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Effect of organic, inorganic and bio-fertilizers on physic-chemical properties of fruits of guava cv. l-49

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Abstract
The present experiments were conducted during two consecutive years and pooled analysis also worked out. The investigation comprised ten different treatments of organic, inorganic and bio-fertilizers viz., T_1-Control (Without nutrient application), T_2-100% RDF (400:300:400 gm NPK/tree), T_3-75% RDF + FYM (40 Kg /tree), T_4-50% RDF + FYM (70 Kg /tree), T_5-75% RDF + *Azospirillum* (250 gm/tree), T_6-50% RDF + *Azospirillum* (250 gm/tree), T_7-75% RDF + PSB (250 gm/tree), T_8-50% RDF + PSB (250 gm/tree), T_9-75% RDF + *Azospirillum* (250 gm/tree)+ PSB (250 gm/tree) and T_{10}- 50% RDF + *Azospirillum* (250 gm/tree)+ PSB (250 gm/tree). The observations were recorded on physical and chemical attributes of fruits. The present investigation revealed that the all the physical and chemical attributes significantly influenced due to the application of different integrated treatments. The application of 75% RDF + FYM 40 Kg /tree (T_3) produced highest fruit weight, fruit length, fruit diameter, volume of fruit and pulp weight of fruit followed by treatment T_2 (100% RDF, 400:300:400 gm NPK/tree). However, minimum average fruit weight fruit length, fruit diameter, volume of fruit and pulp weight were recorded in T_1 (without nutrient application). The maximum accumulation of total soluble solids, acidity, ascorbic acid content, reducing, non-reducing, total sugars was observed with the soil application of 75% RDF + FYM 40 Kg /tree (T_3) as compared treatment T_1 (with out nutrition). Maximum TSS and Sugars acid ratio was calculated in treatment T_3 (75% RDF + FYM 40 Kg /tree) recoded followed by treatment T_{10} (50% RDF + *Azospirillum* (250 gm/tree + PSB (250 gm/tree). However, lowest TSS and sugar acid ratio was recorded in treatment T_1 (without nutrients application).

Keywords: INM, quality attributes, guava

Introduction
The fruit type of guava is a berry with large seedy core. The fruit may be smooth or ridge and waxy layer. Guava is shallow rooted shrub with spreading branches. The plant height is generally 4-5 meters but older trees may reach a height 9 meters. It can be grown in soils with pH ranging from 5.5-7.5 without any irrigation. It can stand maximum at above 46˚C temperature and lowest 12-14 ˚C. Guava fruits can be cultivated in saline, alkaline, waste and neglected lands where most of the horticultural crops cannot be grown.
Guava is fourth important fruit of India after mango, banana and citrus. It is cultivated throughout the tropical and subtropical region. The major Guava producing countries are South Asian countries of the world. Hawiion Island Cuba and India. (Mitra and Bose, 1985) [4].
In northern India guava plant bears flower twice or sometimes thrice in a year. The spring flowering is called “Ambe Bahar”, June or monsoon flowering is called “Mrig Bahar” and third flowering which comes in October is called “Hast Bahar”. Ambe Bahar fruit ripen from July to September and Mrig Bahar fruit ripen from November to February, however, Hast Bahar fruit ripen in spring season, which also known as summer season crop.
In North India including Uttar Pradesh there are two flowering season of guava April-May for rainy season and August - September for winter season crop.
Guava is a rich source of Vitamin C and Pectin. It contain 82.50 per cent water, 2.45 per cent Acid, 5.40 per cent reducing sugar, 4.80 per cent non-reducing, sugar, 13.60 0Brix total soluble solids, 0.48 per cent ash and 147.34 mg, Vitamin “C”/100gm fruit differ with cultivar, stage of maturity and season. Fruit pulp as well as good amount of iron, calcium and phosphorous. These fruit are consumed either fresh or processed in the form of products like jam, jelly, cheese, juice, nectar, ready to serve (RTS) etc.

