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Character associations and path analysis for horticultural traits and fruit-fly infestation in oriental pickling melon (*Cucumis melo* var. *conomon* Mak.)

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Abstract

An experiment was carried out to study character associations and path analysis in 53 accessions of oriental pickling melon at the Department of Vegetable Science, College of Horticulture, Kerala Agriculture University, Thrissur during March to May 2016 in Randomized Complete Block Design (RBD) with two replications. Observations were recorded on 20 quantitative characters to assess the extent of character associations. Fruit yield per plant showed significant direct positive correlations to number of branches per plant (0.84), number of fruits per plant (0.81), seed cavity length (0.63), fruit length (0.57) and seed cavity breadth (0.33). Fruit fly infestation showed significant direct positive correlations to fruit weight (1.06), days taken for fruit maturity (0.99) and fruit girth (0.85). Significant direct negative correlations to fruit fly infestation were exhibited by fruit rind thickness and flesh thickness (-0.98) respectively.

Key words: Character associations, path analysis, fruit fly infestation, yield, oriental picking melon

Introduction

Oriental pickling melon (*Cucumis melo* var. *conomon* Mak.) is a widely cultivated crop in gourd family Cucurbitaceae. It is also called as golden melon or culinary melon. Fruits are varying in size small, medium to big fruits with smooth tender skin, white flesh usually with little sweetness and odour. In view of current trend of expanding cultivation of oriental pickling melon for its fruits as cooked vegetable; identification of promising accessions with yield, resistance to pests and diseases and quality is of prime importance and would be a boon to the farmers in improving their economic returns. Correlations and path coefficient analysis is of immense help in identification of characters contributing to yield, pests/disease resistance and quality and thereby selecting suitable plant type. Correlation coefficient indicates the nature of association among traits whereas, path analysis splits correlation coefficients into measures of direct and indirect effects thus, providing an understanding on direct and indirect contribution of associated traits. In this context, the present study was undertaken to assess the nature and magnitude of associations among yield, fruit fly resistance and the contributing traits for selecting high yielding accessions with resistance to fruit fly in oriental pickling melon.

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Materials and Methods

The study was conducted during March to May (summer season) of 2016 at the Department of Vegetable Science, College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur, Kerala, 680656. The experiment was laid out in RBD with two replications with spacing of 2×1.5 m (9 plants per plot). The experimental material comprised of 53 accessions of oriental pickling melon collected from Kerala and Karnataka. All crop management practices were undertaken as per the package of practices recommendation crops, Kerala Agricultural University (2016). Five plants per replication in each accession were selected for recording biometrical observations. Observations were recorded on days to first female flower production, days to first male flower production, node of first female flower, node of first male flower, vine length, inter nodal length, number of branches per plant, fruit diameter, fruit girth, fruit length, fruit weight, fruit rind thickness, flesh thickness, seed cavity length, seed cavity breadth, number of fruits per plant, days taken for fruit maturity, days to fruit fly infestation after anthesis, percentage of fruit fly infestation and yield per plant. Data were subjected to statistical analysis to find out genotypic and phenotypic correlation coefficients using the method given by Johnson et al. (1955). Path coefficient analysis was done using the method of Dewey and Lu (1959) by partitioning the genotypic correlations into components of direct and indirect effects.

Results and Discussion

Correlations and Path analysis to yield: The correlation coefficients among 20 quantitative characters were worked out for genotypic levels (Table1). Genotypic correlation coefficients were higher than that of phenotypic correlation coefficients for most of the traits which indicated less influence of environmental factors in expression of these traits. Path analysis provided a clear picture of the nature of association of traits towards yield through direct or indirect effects (Table 2). Wherever there were direct effects, such traits could be improved through selection whereas, hybridization would be an appropriate method to improve those traits which showed indirect effects.

Days to first female flower was significantly, positively correlated with days to first male flower production (rg =0.68), days to first female flower had significant negative correlations with days taken for fruit maturity and days to fruit fly infestation after anthesis (rg = - 0.42). Days to first male flower production exhibited significant negative correlations with days to fruit fly infestation after anthesis (rg = - 0.28). Node of first female flower showed significant positive correlations with node of first male flower (rg =0.56) and inter nodal length (rg =0.47). Node of first female flower was significantly, negatively correlated with number of fruits per plant and days to fruit fly infestation after anthesis (rg = -0.29). Node of first male flower had significant negative correlations with the fruit weight (rg = -0.46), fruit diameter and yield per plant (rg = -0.32).

