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Character association study in the botanical groups of *Cucumis melo*

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Abstract
Melo is a species of extremely complex genus *Cucumis* in the cucurbitaceae family, with a somatic chromosome number of 2n=24. With regard to fruit characteristics such as fruit form, size, color, texture, taste and nutritional composition, the species *melo* demonstrates considerable morphological diversity. It is crucial to correlate features that contribute to yield in order to comprehend the direction of selection. Average fruit weight, the number of days until the first fruit picking, fruit girth, pulp thickness and seed cavity size demonstrated a highly significant and favorable relationship with plant overall yield. These attributes might be indirectly selected for significant increase in melons yield.

Keywords: Melo, yield, correlation

Introduction
Melon, which belongs to the family Cucurbitaceae and has the chromosome number of 2n=24, is one of the most genetically diverse species and a significant vegetable crop in the genus *Cucumis*. Although the origin of the melon is thought to be in Africa, central Asia, Iran, India, Turkmenistan, Tajikistan, Transcaucasia and Uzbekistan are seen to be the key centers of variation, along with China and Afghanistan (Zhu *et al*., 2016) [20]. Melons are one of the vegetables planted in India and take up 0.7 lakh ha, producing 15.62 lakh tonnes and yielding 22.31 t/ha. The biggest melon-producing states in India are Uttar Pradesh, Andhra Pradesh, Bihar, Madhya Pradesh and Punjab (Anon., 2021) [1]. It is widely grown in gardens and in riverbeds in temperate and tropical regions around the world (Biswas, 2006) [3]. According to Jeffrey, 1980 [5] and Lija and Beevy 2021 [9], the species *C. melo* is a highly polymorphic taxon with vigorous diversification, considerable physiological, morphological and molecular diversity for a large number of horticultural groups. According to Kirkbride (1993) [7], ovary pubescence distinguishes two subspecies of muskmelon: *C. melo* subsp. *melo*, which has pilose or lanate ovaries (long, spreading soft hairs) and *C. melo* subsp. *agrestis*, which has ovaries with short and appressed hairs. Furthermore, the *C. melo* ssp. *agrestis* has been sub classified into *conomon*, *makuwa*, *chinensis*, *acidulus* and *momordica* groups and *the C. melo* ssp. *melo* into eleven groups: *cantaloupe*, *reticulates*, *adana*, *chandalak*, *ameri*, *inodorus*, *flexuosus*, *chate*, *tibish*, *dudaim* and *chito*.
Yield is a coplex quantitative attribute that is regulated by ecological factors as well as a few yield-related traits. Estimating the correlation coefficient between the characteristics that contribute to yield is crucial to understand the direction of selection and utilizing them effectively in crop improvement programs. Since direct selection for yield may not provide successful improvement. Direct selection for yield may not be effective since it depends on many contributing traits. Yield is the product of the cumulative impact of numerous simply inherited attributes. Understanding the interactions between characteristics has proven extremely helpful in plant breeding. As a result, the study objective was to investigate the relationships between numerous characteristics of *Cucumis melo* botanical groupings.

Material and Methods
At the University of Horticultural Sciences, Bagalkot, fifty genotypes from eight varieties of *Cucumis melo* (ssp. *agrestis*, var. *momordica*, var. *acidulus*, var. *reticulata*, var. *cantalupensis*, var. *flexousus*, var. *chito*, and ssp. *melo*) were planted in two replications using the randomized complete block design (RCBD). At every step of plant development, the recommended agronomic procedures and plant protection measures were applied to ensure excellent crop

growth. Five plants were chosen at random for recording the observations like vine length (m), internodal length (cm), number of primary branches per plant, days to first male flower, node to first male flower, days to 50% flowering, days to first female flower, node of first female flower appearance, days to first fruit harvest, fruit length (cm), fruit diameter (cm), average fruit weight (g), number of fruits per plant, pulp thickness (mm), seed cavity (mm) and total yield per plant (kg).

Results

Days to first female flower appearance showed a significant and positive relationship with node bearing first female flower and node number, whereas diameter of fruit, seed cavity size, pulp thickness, days to first fruit harvest and mean weight of fruit at genotypic level showed significant and negative associations with length of vine, length of internode and number of primary branches (Tables 1 & 2).

Days to first female flower showed a substantial and favorable link with the node carrying the first female flower and the number of fruits produced per plant. However, at the genotypic level, this feature showed a strong and adverse correlation with fruit length, diameter, average weight, pulp thickness and seed cavity size. The genotypic level demonstrated a substantial and negative correlation between the node to first female flower and the mean fruit weight as well as the number of days to first fruit harvest. At the phenotypic level, this feature significantly and negatively correlated with average fruit weight (Tables 1 & 2).

