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Impact of Land Configuration and Various Organic Sources on Yield, Nutrient Content and Uptake by Carrot in Organic Farming

B. Solanki[1], A. R. Kaswala[2*], P. K. Dubey[2] and A. P. Italiya[2]

[1]Department of Soil Science and Agricultural Chemistry, N. M. Collage of Agriculture, India
[2]Department of Natural Resource Management, ASPEE Collage of Horticulture & Forestry, Navsari Agricultural University, Navsari, 396 450, Gujarat, India

**Corresponding author*

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A B S T R A C T

A field experiment was conducted at 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 yield, nutrient content and uptake by 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. The yield was significantly highest with individual treatments C_3, F_1 and L_1 and 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. The nutrient content in root and shoot was not found significant but their total uptake with the treatment C_3 of land configuration, F_1 of fertilizer level and L_1 of liquid formulation were significantly improved. Interaction effect of C x F and F x L had a beneficial effect on total uptake of N, P and K.

Introduction

Nowadays, the indiscriminate use of inorganic fertilizers are producing very hazardous effect on soil properties as well as lowering the 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 fertilizers 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 fertilizers 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. Dilute in water up to 200 lit.

Results and Discussion

Data regarding effect of land configuration, fertilizer level and liquid formulation on root and shoot yield as well as their nutrient content and total uptake are discussed below.

Root and shoot yield

The results of land configuration significantly affected root (11.14 t/ha) and shoot yield (19.29 t/ha) of carrot which was observed maximum under C_3 (Broad bed) treatment. Root and shoot yield was 11 and 16.5 percent, higher than C_1 (Flat bed) respectively when compared with broad bed method (Table 1). Sowing on high elevation is beneficial to clayey soil. 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 values of root yield obtained with 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. Similarly significantly maximum shoot yield was recorded with 100% and 75% N application (Table 1). 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.,* (2014a,b) 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). Amzad *et al.,* (2005) also found that shoot biomass, largest rhizome stub and the highest yield coupled with the lowest weed biomass in turmeric

In case with liquid formulation, the root yield found significantly maximum (11.19 t/ha) with L_1 (Jeevamrut) treatment whereas there were no any significant effect of liquid formulation on shoot yield (Table 1). 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 as well as shoot yield of carrot (Table 2 and 3). The result presented in Table 2 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_1F_2, C_2F_2 and C_2F_3 with value of 9.47, 10.24 and 10.41 t/ha, respectively. Interaction of fertilizer level and liquid formulation (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. Similarly interaction effect of land configuration and fertilizer level (CxF) was also found significant with shoot yield of carrot and recorded maximum with C_3F_2 combination (Table 3).

Nutrient content and uptake

The data on nutrient content and uptake (N, P and K) affected by land configuration, fertilizer level and liquid formulation are presented in Table 4 & 5.

Nutrient content

The plant samples of root and shoot of carrot collected at harvest were analyzed for major nutrient content. The data of N, P and K content in the root and shoot of carrot as affected by different treatments of land configuration, fertilizer level and liquid formulation are presented in Table 4.

The data of N, P and K content in root and shoot of carrot revealed that no significant difference in any of this major nutrient content in root and shoot were found due to land configuration. Numerically higher value of all these nutrient contents was observed in broad bed (C_3).

The result regarding effect of fertilizer levels on N, P and K contents in root and shoot of carrot is reported in Table 4. It revealed that concentration of N, P and K in root and shoot of carrot did not vary significantly due to different treatments of fertilizer level.

Table.1 Effect of land configuration, fertilizer level, liquid formulation and their interaction effect on yield

Treatments	Root yield (t/ha)	Shoot yield (t/ha)
Land Configuration (C)		
C_1- Flat Bed	9.92	16.10
C_2- Ridges	10.74	18.28
C_3- Broad Bed	11.14	19.29
SEm±	0.26	0.08
CD at 5%	0.74	0.23
Fertilizer Level (F)		
F_1- 100 % N	11.24	18.03
F_2- 75 % N	10.61	18.03
F_3- 50 % N	9.94	17.62
SEm±	0.26	0.08
CD at 5%	0.74	0.23
Liquid Formulation (L)		
L_1- Jeevamrut	11.19	17.91
L_2- Amritpani	10.01	17.88
SEm±	0.21	0.07
CD at 5%	0.60	NS
Interaction		
C×F SEm±	0.45	0.14
CD at 5%	1.29	0.41
C×L SEm±	0.37	0.12
CD at 5%	NS	NS
F × L SEm±	0.37	0.12
CD at 5%	1.05	NS
C×F×L SEm±	0.63	0.20
CD at 5%	NS	NS
CV (%)	10.41	1.9