Number of branches per plant showed significant positive correlations with number of fruits per plant (rg =0.92), fruit weight and yield per plant (rg =0.84), fruit length (rg =0.59), and seed cavity length (rg =0.57). Fruit diameter was had significant positive correlations with fruit girth (rg = 0.73), seed cavity breadth (rg =0.53), flesh thickness (rg = 0.49), fruit weight (rg = 0.39), fruit length (rg =0.37) and yield per plant (rg =0.28). Fruit girth was significantly, positively correlated with seed cavity breadth (rg =0.55), fruit weight (rg= 0.48), fruit length (rg =0.38), flesh thickness (rg =0.37) and yield per plant (rg =0.31). Fruit length had significant positive correlations with seed cavity length (rg =0.72), yield per plant (rg =0.57), fruit weight (rg =0.56) and number of fruits per plant (rg =0.44). Fruit weight was significantly, positively correlated with yield per plant (rg =0.83), number of fruits per plant (rg =0.74), seed cavity length (rg =0.56) and seed cavity breadth (rg = 0.33).

Fruit rind thickness had significant positive correlations with days to fruit fly infestation after anthesis (rg =0.68), days taken for fruit maturity (rg =0.36) and number of fruits per plant (rg= 0.33). Fruit rind thickness showed significant negative correlations with percentage of fruit fly infestation (rg = -0.74). Seed cavity length was significantly, positively correlated with yield per plant (rg = 0.63) and number of fruits per plant (rg =0.49). Seed cavity breadth exhibited significant positive

Table 1: Genotypic correlation coefficients in oriental pickling melon

Trait	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1																			
2	0.68**	1																		
3	-0.13	-0.09	1																	
4	-0.27	-0.03	0.56**	1																
5	0.16	0.06	-0.32*	0.21	1															
6	0.02	-0.08	0.47**	0.15	0.02	1														
7	-0.16	-0.09	-0.36	-0.32	-0.02	0.08	1													
8	0.04	0.01	-0.05	-0.32*	0.17	0.01	-0.05	1												
9	0.09	-0.07	-0.01	-0.27	0.08	0.05	0.19	0.73**	1											
10	-0.07	-0.04	-0.16	-0.07	0.08	-0.04	0.59**	0.37**	0.38**	1										
11	-0.01	-0.08	-0.16	-0.46**	0.05	0.03	0.84**	0.39**	0.48**	0.56**	1									
12	-0.23	-0.07	-0.05	0.21	-0.23	-0.08	-0.04	-0.02	0.15	-0.02	0.02	1								
13	0.03	0.13	0.23	0.22	0.19	0.19	-0.32	0.49**	0.37**	0.09	0.04	0.17	1							
14	-0.17	0.05	-0.11	-0.21	0.04	-0.12	0.57**	0.26	0.18	0.72**	0.56**	0.03	0.02	1						
15	-0.06	-0.10	0.12	-0.19	-0.03	0.03	0.11	0.53**	0.55**	0.09	0.33*	-0.03	-0.05	-0.04	1					
16	-0.25	-0.13	-0.29*	-0.17	0.13	-0.14	0.92**	0.11	0.14	0.44**	0.74**	0.33*	-0.03	0.49**	0.06	1				
17	-0.42**	-0.23	-0.25	0.21	0.18	-0.08	0.05	-0.06	-0.15	0.02	-0.04	0.36*	-0.03	-0.01	-0.08	0.38*	1			
18	-0.42**	-0.28*	-0.29*	-0.01	-0.07	-0.07	0.26	-0.06	0.08	0.17	0.23	0.68**	-0.01	0.13	0.07	0.49**	0.59**	1		
19	-0.05	0.08	0.21	0.21	0.18	0.11	-0.21	-0.03	-0.19	-0.01	-0.25	-0.74**	0.11	-0.09	0.03	-0.25	0.14	-0.50**	1	
20	-0.22	-0.09	-0.08	-0.32*	-0.07	-0.04	0.84**	0.28*	0.31*	0.57**	0.83**	0.04	-0.02	0.63**	0.33**	0.81**	0.07	0.23	-0.14	1

1. Days to first female flower production
2. Days to first male flower production
3. Node of first female flower
4. Node of first male flower
5. Vine length (cm)
6. Inter nodal length (cm)
7. Number of branches per plant
8. Fruit diameter (cm)
9. Fruit girth (cm)
10. Fruit length (cm)
11. Fruit weight (g)
12. Fruit rind thickness (cm)
13. Flesh thickness (cm)
14. Seed cavity length (cm)
15. Seed cavity breadth (cm)
16. Number of fruits per plant
17. Days taken for fruit maturity
18. Days to fruit fly infestation after anthesis
19. Percentage of fruit fly infestation
20. Yield per plant

correlations with yield per plant (rg = 0.33). Number of fruits per plant had significant positive correlations with yield per plant (rg = 0.81), days to fruit fly infestation after anthesis (rg=0.49) and days taken for fruit maturity (rg =0.38). Days taken for fruit maturity was significantly, positively correlated to days to fruit fly infestation after anthesis (rg=0.59). Days to fruit fly infestation after anthesis had significant negative correlations with percentage of fruit fly infestation (rg=-0.50).

