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CORRELATION AND CAUSATION STUDIES IN AMARANTHUS (*AMARANTHUS* sp.)

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Amaranthus is a leafy vegetable which is rich in protein, vitamin C, vitamin A and iron. Though its leaf is very popular as vegetable in tropics very little work has been done to breed superior varieties. Kamalanathan *et al.* (1970) made some selections from a collection of 50 land races and the two selections Co-1 and Co-2 were released for cultivation. There are no reports on the components of vegetable yield in amaranthus. The present study was taken up to identify the components of yield and their asssociations as part of breeding programme for higher yield.

Materials and Methods

Sixty seven varieties from different states of India and abroad (U S A, Australia, Taiwan, Nigeria) were used for the experiment. These included species such as *A. tricolor* and its polymorphic types *A. mangostanus* and the grain type *A. hypochondriacus* and *A. caudatus*. They are classified into three groups: 1. dual purpose types (grain types, thinnings of which can be used as vegetable); 2. the pulling types which do not give many cuttings or do not yield appreciable amount of grain (mainly comprising of *A. tricolor)* and 3. the cutting types which are amenable to many cuttings (mainly *A. mangostanus).* Three of the varieties belonged to the wild species *A. spinosus.*

The varieties were planted on raised beds of 2 m x 1 m surrounded by a moat for easy irrigation. Each bed had three rows 20 cm apart. Sowing was done directly and the plants thinned out to avoid thick stand. Five plants per bed were selected at random and the data recorded on growth parameters (Table 1) at the harvestable stage.

The varieties were classified into the above mentioned three groups and product moment correlations were worked out between measurements for the pulling types consisting of 35 varieties and the dual purpose type consisting of 24 varieties. The similar relations were not worked out for cutting types as it consisted of only 5 varieties. The correlations were tested using method suggested by Rao (1951). The correlations were worked out separately for the different groups because the groups are dissimilar in the morphological characteristics and might have been subjected to differential selection pressures under cultivation. The path coefficient analysis of the data was done using method suggested by Dewey and Lu (1959).

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Results and Discussion

The pulling types many of which belong to *A. tricolor* a polymorphic species, exhibited the maximum range of variation in many of the characters (Table 1). A very large potential for improvement in yield existed in the present collection compared to Co-1.

The distance between crown and first leaf did not show any association with all the three yield characters in the two types (Table 2). The internodal length also did not have any association with yield characters and in dual purpose type, leaf area showed a similar behaviour. High correlations were detected between girth and yield in both the types. Height in the case of pulling type, number of leaves, number of branches, number of nodes and petiole length in case of dual purpose type had high correlations with yield. Characters like leaf area which have no association with yield can be subjected to simultaneous selection pressure if a particular situation warrants, without affecting the yield adversely. Similar thing cannot be done with characters having high association with yieldl ike girth. This implies that a type yielding high but with a thin stem cannot be selected within the present material. It is also further seen that the three different facets of yield plant weight, leaf weight and stem weight behave in a similar manner implying an absence of antagonism among these characters.

The correlations between characters indicated the constraints that existed when selecting for individual characters. Height was related to girth in the pulling and dual purpose types and with number of leaves in dual purpose types. Girth was related to height, number of leaves, number of branches and number of nodes in dual purpose and pulling types. The inter-relations of these characters are consequences of the evolution of different plant types in the different groups of amaranthus. These relations sometimes limit the extent of improvement that can be realised from selection.

In the pulling type, girth and height exhibited the maximum direct effects (Table 3). The major portion of the indirect effects was again through girth and height. A plant type combining larger girth and larger heights would be ideal in this case.

As regards the dual purpose types which are grown mainly for their grain yield the major portion of the direct effect was by girth and all other characters influenced yield again mainly through girth. A plant type which has a larger girth will give higher yields but since these types are likely to have a higher fibre content, selection for this character may have limitations. Also from Table 1 it is seen that these types have lesser potential for high yields.