Table.2 Interaction effect of L x F and F x L on carrot yield (t ha^{-1})

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	10.90	9.47	9.40	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
SEm±	0.45			SEm±	0.37	
CD at 5%	1.29			CD at 5%	1.05	

Table.3 Interaction effect of C x F on carrot shoot yield (t ha^{-1})

Land Configuration(C)	Fertilizer level (F)		
	F_1- 100 % N	F_2- 75 % N	F_3- 50 % N
C_1- Flat Bed	16.40	16.38	15.52
C_2- Ridges	18.33	18.15	18.37
C_3- Broad Bed	19.37	19.55	18.97
SEm±	0.14		
CD at 5%	0.41		

Table.4 Effect of land configuration, fertilizer level, liquid formulation and their interaction effect on macronutrient content of root and shoot in carrot

Treatments	N content (%)		P content (%)		K content (%)	
	Root	Shoot	Root	Shoot	Root	Shoot
Land Configuration (C)						
C_1- Flat Bed	1.11	1.81	0.46	0.32	1.04	0.29
C_2- Ridges	1.12	1.84	0.46	0.33	1.05	0.30
C_3- Broad Bed	1.13	1.86	0.47	0.34	1.06	0.31
S.Em±	0.01	0.02	0.01	0.004	0.01	0.004
CD at 5%	NS	NS	NS	NS	NS	NS
Fertilizer Level (F)						
F_1- 100 % N	1.15	1.85	0.48	0.34	1.06	0.31
F_2- 75 % N	1.13	1.83	0.47	0.33	1.05	0.30
F_3- 50 % N	1.09	1.82	0.45	0.32	1.05	0.29
S.Em±	0.02	0.02	0.01	0.004	0.01	0.004
CD at 5%	NS	NS	NS	NS	NS	NS
Liquid Formulation (L)						
L_1- Jeevamrut	1.13	1.84	0.47	0.33	1.06	0.30
L_2- Amritpani	1.12	1.83	0.47	0.32	1.05	0.29
S.Em±	0.02	0.02	0.01	0.003	0.01	0.003
CD at 5%	NS	NS	NS	NS	NS	NS
Interaction						
C×F S.Em±	0.02	0.03	0.01	0.01	0.01	0.01
CD at 5%	NS	NS	NS	NS	NS	NS
C×L S.Em±	0.02	0.03	0.01	0.01	0.01	0.01
CD at 5%	NS	NS	NS	NS	NS	NS
F × L S.Em±	0.03	0.04	0.01	0.01	0.02	0.01
CD at 5%	NS	NS	NS	NS	NS	NS
C×F×L S.Em±	0.04	0.05	0.02	0.01	0.02	0.01
CD at 5%	NS	NS	NS	NS	NS	NS
CV (%)	6.2	4.9	6.8	5.9	4.0	6.0

Table.5 Effect of land configuration, fertilizer level, liquid formulation and their interaction effect on total macro nutrient uptake by carrot

Treatments	Total uptake (kg ha^{-1})		
	N	P	K
Land Configuration (C)			
C_1- Flat Bed	47.88	13.46	23.77
C_2- Ridges	58.92	16.34	28.65
C_3- Broad Bed	63.71	17.83	30.92
SEm±	0.67	0.31	0.59
CD at 5%	1.95	0.88	1.71
Fertilizer Level (F)			
F_1- 100 % N	59.51	16.97	29.55
F_2- 75 % N	57.17	15.88	27.80
F_3- 50 % N	53.84	14.79	25.98
SEm±	0.67	0.31	0.59
CD at 5%	1.95	0.88	1.71
Liquid Formulation (L)			
L_1- Jeevamrut	58.38	16.54	29.21
L_2- Amritpani	55.29	15.21	26.35
SEm±	0.55	0.25	0.48
CD at 5%	1.59	0.72	1.39
Interaction			
C×F SEm±	1.16	0.53	1.02
CD at 5%	3.38	1.53	2.95
C×L SEm±	0.96	0.43	0.83
CD at 5%	2.76	NS	NS
F × L SEm±	0.96	0.43	0.83
CD at 5%	2.76	1.25	2.41
C×F×L SEm±	1.66	0.75	1.45
CD at 5%	NS	NS	NS
CV (%)	5.07	8.19	9.07