Fruit yield per plant had significant direct positive correlations with number of branches per plant (rg=0.84), number of fruits per plant (rg=0.81), seed cavity length (rg=0.63), fruit length (rg=0.57) and seed cavity breadth (rg=0.33). High heritability exhibited by these traits revealed that direct selection for higher mean values of these traits would improve yield (Table 3). Earlier reports by Chaudhary et al. (2004), Kahn et al. (2016) and Sharma et al. (2018) were in agreement with present findings. Days to first female flower production (rg=-0.22) and node of first female flower (rg=-0.08) showed significant direct negative correlations yield. Hence, a selection program based on lower mean value of these traits would improve yield. The results are in line with findings of Kahn et al. (2016).

Fruit weight (rg=0.83), fruit girth (rg=0.31), fruit diameter (rg=0.28), and days taken for fruit maturity (rg=0.07) showed significant positive correlations, direct negative effects on yield and hence, selection for high yield should not focus on these traits. Similar results were reported by Burton (1952) and Hossain et al. (2010) in cucumber. Node of first male flower (rg=-0.32), percentage of fruit fly infestation (rg=-0.14), days to first male flower production (rg=-0.09), vine length (rg=-0.07) and inter nodal length (rg= -0.04) showed significant negative correlations and direct negative effects on yield. It was inferred that while attempting selection for improving yield, these traits should not be focused on. Present findings were in accordance with the reports Babu et al. (2013) in oriental pickling melon; Singh and Singh (2015) and Kumari et al. (2018) in bitter gourd.

Direct positive effects to yield was observed for number of branches per plant (0.634) followed by number of fruits per plant (0.455), seed cavity breadth (0.287), flesh thickness (0.232), seed cavity length (0.201), node at first female flower (0.166), fruit length (0.061) and fruit rind thickness (0.017). Therefore, direct selection could be attempted based on higher mean values of these traits to improve yield. These findings were line with the results of Sharma et al. (2018).

Node of first male flower (-0.281) followed by fruit girth (-0.155), vine length and days to fruit fly infestation after anthesis (-0.076), days to first female flower (-0.060), days taken for fruit maturity (-0.043), inter nodal length (-0.039), fruit diameter (-0.016), percentage of fruit fly infestation (-0.009), days to first female flower production (-0.007) and fruit weight