In some parts of India like hills of U. P, Himachal Pradesh, and Nilgiris amaranthus types like *A. hypochondriacus* and *A. caudatus* are cultivated for grain. Thinnings from the grain crop are used as vegetables. Some selections

Table 1

Performance of diverse types and Co-1 variety of amaranthus

	Characters (mean of 5 plants)	Pulling type	Dual Purpose type	Mean of Co-1 control
1	Height (cm)	5.60—44.34	15.92—36.98	30.94
2	Girth at crown level (cm)	0.44- 1.34	0.39— 1.12	0.68
3	Number of leaves	10.80— 19.00	10.20—19.00	13.20
4	Number of branches	0.00— 12.60	0.00— 9.00	7.00
5	Number of nodes	7.60— 19.60	7.40— 16.80	10.60
6	Internodal length (at 5th internode) cm.	1.40— 4.80	1.60— 4.38	3.14
7	Petiole length (cm of 5th leaf from top)	4.08— 7.28	3.14— 7.58	5.16
8	Plant weight (g)	6.68— 73.78	4.34_47.20	17.02
9	Weight of leaves (g)	2.72— 24.82	1.80—14.46	6.30
10	Weight of stem (g)	1.18— 48.96	1.96—21.06	10.72
11	Distancefrom crown to first leaf (cm)	0.00— 17.24	5.78—15.94	7.64
12	Leaf area (of 5th leaf from top sq. cm).	10.50—23.74	12.54—26.62	14.58

from grain types have yielded fairly good vegetable types like the Co-1 variety (*A. flavus*) from *A. hypochondriacus*. The present study has shown that selection for thicker plants from this group could yield vegetable types though the scope is limited. In the pulling types consisting mostly *A. tricolor* types, selection of taller plants combined with good girth would give better yielding plants. Incidentally this group exhibited the maximum amount of variation for both these characters, compared to the dual purpose types. Thus the present study would help a vegetable amaranathus breeder to look for certain types of plants in each group for enhancement of yield. Further experiments to confirm these results and study of heritability of these cheracters in each group would throw further light on breeding strategy in this group of crops.

Summary

A correlation and causation study on 59 varieties of amaranthus belonging to pulling and the dual purpose types (grain types which can also be used for pulling) has been made. The three different facets of yield *viz.*, plant weight, leaf weight and stem weight had similar type of association with morphological measurements. It was seen that while simultaneous selection for yield and leaf area is possible, characters like girth are strongly related with yield and a

Table 2

Correlation coefficents among different characters of amaranthus

	Height (cm)	Girth (cm)	No. of leaves	No. of branches	No. of nodes	Inter-nodal length (cm)	Petiole length (cm)	Crown to first leaf	Leaf area	Plant weight	Wt. of leaves	Wt. of stem
1	1 (P)	0 56**	0.34**	0.06	0.36**	0.18	0.13	–0.53**	0.30**	0.67**	0 49**	0.74**
	1 (D)	0·21*	0.13	-0.04	0.19	0.25*	0.12	0.51	0.23**	0·30**	0.21**	0.38**
2		1	0.33**	0·33**	0.50**	-0.12	0.12	0.11	0.36**	0.82**	0.75**	0.80**
		1	0.69**	0.72**	0.76**	-0.16	0.78**	-0.19	0.12	0.96**	0.95**	0.94**
3			1	0.56**	0.68**	-0.22*	0.60**	-0.14	–0.11	0.37**	0.46**	0.27**
			1	0.66**	0.61**	-0.20*	0.65**	-0.20*	-0.01	0 70**	0.70**	0.68**
4				1	0.55**	-0.03	0.08	–0.46**	-0.05	0.37**	0.59**	0.25
				1	0,78	-0.19	0.60**	–0.51**	-0.09	0.71**	0.75**	0.66**
5					1	–0.29**	0.02	-0.15	0.08	0.52**	0.50**	0.43**
					1	–0.24**	0.63**	–0.32**	-0.04	0.78**	0.79**	0.76**
6						1	0.10	0.03	0.09	-0.04	-0.01	0.00
						1	-0.21*	0.05	0.28**	-0.18	-0.18	-0.18
7							1	0.14	0.06	0.15	0.12	0.15
							1	-0.20	-0.03	0.74**	0.74**	0.72**
8								1	0.33*	0.13	-0.06	0.25*
								1	0.18	-0.17	-0.25*	-0.01
9									1	0 38**	0.29**	0.41**
									1	0.13	-0.12	0.12
10										1	0.94**	0.97**
										1	0.98	0.98**
11											1	0.83**
											1	0.95**

P = Pulling type, D = Dual purpose type
*(P 0.05) **(P 0.1)

Table 3

Direct and indirect effects of component on plant weight, leaf weight and stem weight in amarnathus