In some counties the leaves are used for curing diarrhoea and also used for dyeing and tanning. The role of nutrients and plant growth regulators for improving the growth and development, fruit set, control of fruit drop, fruit maturation, fruit quality and overcoming the physiological and nutritional disorders have been well established in number of tropical, sub-tropical and temperate fruit crops (Ghosh, 1994) [3]. However, it has been studied the physiological, biochemical and biological activities in plant systems are highly influenced due to interaction of nutrients and plant growth regulators. Generally Indian soil is deficient to N and P. Nitrogen is one of the most important essential plant nutrients.

Materials and Methods

The present study was conducted on eight years old guava plants. cv. L-49 (Sardar), uniform thirty trees were selected for the experimental purpose. All the possible required cultural practices and basal application of manuers and fertilizers were followed as per recommended schedules.

Experimental details

The treatment combinations, consisting of different in-organic, organic and biofertilizers, were used to determine their effects on yield and quality of guava fruits. The details of experimental plan of present investigation as per proposed technical programme is given below:-

Total number of treatments-10

Treatments	Treatments combination
T_1	: Control (Without nutrient application)
T_2	: 100% RDF (400:300:400 gm NPK/tree)
T_3	: 75% RDF + FYM (40 Kg /tree)
T_4	: 50% RDF + FYM (70 Kg /tree)
T_5	: 75% RDF + Azospirillum (250 gm/tree)
T_6	: 50% RDF + Azospirillum (250 gm/tree)
T_7	: 75% RDF + PSB (250 gm/tree)
T_8	: 50% RDF + PSB (250 gm/tree)
T_9	: 75% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)
T_{10}	: 50% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)

Experimental Design - R.B.D. (Randomized Block Design)

Results and Discussion

The present study revealed that the physical characters *viz.*, average fruit weight, length of fruit, diameter of fruit, volume of fruit, pulp weight, number of seeds per fruit and seed weight per fruit were significantly differed treatments to treatments due to application of organic, inorganic and bio-fertilizers during both the years of experimentation and in pooled analysis.

It is evident from the results that the application of 75% RDF + FYM 40 Kg /tree (T_3) produced highest fruit weight, fruit length, fruit diameter, volume of fruit and pulp weight of fruit followed by treatment T_2 (100% RDF, 400:300:400 gm NPK/tree). However, minimum average fruit weight fruit length, fruit diameter, volume of fruit and pulp weight were recorded in T_1 (without nutrient application). The treatment T_3 produced significantly higher average fruit weight, fruit length, fruit diameter, volume of fruit and pulp weight than T_1, T_4, T_6, and T_8 and rest of the treatments produced fruit weight statistically at par with it during both the years (Y_1=2015-16 and Y_2=2016-17) of investigation and in pooled analysis. These favourable effects on physical attributes improvement in the treatment of combined application of organic and inorganic fertilizers may be due to the result of better vegetative growth of the treated plants which resulted in production of higher quantities of photosynthates such as starch and carbohydrates and their translocation to the fruits, thus increasing the length and diameter of fruits. The quality improvement in respect to physical attributes of fruits has also been reported by Sharma (2004) [6]. The lower values of these attributes in the control treatment (T_0) could be the result of poor vegetative growth on account of non- availability of required amount of nutrients during the developmental stages that might have produced fruits of poor quality.

The soil application of 75% RDF + FYM 40 Kg /tree (T_3) recorded minimum number of seeds per fruit and seeds weight per fruit followed by treatment T_4 (50% RDF + FYM @70 Kg /tree). However, maximum number of seeds per fruit and seeds weight per weight was recorded in T_1 (without nutrient application) during both the years (Y_1=2015-16 and Y_2=2016-17) of investigation and in pooled analysis. The present findings are in good agreement with the results reported of earlier researchers Sharma *et al.* (2009) [5] and Atom (2013) [1] in guava.