Table 2: Path coefficient showing direct and indirect effects

Trait	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	**-0.060**	-0.004	-0.020	0.055	-0.006	-0.001	-0.075	-0.005	-0.019	-0.003	-0.000	-0.003	0.003	-0.023	-0.018	-0.076	0.013	0.024	0.004
2	-0.042	**-0.007**	-0.015	0.011	-0.001	0.003	-0.046	0.000	0.098	-0.002	0.001	-0.001	0.023	0.013	-0.026	-0.038	0.009	0.015	-0.001
3	0.008	0.006	**0.166**	-0.117	0.012	-0.014	-0.119	0.007	0.005	-0.009	0.002	-0.002	0.039	-0.027	0.027	-0.097	0.007	0.022	-0.001
4	0.013	0.002	0.069	**-0.281**	-0.003	-0.004	-0.047	0.003	0.034	-0.005	0.006	0.035	0.028	-0.034	-0.045	-0.043	-0.008	0.002	-0.001
5	-0.005	-0.001	-0.045	-0.012	**-0.076**	0.006	0.032	-0.002	-0.016	0.006	-0.001	-0.003	0.035	0.016	-0.001	0.008	-0.006	0.008	-0.001
6	-0.026	0.006	0.061	-0.032	0.001	**-0.039**	0.034	-0.002	-0.003	-0.001	-0.000	-0.007	0.046	-0.017	0.009	-0.057	0.002	0.006	-0.009
7	0.008	0.005	-0.031	0.021	-0.004	-0.021	**0.634**	-0.005	-0.018	0.021	-0.009	-0.003	-0.067	0.062	0.018	0.204	-0.057	-0.011	0.009
8	-0.002	0.000	-0.008	0.059	-0.011	-0.006	0.029	**-0.016**	-0.106	0.019	-0.006	-0.003	0.103	0.041	0.141	0.042	0.028	0.004	0.005
9	-0.008	0.004	-0.005	0.063	-0.008	-0.008	0.074	-0.011	**-0.155**	0.022	-0.009	0.002	0.084	0.041	0.153	0.057	0.004	-0.006	0.001
10	0.004	0.003	-0.026	0.023	-0.007	0.001	0.220	-0.005	-0.056	**0.061**	-0.001	-0.006	0.025	0.139	0.033	0.172	-0.023	-0.013	0.000
11	-0.003	0.005	-0.023	0.100	-0.007	-0.001	0.314	-0.005	-0.074	0.033	**-0.001**	0.007	0.014	0.110	0.091	0.299	-0.007	-0.017	0.001
12	0.013	0.006	-0.001	-0.056	0.015	0.001	-0.011	0.003	-0.022	-0.023	-0.000	**0.017**	0.028	0.002	-0.010	0.118	-0.010	-0.040	0.005
13	-0.001	-0.007	0.028	-0.034	-0.011	-0.078	-0.165	-0.007	-0.056	0.006	-0.001	0.002	**0.232**	0.007	-0.009	-0.008	-0.002	0.008	-0.008
14	0.008	-0.004	-0.019	0.047	-0.006	0.003	0.196	-0.003	-0.031	0.042	-0.001	0.000	0.008	**0.201**	0.001	0.191	-0.001	-0.011	0.006
15	0.004	0.006	0.015	0.043	0.004	-0.001	0.043	-0.007	-0.082	0.007	-0.006	-0.006	-0.007	0.001	**0.287**	0.033	0.002	-0.006	-0.001
16	0.011	0.000	-0.035	0.026	-0.001	0.004	0.285	-0.001	-0.019	0.023	-0.001	0.004	-0.004	0.084	0.021	**0.455**	-0.011	-0.034	0.002
17	0.022	0.001	-0.028	-0.054	-0.010	0.000	0.076	0.001	0.015	0.002	-0.000	0.004	0.011	0.008	-0.019	0.118	**-0.043**	-0.032	-0.000
18	0.022	0.001	-0.047	0.010	0.000	0.003	0.097	0.000	-0.013	0.011	-0.004	0.009	-0.002	0.028	0.023	0.181	-0.018	**-0.076**	0.009
19	0.003	-0.000	0.028	-0.035	-0.098	-0.003	-0.065	0.000	0.027	-0.000	0.003	-0.010	0.021	-0.014	0.005	-0.103	-0.004	0.032	**-0.009**

Residual effect=1.173

1. Days to first female flower production
2. Days to first male flower production
3. Node of first female flower
4. Node of first male flower
5. Vine length (cm)
6. Inter nodal length (cm)
7. Number of branches per plant
8. Fruit diameter (cm)
9. Fruit girth (cm)
10. Fruit length (cm)
11. Fruit weight (g)
12. Fruit rind thickness (cm)
13. Flesh thickness (cm)
14. Seed cavity length (cm)
15. Seed cavity breadth (cm)
16. Number of fruits per plant
17. Days taken for fruit maturity
18. Days to fruit fly infestation after anthesis
19. Percentage of fruit fly infestation

(-0.001) were recorded negative effects on yield in that order. It was inferred that a selection program for improvement of yield should not focus these traits. Similar findings were reported by Veena et al. (2013).

Days to first female flower production showed highest positive indirect effect to node at first male flower (0.055), days to fruit fly infestation after anthesis (0.022), days taken for fruit maturity (0.007) and remaining characters exhibited low values. Days to first female flower production showed highest negative indirect effect to number of fruits per plant (-0.076), number of branches per plant (-0.075), seed cavity length (-0.023), node of first female flower (-0.020), fruit girth (-0.019), seed cavity breadth (-0.018). Days to first male flower production has showed highest positive indirect effect with fruit girth (0.098), flesh thickness (0.023), days to fruit fly infestation after anthesis (0.015), seed cavity length (0.013), node of first male flower (0.011), days taken for fruit maturity (0.009) and remaining characters showed very low values. Days to first male flower production showed highest negative indirect effect with number of branches per plant (-0.046), days to first female flower production (-0.042), node of first female flower (-0.038), seed cavity breadth (-0.026), node of first female flower (-0.015). Node of first female flower showed highest positive indirect effect to flesh thickness (0.039), seed cavity breadth (0.027), days to fruit fly infestation after anthesis (0.022), vine length (0.012) and days to first female flower production (0.008).