Characters	Pulling types: Total direct effect	Total indirect effect	Indirect effects via Girth	Indirect effects via Height	Characters	Dual purpose types: Total direct effect	Total indirect effect	Indirect effects via girth
Plant weight								
1. Height (cm)	0.33	0.34	0.29	—	1. Height (cm)	0.11	0.19	0.17
2, Girth (cm)	0.52	0.30	—	0.18	2. Girth (cm)	0.83	0.13	—
3. No. of leaves	-0.06	0.42	0.17	0.11	3. No. of leaves	0.07	0.63	0 57
4. No. of branches	0.17	0.20	0.17	0.02	4, No. of branches	0.03	0.68	0.59
5. No. of nodes	0.08	0.44	0.26	012	5. No. of nodes	0.09	0,,69	3.63
6 Leaf area (sq. cm)	0.10	0.29	0.19	0.10	6. Petiole length (cm)	-0.04	0.78	0.64
Residual (%)				84				25
Leaf weight								
1. Height (cm)	0.10	0.39	0.28	—	1. Height (cm)	0.02	0.19	0.17
2. Girth (cm)	0.50	0.25	–	0.06	2. Girth (cm)	0.79	0.16	—
3. No. of leaves	0.05	0.42	0.16	0.04	3 No. of leaves	0.06	0 65	0.55
4, No. of branches	0.22	0 27	0.16	0.01	4. No. of branches	0.08	0,,67	0.57
5. No. of nodes	0.15	0.45	0.25	0.04	5. No. of nodes	0.10	0.69	0.60
6. Leaf area (sq.cm)	0.09	0.20	0.18	0.03	6. Petiole length (cm)	-0 03	0,77	0.62
Residual (%)				56				28
Stem weight								
1 Height (cm)	0.45	0.29	0.28	—	1. Height (cm)	0.19	0.20	0.17
2. Girth (cm)	051	0.29	—	0.25	2, Girth (cm)	0.83	0.11	....
3. No. of leaves	-0.12	0.39	0.17	0.15	3. No. of leaves	0 06	0.62	0.59
4. No. of branches	0.11	0.14	0.17	0.03	4. No. of branches	-0.02	0.68	0.57
5. No. of nodes	0.03	0.40	0.25	0.16	5. No. of nodes	010	0.67	0.63
6. Leaf area (sq. cm)	0.09	0.33	0.18	0.14	6, Petiole length (cm)	-0.04	0.76	0.64
Residual (%)				46				28

variety having high yield and thin stem cannot be evolved within the varieties under study. It was further seen that wide variability existed in the types indicating possibility for isolating promising selections. A plant type combining larger girth and larger height was a better ideotype among pulling types. Among the dual purpose types all characters influence yield only through girth, thus making a very high yielding variety thicker and consequently having a stem with more fibre content. This leads to the conclusion that higher yielding varieties are to be identified among the pulling types.

സംഗ്രഹം

പച്ചക്കറിയായി മാത്രം ഉപയോഗിക്കാവുന്നവയും, പച്ചക്കറിയ്ക്കും ധാന്യാവശ്യത്തിനും പററിയവയും ഉൾക്കൊള്ളുന്ന 59 ചീര ഇനങ്ങളിൽ, വളർച്ച വിളവ് മുതലായവയുടെ ഘടകങ്ങൾ tfjxsmlejgg പരസ്പര ബന്ധത്തെപ്പററി പഠിക്കുകയുണ്ടായി. ചെടിയുടെ മുഴുവനോടെയുള്ള തൂക്കം, ഇലയുടെ തൂക്കം, തണ്ടിൻെറ തൂക്കം എന്നീ ffi^crr)"ejs<ft>s5T3Co വിളവിൻെറ കാര്യത്തിലെന്നപോലെ തന്നെ അവയുടെ ബാഹ്യലക്ഷണങ്ങളുമായും ബന്ധപ്പെട്ടിരിക്കുന്നതായി കണ്ടു.

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References

Dewey, D. R. and Lu, K. H. 1959 A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron. J.,* 51, 515-518,

Kamalanathan, S., Sundararajan, S., Thamburaj, S and Shanmugam, A. 1973 Co-1 amaranthus—A high yielding and delicious strain. *Madras agric. J.,* 60 (6), 355-358.

Sao, C. R. 1952 *Advanced Statistical Methods for Biometric Research* John Wiley, p. 232.

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