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Correlation coefficients for yield and Path analysis in Crossandra genotypes for yield and its attributing traits

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Abstract

The study was conducted at the Floriculture department, Horticulture College Munirabad, Koppal district. The experiment was designed in a Randomised Completely Block Design (RCBD) with ten genotypes. Flower yield exhibited a significantly positive correlation with the spike count per plant, number of flowers per spike, spike length, shelf life, leaf area, total chlorophyll, 100 flower weight, plant height, flower diameter, primary branches per plant and secondary branches per plant. At the same time, traits like days to fifty percent flowering and days to first harvest recorded the highest negative correlation with many traits. In the present investigation, the results of path coefficient analysis reveal that shelf life, total chlorophyll, number of flowers per spike, and plant height directly affect flower yield. Meanwhile, the flower diameter, and days to fifty percent flowering negatively affected flower yield.

Keywords: Correlation coefficients, Crossandra genotypes, attributing traits

Introduction

Crossandra is also known as a 'firecracker plant' due to the cracking sound heard during the splitting of the seed pods upon drying (Gowthami *et al.*, 2017) [13]. It has a remarkable range of colours varying from orange, pink, red, yellow and double-coloured blue types with a white throat. Crossandra comprises 52 species and is distributed all over tropical and subtropical regions, such as South Asia, South America, South Africa, Madagascar, Arabia, and the Indian subcontinent. Some species belonging to the genus crossandra are *C. nilotica* (suitable for partial shade), *C. flava* (unbranched shrubs with bright yellow flowers) and *C. guinensis* (suitable for both partial and sunny situations). Orange crossandra (2n=40) sets seeds profusely, breeds true and produces bright orange-coloured flowers. The cultivar Delhi crossandra (2n=30) produces more attractive flowers of bright deep orange. Lutea Yellow is a tetraploid (2n=40) and hardy cultivar with high nematode tolerance (Rahul, 2017) [22]. Even though the flowers lack fragrance, they are widely used in garlands with jasmine to produce charming colour contrasts. It requires warm, humid areas for its cultivation, with having an average temperature between 20 ˚C and 32 ˚C. Even though crossandra can be cultivated in a wide range of soils, loamy soil with pH 6 to 6.7 is ideal (Ashwath *et al.*, 2009) [4].

The crop improvement programme's success depends on the genetic variability available in the genotypes due to the genetic constitution of cultivars or variation in the growing environment. Creating and utilising the variability using proper breeding procedures is the prerequisite for the genetic improvement of most crops, including Crossandra.

The performance of different crossandra genotypes varies from region to region due to genetic, environmental and cultivation factors. Though many cultivars of Crossandra have been released for commercial cultivation, their performance has been assessed so far; hence, no standard package of practices (PoP) for cultivation is available, especially under the Northern dry zone of Karnataka. Considering the importance and popularity of the crossandra in the domestic market, there is a need to study the performance of different genotypes and to Standardise agro techniques for cultivation under the Northern dry zone of Karnataka. It would help the farmers select the best variety and follow the best package of practices for profitable commercial cultivation of crossandra.

The present investigation entitled "Studies on genetic variability and Standardization of Agro-techniques in Crossandra [*Crossandra infundibuliformis* (L.) Nees.] under Northern dry zone of Karnataka" was carried out in the experimental field of the Department of Floriculture, College of Horticulture, Munirabad, Koppal District, Karnataka during the year 2019-2020. The soil in the experiment field was red sandy loam in texture. College of Horticulture, Munirabad is located in the Northern dry zone of Karnataka at 15° 17' 43.9692" North latitude, 76° 19' 3.7164" East longitude and it is located at an altitude of 529 m above MSL. The experimental location is geographically situated with an average annual rainfall of 569 mm and an average rainy day of 31 distributed in four to six months (June to December). The average maximum temperature of the location is 33°C, the average minimum temperature is 18°C, and the relative humidity varies from 60 to 90 percent. The meteorological data recorded during the experimental period is presented in Appendix 1. The details of the material used to conduct experiments and methodologies or techniques adopted during experimentations are presented in this chapter.