The quality attributes of guava *viz.*, total soluble solids, acidity, ascorbic acid content, reducing, non-reducing, total sugars, TSS acid ratio and sugar acid ratio were influenced due different organic, inorganic and bio-fertilizers application during both the years of investigation and in pooled analysis.

The maximum accumulation of total soluble solids, acidity, ascorbic acid content, reducing, non-reducing, total sugars was observed with the soil application of 75% RDF + FYM 40 Kg /tree (T_3) as compared treatment T_1 (with out nutrition). The application of 100% RDF, 400:300:400 gm NPK/tree remained statistically at par with treatment T_3 during both the years (Y_1=2015-16 and Y_2=2016-17) of investigation and in pooled analysis. However minimum accumulation of total soluble solids, acidity, ascorbic acid content, reducing, non-reducing, total sugars was observed in T_1 (Without nutrition). The application of inorganic fertilizers along with farm yard manure might have helped in improving the soil physical, chemical and biological condition thereby, making the efficient and balanced nutrient availability for the fundamental processes of the plants. The present findings are in accordance with the report of Sharma (2004) [6] in papaya and Atom (2013) [1] in guava.

The results of present investigation clearly indicated that the maximum TSS and Sugars acid ratio was calculated in treatment T_3 (75% RDF + FYM 40 Kg /tree) recoded followed by treatment T_{10} (50% RDF + *Azospirillum* (250 gm/tree + PSB (250 gm/tree). However, lowest TSS and sugar acid ratio was recorded in treatment T_1 (without nutrients application). The improvement in TSS and sugar acid ratio of fruits may be due to the balanced absorption of macro and micro nutrients which have exerted regulatory role as an important constituent of endogenous factors in affecting the quality of the fruits. The carbohydrate reserves of the roots and stems are drawn heavily which might have resulted in higher TSS and sugar contents in fruits. These findings are in alignment with earlier researcher Sharma (2004) [6] and Dey *et al.* (2005) [2] in guava.

Table 1: Effect of integrated nutrient management on average fruit weight

Treatments		g		
		Y_1	Y_2	Pooled
T_1	Control (Without nutrient application)	127.80	132.27	130.04
T_2	100% RDF (400:300:400 gm NPK/tree)	170.10	176.05	173.08
T_3	75% RDF + FYM (40 Kg /tree)	173.55	179.62	176.59
T_4	50% RDF + FYM (70 Kg /tree)	150.45	155.72	153.08
T_5	75% RDF + Azospirillum (250 gm/tree)	165.00	170.78	167.89
T_6	50% RDF + Azospirillum (250 gm/tree)	142.66	147.65	145.16
T_7	75% RDF + PSB (250 gm/tree)	164.75	170.52	167.63
T_8	50% RDF + PSB (250 gm/tree)	130.33	134.89	132.61
T_9	75% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	168.15	174.04	171.09
T_{10}	50% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	161.80	167.46	164.63
CD at 5%		12.70	13.15	12.93
SEm±		4.24	4.39	4.31

Table-2 Effect of integrated nutrient management on length of fruit

Treatments		cm		
		Y_1	Y_2	Pooled
T_1	Control (Without nutrient application)	5.12	5.24	5.18
T_2	100% RDF (400:300:400 gm NPK/tree)	8.29	8.48	8.39
T_3	75% RDF + FYM (40 Kg /tree)	9.18	9.40	9.29
T_4	50% RDF + FYM (70 Kg /tree)	6.47	6.63	6.55
T_5	75% RDF + Azospirillum (250 gm/tree)	7.94	8.13	8.03
T_6	50% RDF + Azospirillum (250 gm/tree)	6.30	6.45	6.37
T_7	75% RDF + PSB (250 gm/tree)	7.37	7.55	7.46
T_8	50% RDF + PSB (250 gm/tree)	6.00	6.14	6.07
T_9	75% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	8.12	8.32	8.22
T_{10}	50% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	7.12	7.29	7.20
CD at 5%		0.59	0.61	0.60
SEm±		0.19	0.20	0.20