Fruit diameter, average fruit weight, seed cavity and pulp thickness all showed extremely significant and positive associations with days to first fruit harvesting at both the genotypic and phenotypic levels. Days until first fruit harvest showed an extremely significant and negative correlation with the number of fruits per plant. Fruit diameter significantly and positively correlated with seed cavity size, pulp thickness and fruit mean weight. The amount of fruits produced from a plant was negatively correlated with this trait, which was very significant. The average fruit weight showed a highly significant and positive correlation with the thickness of the pulp and the size of the seed cavity. However, this trait demonstrated a very strong and negative correlation with the number of fruits produced per plant. Number of fruits per plant showed a significant and negative correlation with pulp thickness and seed cavity size. Fruit characteristics including average weight, number of days before first picking, fruit diameter, pulp thickness, and seed cavity size had a highly significant and positive relation with the overall yield per plant. However, there was a negative correlation between total yield per plant and the number of fruits per plant, node to the development of the first female bloom, and the number of primary branches per plant (Table 1 & 2).

Discussion

Total yield produced in a plant expressed significant and positive association with mean weight of fruit, days required to first fruit picking, fruit diameter, thickness of pulp, seed cavity size and the yield could be indirectly improved by considering these attributes. Similar results were reported by Nanthkumar *et al*., 2021 [11] in musk melon, Kumbar *et al*., 2021 [8] in *acidulus*, Silpa *et al*., 2020 [18] in oriental pickling melon, Pasha *et al*., 2019 [12] in snap melon and Ibrahim and Ramadan, 2013 [4] in sweet melon for mean fruit weight; Reddy *et al*., 2007 [16] in snap melon and Babu *et al*., 2014 [21] in oriental pickling melon for days to first fruit harvest; Priyanka *et al*., 2020 [14] in musk melon, Kumbar *et al*., 2021 [8] *acidulus*, Babu *et al*., 2014 [21] in oriental pickling melon, Pasha *et al*., 2019 [12] in snap melon for fruit diameter; Prajapati *et al*., 2022 [13] in musk melon, Kumbar *et al*., 2021 [8] *acidulus*, Babu *et al*., 2014 [21] in oriental pickling melon, Pasha *et al*., 2019 [12] in snap melon; Ibrahim and Ramadan, 2013 [4] in sweet melon and Karadi *et al*., 2016 [6] in wild melon for pulp thickness and Mehta *et al*., 2009 [10] in musk melon; Kumbar *et al*., 2021 [8] in *acidulus* for seed cavity size. Yield in a plant had considerable negative relation with length of internode, number of primary branches per plant, number of fruits per plant (Ramana, 2000 [15] in oriental pickling melon; Reddy *et al*., 2007 [16] in snap melon and Ibrahim and Ramadan, 2003 [4] in sweet melon), days to first female flower appearance (Nanthakumar *et al*., 2021 [11] in musk melon) and node to first female flower appearance (Reddy *et al*., 2017 [17] in musk melon). Genotypes yield could be improved by selecting factors that are positively correlated with yield. These positively correlated traits with yield can be used to practice selection with more efficiency.

Table 1: Genotypic correlation coefficients for growth, yield and quality traits in *Cucumis melo*

Trait	VL	IL	NPB	DFMF	NFMF	DFF	DFFF	NFFF	DFFH	FL	FD	AFW	NFPP	PT	SC	TYPP
VL	1.000	0.683**	0.414**	-0.034	0.064	0.027	0.147	-0.134	-0.521**	0.133	-0.619**	-0.365**	0.715**	-0.531**	-0.563**	-0.157
IL		1.000	0.259	-0.063	-0.057	0.104	0.024	0.033	-0.377**	0.147	-0.472**	-0.334*	0.406**	-0.443**	-0.373**	-0.279*
NPB			1.000	0.182	-0.386**	0.239	0.448**	0.607**	-0.732**	-0.121	-0.707**	-0.646**	0.677**	-0.595**	-0.623**	-0.545**
DFMF				1.000	-0.078	0.917**	0.809**	-0.099	-0.090	-0.331*	-0.136	-0.120	-0.006	-0.237	-0.079	-0.123
NFMF					1.000	-0.071	-0.188	-0.359*	0.254	-0.166	0.287*	0.104	-0.138	0.307*	0.169	0.150
DFF						1.000	0.907**	-0.158	-0.076	-0.389**	-0.282*	-0.115	0.017	-0.283*	-0.276	-0.198
DFFF							1.000	0.316*	-0.204	-0.383**	-0.418**	-0.375**	0.317*	-0.364**	-0.359*	-0.296*
NFFF								1.000	-0.307*	-0.018	-0.257	-0.328*	0.241	-0.251	-0.193	-0.326*
DFFH									1.000	-0.200	0.980**	0.909**	-0.824**	0.852**	0.874**	0.878**
FL										1.000	-0.151	0.075	0.080	-0.195	-0.171	0.081
FD											1.000	0.828**	-0.833**	0.834**	0.999**	0.721**
AFW												1.000	-0.720**	0.729**	0.729**	0.928**
NFPP													1.000	-0.642**	-0.776**	-0.547**
PT														1.000	0.650**	0.685**
SC															1.000	0.620**
TYPP																1.000