Table.6 Interaction effect of land configuration and fertilizer level on total N, P and K uptake (kg ha^{-1}) by carrot

Land Configuration (C)	Fertilizer Level (F)								
	F_1- 100 % N			**F_2- 75 % N**			**F_3- 50 % N**		
	N	**P**	**K**	**N**	**P**	**K**	**N**	**P**	**K**
C_1- Flat Bed	50	15	26	47	13	22	46	13	23
C_2- Ridges	64	18	31	57	16	28	56	16	28
C_3- Broad Bed	65	18	32	67	19	34	59	16	27

Table.7 Interaction effect of fertilizer level and liquid formulation on total N, P and K uptake (kg ha^{-1}) by carrot

Fertilizer Level (F)	Liquid Formulation (L)					
	L_1- Jeevamrut			L_2- Amritpani		
	N	P	K	N	P	K
F1- 100 % N	63	18	33	56	16	27
F2- 75 % N	58	16	29	56	16	27
F3- 50 % N	54	15	26	54	14	26

Table.8 Interaction effect of land configuration and liquid formulation on total N uptake (kg ha^{-1}) by carrot

Land Configuration (C)	Liquid Formulation (L)	
	L_1- Jeevamrut	L_2- Amritpani
C_1- Flat Bed	48	48
C_2- Ridges	61	57
C_3- Broad Bed	67	61

The assessment of the data revealed that the N, P and K content in root and shoot of carrot did not influence significantly due to liquid formulations. The interaction effect of land configuration, fertilizer level and liquid formulation was non-significant in all the cases of major nutrient content.

Total uptake

The individual nutrient uptake by root and shoot were worked out by computing the value of content in dry root as well shoot and by using these value total uptake of nutrient was work out by summation of individual nutrient uptake is presented in Table 5 to 8.

The result regarding total uptake of macronutrients revealed that the effect of different treatments of land configuration significantly affected the total uptake of N, P and K by carrot plant. Highest total uptake of N, 63.71 kg ha^{-1} was observed due to C_3 (Broad bed) treatment followed by 58.92 kg ha^{-1} due to C_2 (Ridge and furrow) and 47.88 kg ha^{-1} due to C_1 (Flat bed). The treatment C_3 was found significantly superior over all the other treatment. Similar trend was also observed in case of total P uptake by carrot plant. Maximum total P uptake was recorded under C_3 treatment (17.83 kg ha^{-1}) whereas the minimum total uptake of P was observed in C_1 treatment (16.34 kg ha^{-1}). Like total uptake of N and P, total uptake of K (Table 5) was also behaved similarly and highest total uptake of K (30.92 kg ha^{-1}) was obtained under C_3 (Broad bed) followed by C_2 treatment (28.65 kg ha^{-1}) and least with C_1 (23.77 kg ha^{-1}).

Application of N through vermicompost at different rates was found significant on total uptake of N, P and K (Table 5). The significantly highest total uptake of N (59.51 kg ha^{-1}) noted at highest level of N application (100 % N) which found decreased with decrease in level of N application and the lowest value of total N uptake (53.84 kg ha^{-1}) was reported at 50% N application. Similar result was also observed for the total uptake of P and K by carrot plant.

The data of total uptake of N, P and K as influenced by the treatment of Jeevamrut (L_1)

and Amritpani (L_2) are presented in Table 5. Application of 600 l/ha of Jeevamrut (L_1) showed significantly higher value of 58.38, 16.45 and 29.21 kg/ha of total uptake N, P and K by carrot, respectively. The treatment L_2 (Amritpani) removed less amount total N, P and K from soil.