Table-3: Effect of integrated nutrient management on diameter of fruit

Treatments		cm		
		Y_1	Y_2	Pooled
T_1	Control (Without nutrient application)	5.51	5.58	5.54
T_2	100% RDF (400:300:400 gm NPK/tree)	8.68	8.80	8.74
T_3	75% RDF + FYM (40 Kg /tree)	9.57	9.70	9.63
T_4	50% RDF + FYM (70 Kg /tree)	6.86	6.96	6.91
T_5	75% RDF + Azospirillum (250 gm/tree)	8.33	8.44	8.39
T_6	50% RDF + Azospirillum (250 gm/tree)	6.69	6.78	6.73
T_7	75% RDF + PSB (250 gm/tree)	7.76	7.87	7.81
T_8	50% RDF + PSB (250 gm/tree)	6.39	6.48	6.43
T_9	75% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	8.51	8.63	8.57
T_{10}	50% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	7.51	7.61	7.56
CD at 5%		0.62	0.63	0.63
SEm±		0.20	0.21	0.21

Table 4: Effect of integrated nutrient management on pulp weight of fruit

Treatments		g		
		Y_1	Y_2	Pooled
T_1	Control (Without nutrient application)	89.46	90.68	90.07
T_2	100% RDF (400:300:400 gm NPK/tree)	125.02	126.72	125.87
T_3	75% RDF + FYM (40 Kg /tree)	129.40	131.16	130.28
T_4	50% RDF + FYM (70 Kg /tree)	109.08	110.56	109.82
T_5	75% RDF + Azospirillum (250 gm/tree)	119.63	121.25	120.44
T_6	50% RDF + Azospirillum (250 gm/tree)	103.43	104.84	104.13
T_7	75% RDF + PSB (250 gm/tree)	119.44	121.07	120.26
T_8	50% RDF + PSB (250 gm/tree)	94.49	95.77	95.13
T_9	75% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	122.75	124.42	123.58
T_{10}	50% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	117.31	118.90	118.10
CD at 5%		9.23	9.35	9.29
SEm±		3.08	3.13	3.10

Table-5 Effect of integrated nutrient management on volume of fruit

Treatments		Cm³		
		Y1	Y2	Pooled
T1	Control (Without nutrient application)	124.31	126.00	125.15
T2	100% RDF (400:300:400 gm NPK/tree)	317.23	321.54	319.38
T3	75% RDF + FYM (40 Kg /tree)	387.43	392.70	390.07
T4	50% RDF + FYM (70 Kg /tree)	195.95	198.62	197.28
T5	75% RDF + Azospirillum (250 gm/tree)	291.72	295.69	293.70
T6	50% RDF + Azospirillum (250 gm/tree)	185.84	188.37	187.10
T7	75% RDF + PSB (250 gm/tree)	252.29	255.72	254.01
T8	50% RDF + PSB (250 gm/tree)	169.05	171.35	170.20
T9	75% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	304.96	309.11	307.03
T10	50% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	235.78	238.98	237.38
CD at 5%		21.02	21.30	21.16
SEm±		7.02	7.11	7.06

Table 6: Effect of integrated nutrient management on number of seeds per fruit

Treatments				
		Y1	Y2	Pooled
T1	Control (Without nutrient application)	333.00	329.67	331.34
T2	100% RDF (400:300:400 gm NPK/tree)	280.66	277.85	279.26
T3	75% RDF + FYM (40 Kg /tree)	240.00	237.60	238.80
T4	50% RDF + FYM (70 Kg /tree)	267.50	264.83	266.16
T5	75% RDF + Azospirillum (250 gm/tree)	269.14	266.45	267.79
T6	50% RDF + Azospirillum (250 gm/tree)	266.14	263.48	264.81
T7	75% RDF + PSB (250 gm/tree)	300.00	297.00	298.50
T8	50% RDF + PSB (250 gm/tree)	291.66	288.74	290.20
T9	75% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	268.50	265.82	267.16
T10	50% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	265.58	262.93	264.25
CD at 5%		9.29	9.20	9.25
SEm±		3.10	3.07	3.09