Design and experimental layout

The experiment was formulated with Randomized Completely Block Design (RCBD) in 2019-20 at the College of Horticulture, Munirabad Koppal District, Karnataka. The treatments in each replication were allotted randomly in 3 replications with 10 genotypes having a 7.2 m^2 gross plot size. 60 cm X 30 cm spacing was followed, and RDF (Recommended dosage of fertilisers) FYM (25 t/ha) + 100: 60: 60 kg NPK/ha. As suggested by Wright (1921) and further developed by Dewey and Lu (1959), path coefficient analysis was employed to understand the direct and indirect contribution of various traits towards flower yield.

Results and Discussion

Correlation

Correlation studies aim to identify suitable traits for indirect selection, as direct selection for crop yield can lead to unintended changes in associated traits. Yield is a complex quantitative character strongly influenced by the environment, making it challenging for direct selection. Genotypic and environmental interactions further limit improvement possibilities. Hence, understanding the correlations between yield and its components becomes crucial in designing effective selection programs for crop improvement. Breeders can enhance overall yield by focusing on correlated traits without negatively impacting other important characteristics.

Plant height recorded a significantly positive correlation with spike length, spike count per plant, number of flowers per spike, flower yield, shelf life, leaf area, secondary branches per plant, primary branches per plant and total chlorophyll. The number of primary branches per plant exhibited a significantly positive correlation with secondary branches per plant, the number of spikes per plant and plant height. Leaf area exhibited a significantly positive correlation with shelf life, number of spikes per plant, total chlorophyll, flower yield, number of flowers per spike, spike length and 100 flower weight. Total chlorophyll exhibited a significantly positive correlation with leaf area, shelf life, flower yield, spike count per plant, number of flowers per spike, spike length and 100 flower weight. The number of flowers per spike exhibited a significantly positive correlation with spike length, flower yield, number of spikes per plant, plant height, leaf area, shelf life and total chlorophyll. The number of spikes per plant positively correlated significantly with shelf life, flower yield, leaf area, number of flowers per spike, spike length, plant height, total chlorophyll, 100 flower weight and primary branches per plant. Spike length exhibited a significantly positive correlation with the number of flowers per spike, flower yield, number of spikes per plant, plant height, leaf area, shelf life and total chlorophyll. 100 flower weight positively correlated significantly with shelf life, number of spikes per plant, flower diameter, leaf area, total chlorophyll and flower yield.

Flower diameter positively correlated with 100 flower weight and shelf life. Shelf life exhibited a significantly positive correlation with several spikes per plant, leaf area, total chlorophyll, flower yield, 100 flower weight, spike length, plant height and number of flowers per spike. Flower yield exhibited a significantly positive correlation with the spike count per plant, number of flowers per spike, spike length, shelf life, leaf area, total chlorophyll, 100 flower weight, plant height, flower diameter, primary branches per plant and secondary branches per plant. At the same time, traits like days to fifty percent flowering and days to first harvest recorded the highest negative correlation with many traits. The results align with Teerath *et al.* (2017) [26], who observed similar results in China aster. Kumar *et al.* (2019) [14] in Marigold stated that flower yield per hectare positively correlated with plant height, plant spread, dry weight of flower, number of flowers per plant, flower diameter and flower yield per plant. Bennurmath *et al.* (2022) [6] observed similar results in chrysanthemum.

At phenotypic level, flower yield trait exhibited significantly positive correlation with traits like number of spikes per plant (0.922), number of flowers per spike (0.869), spike length (0.847), shelf life (0.827), leaf area (0.824), total chlorophyll (0.831), 100 flower weight (0.623), plant height (0.778), primary branches per plant (0.593) and secondary branches per plant (0.537). It also exhibited negative significant association with days to 50 percent flowering (-0.778) and days to first harvest (-0.681).

At genotypic level, flower yield trait exhibited significantly positive correlation with traits like number of spikes per plant (0.910), number of flowers per spike (0.852), spike length (0.831), shelf life (0.811), leaf area (0.821), total chlorophyll (0.801), 100 flower weight (0.598), plant height (0.774), primary branches per plant (0.579) and secondary branches per plant (0.517). It also exhibited negative significant association with days to 50 percent flowering (-0.775) and days to first harvest (-0.671).