The interaction effect of C x F was found to be significant on the total uptake of all the macronutrients (N, P and K) individually. Results presented in Table 6 revealed that treatment combination C_3F_2 removed highest amount of N (67 kg ha^{-1}) followed by C_3F_1 (65 kg ha^{-1}) and C_2F_1 (64 kg ha^{-1}) which were statistically similar. Significantly lower but at par value of total N uptake was recorded under C_1F_3 (46 kg ha^{-1}), C_1F_2 (47 kg ha^{-1}) and C_1F_1 (50 kg ha^{-1}). Interaction of C x F was also significantly affected the total P uptake by carrot and followed almost similar pattern as obtained in the case of total uptake of N. Significantly more amount of total uptake of P was occurred under C_3F_2 (19 kg ha^{-1}) followed by C_3F_1 (18 kg ha^{-1}) and C_2F_1 (18 kg ha^{-1}) treatments. The treatment combination C_3F_2, C_3F_1 and C_2F_1 were statistically same and minimum amount of 13 kg ha^{-1} was removed by C_1F_3 treatment. It was significantly lowest, however it was statistically at par with C_1F_2 (13 kg ha^{-1}) and C_1F_1 (15 kg ha^{-1}). Interaction effect of C x F on total uptake of K by carrot was conspicuous but found significant. The total uptake of K with respect to C x F treatment ranged from 22 kg ha^{-1} under C_1F_2 combination to 34 kg ha^{-1} under C_3F_2 combination but the treatment C_3F_2 and C_3F_1 as well as treatment C_1F_2 and C_1F_3 showed non significant difference between them (6).

The interaction of F x L also influenced on the total uptake of N, P and K by carrot. Total uptake of N by carrot varied significantly due to F x L treatment effect (Table 7). The F_1L_1 treatment removed significantly highest amount of N (63 kg ha^{-1}) compared to rest of the treatments and F_3L_2 and F_1L_2 were same with respect to statistics. In case with total uptake of P, treatment F_1L_1 registered significantly higher total P uptake (18 kg ha^{-1}) in comparison to rest of combinations of F x L. It was significantly superior among all the combinations. Significantly lower value of 14 kg ha^{-1} total P uptake was recorded with F_3L_2 treatment and it was at par with F_2L_2 (16 kg ha^{-1}), F_1L_2 (16 kg ha^{-1}) and F_3L_1 (15 kg ha^{-1}) treatments (Table 7). Similar to those of N and P, total uptake of K was also affected considerably due to interaction effect of F x L. The treatment combination F_1L_1 recorded to significantly higher K uptake (33 kg ha^{-1}) compared to other combination and it continued to show its superiority over rest of the combination (Table 7). Significantly lower values of uptake of K (26 kg ha^{-1}) by carrot was obtained with F_3L_2 treatment and was at par with F_2L_1 (29 kg ha^{-1}), F_1L_2 (27 kg ha^{-1}) and F_3L_1 (26 kg ha^{-1}).

Interaction effect of land configuration and liquid formulation (C x L) exerted significant effect only on total uptake of N by carrot while, their effects on total uptake of P and K was found non significant. Jeevamrut (L_1) application in Broad bed (C_3) (*i.e.* C_3L_1) resulted in significantly superior total uptake of N (67 kg ha^{-1}) whereas in flat bed application (C_1L_1) it resulted significantly inferior (48 kg ha^{-1}) total uptake of N (Table 8).

The beneficial effects of land configuration along with solid and liquid fertilizer showed beneficial effects on the availability of plant nutrients in steady supply throughout crop growth partitioning into different nutrient uptake. These results are supported by finding of Ahmed *et al* (2014b), they attributed to the improvement in soil structure and enhanced nutrient and moisture availability and thus by increasing the uptake. They also observed that

the use of FYM, shoot manure and poultry manure have beneficial effect on growth and yield of carrot. Patil and Kolambe (2013) recorded the maximum uptake of macro nutrients by garlic leaves and bulb in the treatment receiving 100 % castor cake + 2000 l banana sap followed by 1500 l banana sap. Due to the application of organic manures which results in enhancement of microbial activities in soil there by release of nutrients in available forms and directly taken up by plant. Hence there was higher uptake of nutrients. Similar increased in uptake of nutrient in onion due to fertilizer levels and banana sap was also reported by Salunkhe *et al.,* (2012) in onion and in carrot by Zakir *et al.,* (2012). The overall improvement in physic-chemical and biological properties due to combined application of organic solid and liquid manures which may be attributed due to higher microbial activity and plant growth promoters present in it responsible for higher yield and uptake of crop (Gore and Sreenivasa, 2011).

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