Table-7 Effect of integrated nutrient management on seed weight per fruit

Treatments		g		
		Y1	Y2	Pooled
T1	Control (Without nutrient application)	8.00	7.92	7.96
T2	100% RDF (400:300:400 gm NPK/tree)	7.65	7.57	7.61
T3	75% RDF + FYM (40 Kg /tree)	5.68	5.62	5.65
T4	50% RDF + FYM (70 Kg /tree)	6.65	6.58	6.62
T5	75% RDF + Azospirillum (250 gm/tree)	7.56	7.48	7.52
T6	50% RDF + Azospirillum (250 gm/tree)	7.26	7.19	7.22
T7	75% RDF + PSB (250 gm/tree)	7.21	7.14	7.17
T8	50% RDF + PSB (250 gm/tree)	7.33	7.26	7.29
T9	75% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	7.00	6.93	6.97
T10	50% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	6.88	6.81	6.84
CD at 5%		0.23	0.23	0.23
SEm±		0.08	0.08	0.078

Table 8: Effect of integrated nutrient management on total soluble solids

Treatments		⁰Brix		
		Y1	Y2	Pooled
T1	Control (Without nutrient application)	8.35	8.38	8.37
T2	100% RDF (400:300:400 gm NPK/tree)	10.11	10.15	10.13
T3	75% RDF + FYM (40 Kg /tree)	10.56	10.60	10.58
T4	50% RDF + FYM (70 Kg /tree)	9.10	9.13	9.12
T5	75% RDF + Azospirillum (250 gm/tree)	9.66	9.69	9.68
T6	50% RDF + Azospirillum (250 gm/tree)	8.92	8.95	8.94
T7	75% RDF + PSB (250 gm/tree)	9.41	9.44	9.43
T8	50% RDF + PSB (250 gm/tree)	8.67	8.70	8.69
T9	75% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	9.93	9.97	9.95
T10	50% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	9.22	9.25	9.24
CD at 5%		0.31	0.31	0.31
SEm±		0.10	0.10	0.10

Table 9: Effect of integrated nutrient management on acidity

Treatments		%		
		Y_1	Y_2	Pooled
T_1	Control (Without nutrient application)	0.546	0.548	0.547
T_2	100% RDF (400:300:400 gm NPK/tree)	0.542	0.544	0.543
T_3	75% RDF + FYM (40 Kg /tree)	0.375	0.376	0.376
T_4	50% RDF + FYM (70 Kg /tree)	0.452	0.454	0.453
T_5	75% RDF + Azospirillum (250 gm/tree)	0.456	0.457	0.457
T_6	50% RDF + Azospirillum (250 gm/tree)	0.472	0.473	0.472
T_7	75% RDF + PSB (250 gm/tree)	0.541	0.543	0.542
T_8	50% RDF + PSB (250 gm/tree)	0.447	0.449	0.448
T_9	75% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	0.521	0.523	0.522
T_{10}	50% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	0.435	0.436	0.435
CD at 5%		0.017	0.017	0.017
SEm±		0.006	0.006	0.006

Table-10 Effect of integrated nutrient management on ascorbic acid content

Treatments		Mg/100g		
		Y_1	Y_2	Pooled
T_1	Control (Without nutrient application)	179.35	180.00	179.67
T_2	100% RDF (400:300:400 gm NPK/tree)	211.56	212.32	211.94
T_3	75% RDF + FYM (40 Kg /tree)	220.36	221.15	220.76
T_4	50% RDF + FYM (70 Kg /tree)	200.10	200.82	200.46
T_5	75% RDF + Azospirillum (250 gm/tree)	195.66	196.36	196.01
T_6	50% RDF + Azospirillum (250 gm/tree)	199.92	200.64	200.28
T_7	75% RDF + PSB (250 gm/tree)	205.45	206.19	205.82
T_8	50% RDF + PSB (250 gm/tree)	199.67	200.39	200.03
T_9	75% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	195.33	196.03	195.68
T_{10}	50% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	188.93	189.61	189.27
CD at 5%		6.71	6.74	6.73
SEm±		2.24	2.25	2.24