Table 1: Correlation coefficients for yield and yield attributing traits in crossandra

Variables		PH	NPB	NSB	LA	TC	50% F	1ST H	F/S	S/P	SL	100 FW	FD	CTL	Sl	FY
PH	P	1.0000	0.607**	0.634**	0.662**	0.482*	-0.559*	-0.596**	0.797**	0.806**	0.809**	0.474*	0.406*	0.2725	0.696**	0.778**
	G	1.0000	0.601**	0.631**	0.660**	0.481*	-0.544*	-0.563*	0.792**	0.804**	0.802**	0.467*	0.397*	0.2775	0.680**	0.774**
NPB	P		1.0000	0.811**	0.520*	0.3367	-0.553*	-0.589**	0.564*	0.691**	0.502*	0.568*	0.560*	0.1558	0.575**	0.593**
	G		1.0000	0.804**	0.518*	0.3403	-0.528*	-0.540*	0.569*	0.692**	0.508*	0.574**	0.567*	0.1604	0.575**	0.579**
NSB	P			1.0000	0.464*	0.2935	-0.2477	-0.365*	0.596**	0.623**	0.574**	0.3056	0.3507	-0.1392	0.479*	0.537*
	G			1.0000	0.456*	0.2955	-0.2118	-0.2979	0.598**	0.625**	0.573**	0.3171	0.3602	-0.0829	0.458*	0.517*
LA	P				1.0000	0.858**	-0.632**	-0.728**	0.735**	0.903**	0.707**	0.695**	0.495*	0.2890	0.911**	0.824**
	G				1.0000	0.857**	-0.624**	-0.700**	0.730**	0.900**	0.703**	0.685**	0.487*	0.2782	0.903**	0.821**
TC	P					1.0000	-0.597**	-0.649**	0.680**	0.808**	0.675**	0.661**	0.449*	0.383*	0.831**	0.809**
	G					1.0000	-0.580**	-0.609**	0.681**	0.809**	0.677**	0.661**	0.451*	0.377*	0.826**	0.801**
50% F	P						1.0000	0.719**	-0.668**	-0.696**	-0.590**	-0.631**	-0.490*	-0.545*	-0.633**	-0.778**
	G						1.0000	0.727**	-0.638**	-0.670**	-0.564*	-0.589**	-0.450*	-0.480*	-0.619**	-0.775**
1ST H	P							1.0000	-0.621**	-0.709**	-0.522*	-0.714**	-0.607**	-0.3205	-0.681**	-0.681**
	G							1.0000	-0.567*	-0.658**	-0.476*	-0.638**	-0.532*	-0.2339	-0.650**	-0.671**
F/S	P								1.0000	0.835**	0.904**	0.433*	0.418*	0.2624	0.695**	0.869**
	G								1.0000	0.836**	0.905**	0.443*	0.428*	0.2686	0.690**	0.852**
S/P	P									1.0000	0.815**	0.725**	0.531*	0.3500	0.936**	0.922**
	G									1.0000	0.815**	0.725**	0.534*	0.3544	0.925**	0.910**
SL	P										1.0000	0.378*	0.3363	0.2749	0.699**	0.847**
	G										1.0000	0.388*	0.3482	0.2749	0.697**	0.831**
100 FW	P											1.0000	0.6981	0.416*	0.795**	0.623**
	G											1.0000	0.707**	0.418*	0.787**	0.598**
FD	P												1.0000	0.436*	0.626**	0.3349
	G												1.0000	0.435*	0.622**	0.3130
CTL	P													1.0000	0.406*	0.3490
	G													1.0000	0.369*	0.3256
Sl	P														1.0000	0.827**
	G														1.0000	0.811**
FY	P															1.0000
	G															1.0000

* Significant at 5% level and ** 1% Level of significance.

