (Natrajan, 2007 and Sreenivasa *et al*., 2009).

Among the various interactions, the interaction between fertilizer level and liquid formulation only produced significant effect on carotene and TSS content of carrot (Table 9). The perusal of data indicated that when 100% N was supplied along with Jeevamrut @600 l/ha (F_1L_1) favors to increase the carotene and TSS content. However, for carotene content it was at par with F_2L_1, F_3L_1, F_1L_2 and F_3L_2 and for TSS content F_2L_1, F_3L_1, F_1L_2 and F_2L_2. Sunanda Rani and Malareddy (2007) also reported that application of organic manure in carrot resulted in maximum carotene (4.6 mg kg^{-1}), total sugar and total soluble salts (TSS) when compared to other INM treatments.

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