Table-11 Effect of integrated nutrient management on sugars contents

Treatments		Reducing sugar %			Non-reducing sugar %			Total sugars %		
		Y_1	Y_2	Pooled	Y_1	Y_2	Pooled	Y_1	Y_2	Pooled
T_1	Control (Without nutrient application)	3.02	3.03	3.02	2.16	2.17	2.17	5.18	5.20	5.19
T_2	100% RDF (400:300:400 gm NPK/tree)	3.79	3.80	3.80	2.72	2.73	2.72	6.51	6.53	6.52
T_3	75% RDF + FYM (40 Kg /tree)	3.96	3.97	3.97	2.84	2.85	2.84	6.80	6.82	6.81
T_4	50% RDF + FYM (70 Kg /tree)	3.41	3.42	3.42	2.45	2.45	2.45	5.86	5.88	5.87
T_5	75% RDF + Azospirillum (250 gm/tree)	3.62	3.63	3.63	2.60	2.61	2.60	6.22	6.24	6.23
T_6	50% RDF + Azospirillum (250 gm/tree)	3.34	3.36	3.35	2.40	2.41	2.40	5.74	5.76	5.75
T_7	75% RDF + PSB (250 gm/tree)	3.53	3.54	3.53	2.53	2.54	2.53	6.06	6.08	6.07
T_8	50% RDF + PSB (250 gm/tree)	3.25	3.26	3.26	2.33	2.34	2.33	5.58	5.60	5.59
T_9	75% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	3.72	3.74	3.73	2.67	2.68	2.67	6.39	6.41	6.40
T_{10}	50% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	3.46	3.47	3.46	2.48	2.49	2.48	5.93	5.95	5.94
CD at 5%		0.12	0.12	0.11	0.08	0.09	0.083	0.20	0.20	0.19
SEm±		0.04	0.04	0.039	0.03	0.03	0.028	0.07	0.07	0.06

Table 12: Effect of integrated nutrient management on sugar and TSS acid ratio

Treatments		Sugars acid ratio			TSS acid ratio		
		Y_1	Y_2	Pooled	Y_1	Y_2	Pooled
T_1	Control (Without nutrient application)	9.49	9.49	9.49	15.29	15.29	15.30
T_2	100% RDF (400:300:400 gm NPK/tree)	12.01	12.00	12.01	18.65	18.66	18.66
T_3	75% RDF + FYM (40 Kg /tree)	18.13	18.14	18.11	28.16	28.19	28.14
T_4	50% RDF + FYM (70 Kg /tree)	12.96	12.95	12.96	20.13	20.11	20.13
T_5	75% RDF + Azospirillum (250 gm/tree)	13.63	13.64	13.63	21.18	21.20	21.18
T_6	50% RDF + Azospirillum (250 gm/tree)	12.16	12.18	12.18	18.90	18.92	18.94
T_7	75% RDF + PSB (250 gm/tree)	11.20	11.20	11.20	17.39	17.38	17.40
T_8	50% RDF + PSB (250 gm/tree)	12.48	12.47	12.48	19.40	19.38	19.40
T_9	75% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	12.26	12.26	12.26	19.06	19.06	19.06
T_{10}	50% RDF + Azospirillum (250 gm/tree)+ PSB (250 gm/tree)	13.64	13.65	13.65	21.20	21.22	21.24
CD at 5%		0.40	0.41	0.40	0.63	0.63	0.62
SEm±		0.13	0.14	0.13	0.21	0.21	0.20

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