P- Phenotypic level G – Genotypic level

PH=Plant height, NPB= No. of primary branches, NSB= No. of secondary branches, LA= leaf area, TC= total chlorophyll, 50% F=50% flowering, 1st H= first harvest, F/S= flowers/spike, S/P= spikes/plant, SL= spike length, 100FW= 100 flower weight, FD= flower diameter, CTL= corolla tube length, Sl= shelf life, FY= flower yield

Table 2: Path coefficient analysis for yield and yield attributing traits in crossandra

Variables		PH	NPB	NSB	LA	TC	50% F	1ST H	F/S	S/P	SL	100 FW	FD	CTL	Sl	FY
PH	P	0.1286	0.0781	0.0815	0.0851	0.0620	-0.0718	-0.0766	0.1025	0.1036	0.1041	0.0610	0.0522	0.0350	0.0895	0.778**
	G	0.1430	0.0860	0.0902	0.0944	0.0687	-0.0778	-0.0805	0.1132	0.1149	0.1147	0.0667	0.0568	0.0397	0.0973	0.774**
NPB	P	0.0355	0.0585	0.0474	0.0304	0.0197	-0.0323	-0.0344	0.0330	0.0404	0.0293	0.0332	0.0328	0.0091	0.0336	0.593**
	G	-0.0018	-0.0029	-0.0023	-0.0015	-0.0010	0.0015	0.0016	-0.0017	-0.0020	-0.0015	-0.0017	-0.0017	-0.0005	-0.0017	0.579**
NSB	P	0.0644	0.0824	0.1016	0.0472	0.0298	-0.0252	-0.0371	0.0606	0.0633	0.0583	0.0311	0.0356	-0.0141	0.0487	0.537*
	G	0.0961	0.1224	0.1523	0.0695	0.0450	-0.0323	-0.0454	0.0910	0.0951	0.0872	0.0483	0.0549	-0.0126	0.0698	0.517*
LA	P	-0.1650	-0.1298	-0.1158	-0.2494	-0.2140	0.1577	0.1815	-0.1832	-0.2252	-0.1763	-0.1732	-0.1235	-0.0721	-0.2272	0.824**
	G	-0.1542	-0.1209	-0.1066	-0.2336	-0.2001	0.1457	0.1636	-0.1706	-0.2103	-0.1643	-0.1600	-0.1138	-0.0650	-0.2111	0.821**
TC	P	0.1529	0.1067	0.0930	0.2720	0.3170	-0.1894	-0.2056	0.2154	0.2563	0.2141	0.2097	0.1422	0.1214	0.2635	0.809**
	G	0.1522	0.1078	0.0936	0.2713	0.3167	-0.1836	-0.1929	0.2155	0.2561	0.2142	0.2092	0.1428	0.1193	0.2616	0.801**
50% F	P	0.1642	0.1624	0.0728	0.1859	0.1756	-0.2940	-0.2113	0.1963	0.2045	0.1733	0.1854	0.1440	0.1602	0.1860	-0.778**
	G	0.1797	0.1743	0.0699	0.2058	0.1914	-0.3301	-0.2399	0.2108	0.2213	0.1863	0.1944	0.1484	0.1583	0.2044	-0.775**
1ST H	P	0.0146	0.0145	0.0090	0.0179	0.0159	-0.0177	-0.0246	0.0153	0.0174	0.0128	0.0176	0.0149	0.0079	0.0167	-0.681**
	G	0.0328	0.0314	0.0173	0.0407	0.0354	-0.0423	-0.0582	0.0330	0.0383	0.0277	0.0371	0.0310	0.0136	0.0378	-0.671**
F/S	P	0.2165	0.1532	0.1619	0.1995	0.1845	-0.1814	-0.1686	0.2716	0.2267	0.2454	0.1177	0.1135	0.0713	0.1887	0.869**
	G	0.1682	0.1209	0.1270	0.1552	0.1446	-0.1357	-0.1204	0.2125	0.1776	0.1922	0.0942	0.0910	0.0571	0.1467	0.852**
S/P	P	0.0105	0.0090	0.0081	0.0118	0.0105	-0.0091	-0.0092	0.0109	0.0130	0.0106	0.0094	0.0069	0.0046	0.0122	0.922**
	G	0.0838	0.0722	0.0652	0.0939	0.0844	-0.0699	-0.0686	0.0872	0.1043	0.0850	0.0756	0.0557	0.0370	0.0965	0.910**
SL	P	0.0067	0.0042	0.0048	0.0059	0.0056	-0.0049	-0.0043	0.0075	0.0068	0.0083	0.0031	0.0028	0.0023	0.0058	0.847**
	G	-0.0142	-0.0090	-0.0101	-0.0124	-0.0120	0.0100	0.0084	-0.0160	-0.0144	-0.0177	-0.0069	-0.0062	-0.0049	-0.0123	0.831**
100 FW	P	0.0515	0.0616	0.0332	0.0754	0.0718	-0.0684	-0.0775	0.0470	0.0787	0.0410	0.1085	0.0758	0.0451	0.0862	0.623**
	G	0.0350	0.0430	0.0238	0.0513	0.0495	-0.0441	-0.0478	0.0332	0.0543	0.0291	0.0749	0.0530	0.0313	0.0590	0.598**
FD	P	-0.1596	-0.2204	-0.1380	-0.1948	-0.1765	0.1926	0.2388	-0.1644	-0.2090	-0.1323	-0.2746	-0.3934	-0.1713	-0.2461	0.3349
	G	-0.1560	-0.2226	-0.1414	-0.1912	-0.1770	0.1764	0.2089	-0.1681	-0.2096	-0.1366	-0.2776	-0.3925	-0.1707	-0.2441	0.3130
CTL	P	-0.0001	-0.0001	0.0001	-0.0001	-0.0002	0.0003	0.0001	-0.0001	-0.0002	-0.0001	-0.0002	-0.0002	-0.0005	-0.0002	0.3490