* And ** indicates significance at $p \leq 0.05$and $p \leq 0.01$, respectively

VL- Vine length (m)	DFFH- Days to first fruit harvest
IL- Internodal length (cm)	FL- Fruit length (cm)
NPB- Number of primary branches per plant	FD- Fruit diameter (cm)
DFMF- Days to first male flower	AFW- Average fruit weight (g)
NFMF- Node to first male flower	NFPP- Number of fruits per plant
DFF- Days to 50% flowering	PT- Pulp thickness (mm)
DFFF- Days to first female flower	SC- Seed cavity (mm)
NFFF- Node of first female flower appearance	TYPP- Total yield per plant (kg)

Table 2: Phenotypic correlation coefficients for growth, yield and quality traits in *Cucumis melo*

Traits	VL	IL	NPB	DFMF	NFMF	DFF	DFFF	NFFF	DFFH	FL	FD	AFW	NFPP	PT	SC	TYPP
VL	1.000	0.530**	0.343*	0.015	0.047	-0.033	0.091	-0.110	-0.448**	0.137	-0.507**	-0.289*	0.617**	-0.432**	-0.513**	-0.189
IL		1.000	0.243	-0.042	-0.011	0.012	-0.006	0.016	-0.316*	0.130	-0.379**	-0.250	0.331*	-0.412**	-0.321*	-0.223
NPB			1.000	0.137	-0.214	0.094	0.331*	0.487**	-0.644**	-0.125	-0.618**	-0.573**	0.627**	-0.551**	-0.585**	-0.499**
DFMF				1.000	-0.036	0.564**	0.408**	-0.070	-0.051	-0.209	-0.076	-0.030	-0.033	-0.116	-0.091	-0.090
NFMF					1.000	-0.081	0.063	-0.276	0.161	-0.020	0.163	0.106	-0.085	0.192	0.113	0.102
DFF						1.000	0.486**	0.015	-0.058	-0.146	-0.132	-0.084	0.008	-0.161	-0.073	-0.077
DFFF							1.000	0.224	-0.163	-0.229	-0.286*	-0.215	0.177	-0.233	-0.254	-0.191
NFFF								1.000	-0.272	-0.019	-0.203	-0.287*	0.195	-0.216	-0.151	-0.284*
DFFH									1.000	-0.185	0.845**	0.811**	-0.754**	0.754**	0.802**	0.751**
FL										1.000	-0.154	0.089	0.070	-0.186	-0.137	0.056
FD											1.000	0.731**	-0.757**	0.777**	0.894**	0.650**
AFW												1.000	-0.665**	0.675**	0.669**	0.896**
NFPP													1.000	-0.592**	-0.731**	-0.475**
PT														1.000	0.597**	0.624**
SC															1.000	0.573**
TYPP																1.000

* and ** indicates significance at $p \leq 0.05$and $p \leq 0.01$, respectively

VL- Vine length (m)	DFFH- Days to first fruit harvest
IL- Internodal length (cm)	FL- Fruit length (cm)
NPB- Number of primary branches per plant	FD- Fruit diameter (cm)
DFMF- Days to first male flower	AFW- Average fruit weight (g)
NFMF- Node to first male flower	NFPP- Number of fruits per plant
DFF- Days to 50% flowering	PT- Pulp thickness (mm)
DFFF- Days to first female flower	SC- Seed cavity (mm)
NFFF- Node of first female flower appearance	TYPP- Total yield per plant (kg)

Conclusion

Character association study for multiple variables in the genotypes of *Cucumis melo* belonging to distinct botanical groups revealed a highly significant and positive correlation between total fruit yield per plant and mean fruit weight, fruit girth and pulp thickness, which means that indirect selection for these traits might increase yield.

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