Node of first female flower showed highest negative indirect effect on number of branches per plant (-0.119), node of first female flower (-0.117), number of fruits per plant (-0.097) followed by seed cavity length (-0.027), inter nodal length (-0.014) and fruit length (-0.009). Node of first male flower showed highest positive indirect effect to fruit rind thickness (0.035), fruit girth (0.034), flesh thickness (0.028), days to first female flower (0.013) and fruit weight (0.006). Node of first male flower showed highest negative effect with number of branches per plant (-0.047), seed cavity breadth (-0.045), number of fruits per plant (-0.043), seed cavity length (-0034), days taken for fruit maturity (-0.008) and remaining characters showed low values.

Vine length has showed highest positive indirect effect with flesh thickness (0.035), number of branches per plant (0.034), seed cavity length (0.016), number of fruits per plant and days to fruit fly infestation after anthesis (0.008) and remaining characters exhibits low values. Vine length has showed highest negative indirect effect with number of fruits per plant (-0.045), fruit girth (-0.016), node of first male flower (-0.012), days taken for fruit maturity (-0.006) and days to first female flower production (-0.005). Inter nodal length has showed highest positive indirect effect with number of fruits per plant (0.061), flesh thickness (0.046), number of branches per plant (0.034), seed cavity breadth

Table 3: Estimates of variability parameters for oriental pickling melon

S. No.	Characters	GV	PV	GCV	PCV	H^2	GA	GAM
1	Days to first female flower production	2.63	2.88	6.02	6.96	74.79	3.02	10.72
2	Days to first male flower production	1.27	1.46	76.17	76.62	98.83	20.86	155.99
3	Node of first female flower	1.32	2.08	26.32	36.10	53.14	2.08	39.52
4	Node of first male flower	3.25	3.93	75.09	86.69	75.04	232.00	134.00
5	Vine length (cm)	5701.78	9356.83	129.29	135.44	91.14	247.53	254.28
6	Inter nodal length (cm)	1.53	1.76	50.86	52.93	92.36	5.45	100.70
7	Number of branches per plant	0.18	0.54	41.79	46.06	82.30	5.98	78.09
8	Fruit diameter (cm)	2.66	2.87	37.83	46.08	67.38	13.93	63.97
9	Fruit girth (cm)	42.21	54.54	19.92	32.44	37.71	6.21	25.20
10	Fruit length (cm)	34.16	37.50	65.87	106.93	37.96	529.09	83.60
11	Fruit weight (g)	3254.91	3732.87	121.66	175.27	48.19	557.93	173.98
12	Fruit rind thickness (cm)	0.003	0.004	63.48	70.21	81.75	2.09	118.24
13	Flesh thickness (cm)	0.26	0.29	58.36	69.27	70.98	9.39	101.30
14	Seed cavity length (cm)	20.53	23.76	46.26	61.29	56.97	4.91	71.94
15	Seed cavity breadth (cm)	1.44	1.50	89.89	98.02	84.12	3.58	169.85
16	Seed length (cm)	0.002	0.003	79.34	103.65	58.59	273.67	125.11
17	Number of seeds per fruit	18712	39473	136.93	162.66	70.87	293.01	237.47
18	Number of fruits per plant	1.80	2.38	64.05	65.67	95.15	57.20	128.71
19	Days taken for fruit maturity	19.75	30.53	5.89	6.98	71.29	6.35	10.25
20	Days to first harvest	1.19	3.29	11.28	11.74	92.52	16.09	22.37
21	Days to last harvest	2.89	5.67	129.01	131.88	95.69	72.86	259.99
22	Marketable yield per plant (kg)	3.51	4.54	60.41	63.53	90.41	7.08	118.32
23	Days to fruit fly infestation after anthesis	1.99	2.31	61.95	68.29	82.28	57.07	115.76
24	Percentage of fruit fly infestation (per cent)	274.23	338.06	119.10	126.71	88.35	58.63	230.62
25	Yield per plant (kg)	31.39	44.15	61.92	64.59	91.87	24.60	122.26

(0.009) and days to fruit fly infestation after anthesis (0.006). Inter nodal length has showed highest negative indirect effect with number of fruits per plant (-0.057), node of first male flower (-0.032), days to first female flower production (-0.026), seed cavity length (-0.017), percentage of fruit fly infestation (-0.009) and remaining values showed low values. Number of branches per plant showed highest positive indirect effect with number of fruits per plant (0.204), seed cavity length (0.062), node of first male flower and fruit length (0.021), seed cavity breadth (0.018), percentage of fruit fly infestation (0.009), days to first female flower production (0.008) and days to first male flower production (0.005) whereas flesh thickness (-0.067) showed highest negative indirect effect followed by days taken for fruit maturity (-0.057), node of first female flower (-0.031), inter nodal length (-0.021), fruit girth (-0.018), days to fruit fly infestation after anthesis (-0.011) and fruit weight (-0.009).