	G	0.0031	0.0018	-0.0009	0.0031	0.0042	-0.0054	-0.0026	0.0030	0.0040	0.0031	0.0047	0.0049	0.0113	0.0041	0.3256
Sl	P	0.2572	0.2126	0.1771	0.3369	0.3074	-0.2340	-0.2516	0.2570	0.3460	0.2587	0.2939	0.2314	0.1500	0.3698	0.827**
	G	0.2064	0.1744	0.1390	0.2740	0.2505	-0.1878	-0.1972	0.2093	0.2805	0.2115	0.2386	0.1887	0.1118	0.3033	0.811**
Partial R^2	P	0.1000	0.0347	0.0545	-0.2054	0.2566	0.2286	0.0167	0.2361	0.0120	0.0070	0.0676	-0.1317	-0.0002	0.3059	
	G	0.1107	-0.0017	0.0787	-0.1917	0.2535	0.2560	0.0390	0.1811	0.0949	-0.0147	0.0448	-0.1229	0.0037	0.2461	

* and ** Significant at 5% and 1% Level of significance respectively P- Phenotypic level G – Genotypic level
H=Plant height, NPB= No. of primary branches, NSB= No. of secondary branches, LA= leaf area, TC= total chlorophyll, 50% F=50% flowering, 1st H= first harvest, F/S= flowers/spike, S/P= spikes/plant, SL= spike length, 100FW= 100 flower weight, FD= flower diameter, CTL= corolla tube length, Sl= shelf life, FY= flower yield

Path analysis

In the present investigation, path coefficient analysis results reveal that shelf life, total chlorophyll, the number of flowers per spike, and plant height directly affected flower yield. Meanwhile, the flower diameter and days to fifty percent flowering directly affected flower yield.

Similarly, traits like shelf life, total chlorophyll, and number of flowers per spike exhibited the highest positive indirect effect on flower yield through most traits, indicating that more emphasis should be given to these traits in improving flower yield. Whereas traits like flower diameter, days to 50% flowering, and days to first harvest exhibited the highest negative effect on flower yield through most traits, indicating the yield hindrances nature through these traits. Thus, breeders should understand the route cause for selection to improve flower yield. Kumar *et al*. (2019) [14] recorded high positive and direct effects of plant height, flower diameter, flower yield per plant and thousand seed weight on yield per hectare in Marigold. Thus, selecting based on these characteristics will enhance performance and improve the flower yield. These agree with the results of Veluru *et al.* (2019) [27] in China and Bennurmath *et al.* (2022) [6] in chrysanthemum.

Conclusion

Flower yield exhibited a significantly positive correlation with the number of spikes count per plant, number of flowers per spike, spike length, shelf life, leaf area, total chlorophyll, 100 flower weight, plant height, flower diameter, primary branches per plant and secondary branches per plant. At the same time, traits like days to fifty percent flowering and days to first harvest recorded the highest negative correlation with many traits. Path coefficient analysis results reveal that shelf life, total chlorophyll, number of flowers per spike and plant height directly affect flower yield. Meanwhile, the flower diameter, days to fifty percent flowering, and leaf area negatively affected flower yield.

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