Fruit diameter showed highest positive direct effect with seed cavity breadth (0.141), flesh thickness (0.103), node of first male flower (0.059), number of fruits per plant (0.042), seed cavity length (0.041), number of branches per plant (0.029), days taken for fruit maturity (0.028), fruit length (0.019), percentage of fruit fly infestation (0.005) and days to fruit fly infestation after anthesis (0.004). Fruit diameter showed highest negative indirect effect with vine length (-0.011), node of first male flower (-0.008), fruit girth and fruit weight (-0.006). Fruit girth showed highest positive effect to seed cavity breadth (0.153), flesh thickness (0.084), number of branches per plant (0.074), node of first male flower (0.063), number of fruits per plant (0.057), seed cavity length (0.041), fruit length (0.022), days to first male flower and days taken for fruit maturity (0.004) whereas fruit diameter showed highest negative indirect effect (-0.011) followed by days to first female flower production, vine length and inter nodal length (-0.008). Fruit length showed highest positive indirect effect with number of branches per plant (0.220), number of fruits per plant (0.172), seed cavity length (0.139), seed cavity breadth (0.033), flesh thickness (0.025), node of first male flower (0.023) and remaining characters having low values. Fruit length showed highest negative indirect effect with fruit girth (-0.056), node of first female flower (-0.026), days taken for fruit maturity (-0.023) and days to fruit fly infestation after anthesis (-0.013). Fruit weight showed highest positive indirect effect number of branches per plant (0.314), number of fruits per plant (0.299), seed cavity length (0.110), node of first male flower (0.100), seed cavity breadth (0.91), fruit length (0.033), flesh thickness (0.014) and fruit rind thickness (0.007) whereas, fruit weight showed highest negative indirect effect to fruit girth (-0.074), node of first female flower (-0.023), days to fruit fly infestation after anthesis (-0.017), vine length and days taken for fruit maturity (-0.007), fruit diameter (-0.005) and remaining characters were having low values.

Fruit rind thickness showed highest positive indirect effect to number of fruits per plant (0.118), flesh thickness (0.028), vine length (0.015), days to first female flower (0.013), days to first male flower (0.006) and remaining characters showed low values. Fruit rind thickness showed highest negative indirect effect with node of first male flower (-0.056), fruit length (-0.023), fruit girth (-0.022), days to fruit fly infestation after anthesis (-0.040), seed cavity length and days taken for fruit maturity (-0.010). Flesh thickness showed highest positive indirect effect with node of first female flower (0.028), days to fruit fly infestation after anthesis (0.008), seed cavity length (0.007) and fruit length (0.006) whereas, number of branches per plant showed highest negative indirect effect (-0.165) followed by inter nodal

Table 4: Genotypic correlations to percentage of fruit fly infestation

Trait	1	2	3	4	5	6	7	8	9	10
1	1									
2	-0.98**	1								
3	0.96**	-0.61**	1							
4	-1.16**	0.84**	-0.95**	1						
5	1.03**	-0.82**	0.95**	-0.97**	1					
6	1.03**	-0.78**	1.03**	-0.96**	1.01**	1				
7	-1.05**	0.75**	-1.04**	0.97**	-1.01**	-0.99**	1			
8	0.98**	-0.70**	1.03**	-0.93**	0.96**	0.99**	-0.97**	1		
9	1.02**	-0.68**	1.12**	-0.96**	0.98**	0.97**	-0.97**	0.94**	1	
10	-0.99**	0.85**	-1.04**	1.06**	-0.98**	-0.98**	0.99**	-0.95**	-0.97**	1

1. Fruit diameter (cm)
2. Fruit girth (cm)
3. Fruit length (cm)
4. Fruit weight (g)
5. Fruit rind thickness (cm)
6. Flesh thickness (cm)
7. Days taken for fruit maturity
8. Marketable yield per plant (kg)
9. Days to fruit fly infestation after anthesis
10. Percentage of fruit fly infestation

length (-0.078), fruit girth (-0.056), node of first male flower (-0.034), vine length (-0.011), seed cavity breadth (-0.009), number of fruits per plant and percentage of fruit fly infestation (-0.008). Seed cavity length showed highest positive indirect effect to number of branches per plant (0.196), number of fruits per plant (0.191), node of first male flower (0.047), fruit length (0.042), days to first female flower, flesh thickness (0.008), percentage of fruit fly infestation (0.006) and inter nodal length (0.003). Seed cavity length showed highest negative indirect effect with fruit girth (-0.031), node of first female flower (-0.019), days to fruit fly infestation after anthesis (-0.011) and vine length (-0.006). Seed cavity breadth had highest positive indirect effect with node of first male flower and number of branches per plant (0.043), number of fruits per plant (0.033), node of first female flower (0.015), fruit length (0.007), days to first male flower (0.006) whereas, fruit girth (-0.082) showed highest negative indirect effect followed by fruit diameter and flesh thickness (-0.007), fruit weight, fruit rind thickness and days to fruit fly infestation after anthesis (-0.006).

Number of fruits per plant exhibited highest positive indirect effect with number of branches per plant (0.285), seed cavity length (0.084), node of first male flower (0.026), fruit length (0.023), Seed cavity breadth (0.021), days to first female flower (0.011) whereas, node of first female flower had highest negative indirect effect (-0.035) followed by days to fruit fly infestation after anthesis (-0.034) fruit girth (-0.019) and days taken for fruit maturity (-0.011). Days taken for fruit maturity showed highest positive indirect effect to number of fruits per plant (0.118), number of branches per plant (0.076), days to first female flower (0.022), fruit girth (0.015), flesh thickness (0.011) and seed cavity length (0.008) while node of first male flower (-0.054) had highest negative indirect effect followed by days to fruit fly infestation after anthesis(-0.032), node of first female flower (-0.028), seed cavity breadth (-0.019) and vine length (-0.010). Days to fruit fly infestation after anthesis exhibited highest positive indirect effect with number of fruits per plant (0.181), number of branches per plant (0.097), seed cavity length (0.028), seed cavity breadth (0.023), days to first female flower (0.022), fruit length (0.011), node of first male flower (0.010), fruit rind thickness and percentage of fruit fly infestation (0.009) whereas, node of first female flower showed highest negative indirect effect (-0.047) followed by days taken for fruit maturity (-0.018) and fruit girth (-0.013). Percentage of fruit fly infestation had positive indirect effect with through days to fruit fly infestation after anthesis (0.032), node of first female flower (0.028), fruit girth (0.027) and flesh thickness (0.021) whereas number of fruits per plant showed highest negative indirect effect (-0.103) followed by vine length (-0.098), number of branches per plant (-0.065), node of first male flower (-0.035), seed cavity length (-0.014) and fruit rind thickness(-0.010).

Selection of those traits which had direct and indirect effects on yield may lead to improvement in the total yield in oriental pickling melon. The present study suggested that more emphasis should be given for selecting genotype with higher fruit weight, which is confirmation with the finding of Singh et al. (2006) in pointed gourd and Kumaresan et al. (2006) in snake gourd.

Correlations and path analysis to fruit fly infestation: Path analysis provided a clear picture to the associations of traits towards fruit fly infestation through direct, indirect effects. The residual effects were very low (0.035), which suggested that the most of the traits in the present study was explained (Table 4 and Table 5). Fruit length (-1.04), fruit diameter (-0.99),

Table 5: Path coefficient showing direct and indirect effects to fruit-fly infestation

	1	2	3	4	5	6	7	8	9
1	**-0.627**	-0.278	-0.134	0.235	1.036	0.221	-0.785	-0.307	-0.355
2	0.613	**0.285**	0.085	-0.171	-0.818	-0.167	0.564	0.219	0.237
3	-0.604	-0.173	**-0.139**	0.193	0.955	0.222	-0.775	-0.323	-0.389
4	0.729	0.239	0.132	**-0.202**	-0.980	-0.206	0.727	0.289	0.331
5	-0.646	-0.232	-0.132	0.197	**1.004**	0.215	-0.749	-0.301	-0.342
6	-0.644	-0.222	-0.144	0.194	1.006	**0.215**	-0.741	-0.308	-0.337
7	0.658	0.215	0.144	-0.197	-1.007	-0.213	**0.747**	0.302	0.336
8	-0.616	-0.199	-0.144	0.187	0.967	0.213	-0.723	**-0.312**	-0.326
9	-0.641	-0.195	-0.156	0.193	0.989	0.209	-0.725	-0.294	**-0.347**

Residual effect=0.035

1. Fruit diameter (cm)
2. Fruit girth (cm)
3. Fruit length (cm)
4. Fruit weight (g)
5. Fruit rind thickness (cm)
6. Flesh thickness (cm)
7. Days taken for fruit maturity
8. Marketable yield per plant (kg)
9. Days to fruit fly infestation after anthesis

fruit rind thickness (-0.98), flesh thickness (-0.98), days to fruit fly infestation (-0.97) and marketable yield per plant (-0.95) had significant negative correlations with percentage of fruit fly infestation. Fruit weight (1.06), days taken for fruit maturity (0.99) and fruit girth (0.85) had significant positive correlations with percentage of fruit fly infestation. It was inferred that traits which exhibited negative correlations would leads to less infestation by fruit fly and hence, favoured resistance to fruit fly. Fruit diameter (-0.627), days to fruit fly infestation after anthesis (-0.347), marketable yield per plant (-0.312), fruit weight (-0.202) and fruit length (-0.139) recorded direct negative effects to percentage of fruit fly infestation. Hence, a selection programme for improving resistance to fruit fly infestation should focus on lower mean values of these traits. Fruit rind thickness (1.004), fruit girth (0.285) and flesh thickness (0.215) recorded direct positive effects to percentage of fruit fly infestation. Hence, these traits favoured resistance to fruit fly infestation and simultaneously could be improved through selection.

Fruit weight (1.06), days taken for fruit maturity (0.99) and fruit girth (0.85) had significant positive correlations with percentage of fruit fly infestation. GCV were higher than the PCV for all these traits, which indicated less influence of environmental factors on the expression of these traits. Heritability for these traits was moderate to high, which indicated that these traits could be improved through selection. Fruit rind thickness and flesh thickness (-0.98) respectively exhibited significant negative correlations, direct positive effects on percentage of fruit fly infestation. These traits also exhibited close association between PCV and GCV (63.48, 70.21; 58.36, 69.27), high heritability (81.75, 70.98), GA (2.09, 9.39) and GAM (118.24, 101.30) respectively. Direct selections can be made based on higher mean values of these traits for lower percentage of fruit fly infestation. Similar results were reported by Haldhar et al. (2015a) in watermelon and Haldhar et al. (2015b) in ridge gourd, Haldhar et al. (2018) in snap melon.

Conclusion

Present study revealed that genotypic correlations were higher than phenotypic correlations which indicated high heritability of the traits. Number of branches per plant, number of fruits per plant, seed cavity length, fruit length and seed cavity breadth showed significant positive associations and direct positive effects on yield. Direct selections based on these traits would improve the yield. Fruit rind thickness and flesh thickness exhibited significant negative correlations and direct positive effects on percentage of fruit fly infestation. Direct selections based on the higher mean values would result in the lower percentage of fruit fly infestation. From the present study it was concluded that direct selections based on higher mean values for number of branches per plant, fruit length, seed cavity length, seed cavity breadth and number of fruits per plant, fruit rind thickness and flesh thickness will be rewarding for realizing higher yield per plant along with resistance to fruit fly infestation in oriental pickling melon.

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सारांश

ओरिएन्टल पिकलिंग मेलन के 53 प्रविष्टियों का मूल्यांकन गुण संगतियों व पथ विश्लेषण ज्ञात करने के लिये बुआई सब्जी विज्ञान विभाग, उद्यान महाविद्यालय, केरल कृषि विश्वविद्यालय, त्रिशुर (केरल) में मई, 2016 में रैण्डोमाइल्ड ब्लाक डिजाइन के दो प्रतिकृतियों में किया गया। कुल 20 मात्रात्मक गुणों को समाहित कर गुण संगति का आंकलन किया गया। फल उपज/पौध ने सार्थक सीधे धनात्मक सह–सम्बन्ध प्रति पौध शाखाओं की संख्या (0.84), प्रति पौध फलों की संख्या (0.81), बीज गुहिका की लम्बाई (0.63), फल की लम्बाई (0.57) एवं बीज गुहिका चौड़ाई (0.33) के प्रति स्पष्ट किया। फल मक्खी प्रकोप ने सार्थक सीधे धनात्मक सह–सम्बन्ध फल भार (1.06), फल पकाव के दिन (0.99) तथा फल व्यास (0.85) के प्रति रहा। सार्थक सीधे नकारात्मक सह–सम्बन्ध फल मक्खी के प्रकोप के प्रति फल के छिलके की मोटाई व गूदा की मोटाई (0.98) ने स्पष्ट किया।

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