International Journal of Research
International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 05, May 2015
Available at http://internationaljournalofresearch.org

Estimation of Association Characters in Amaranths Germplasm Accessions (*Amaranthus* Spp.) Under Mizan and Tepi Condtions, South West Ethiopia

Ayehu Fekadu Hailu[1] ; S.Lal[2] & Sinatayehu Alameraw [3]
Addis Ababa University Seleale campus Horticulture department[1]
Jimma university horticulture [2] and plant breeding[3] department
Tel: +251-0932285910 Email: ayehufekadu5@gmail.com

ABSTRACT

Amaranthus is one of the most nutritious leafy vegetables in the world and dominantly consumed in the pastoralist area in Ethiopia. However this crop has received less research attention and little or nothing has been done on extent of character association studies on this crop. Hence, 36 accessions of Amaranthus spp. were evaluated in 6x6 simple lattices design at Tepi and Mizan experimental sites. The overall objective was to estimate the extent of genetic association among yield and yield related traits. Variances component method was used to estimate, genetic relationship among traits was also estimated by using standard method. Analysis of variance revealed that there was a significant difference (p< 0.01) among thirty six germplasm accessions for all the characters studied except for thousand seed weight which was non significant (p>0.05). Less value of phenotypic correlation coefficient than the genotypic correlation coefficient were found in most of the characters. The green leaf yield per plant showed a positive and significant relationship with the majority of the traits except lateral inflorescence which had negative significant association with green leaf yield .The maximum positive direct effect were recorded in biomass per plant, average branch length, leaf area, days to flowering, leaf width and plant height on the other hand, length of medium branch `exerted the highest negative direct effect on yield.

The overall study confirmed that there were interrelation between two characters this could be exploited in the genetic improvement of the crop through hybridization and selection. Among others biomass per plant will be useful traits for indirect selection to increases green leaf yield

Key words:-
Amaranthus; genetic correlation; phenotypic correlation

1. INTRODUCTION

Amaranthus belongs to the family Amaranthaceae and the genus *Amaranthus.* Vegetables species of *Amaranthus* included *Amaranthus biltium*, *Amaranthus tricolor, Amaranthus dubiles, Amaranthus spinosus, Amaranthus virdis and Amaranthus curentes.* The fresh tender stem with leaves of amaranths is delicious when cooked like other leafy vegetable (Bressani, 1990).

The attainment of characteristic form and function in crop plants depends upon a chain of biologically integrated and interrelated events. Estimation of genotypic and phenotypic correlation coefficients leads to the understanding of characters that form basis of selection (Allard, 1999).

Phenotypic correlation is the observable correlation between two variables; it includes both genotypic and environmental effects. The association between two characters that can be directly observed is the phenotypic correlation and is determined from measurements of two characters in a number of individuals of the population. Genotypic correlation is the inherent association between two variable; it may be either poleitropic action of genes, linkage or more likely both. It is the correlation of breeding value (Falconer, 1981).

The correlation coefficient can range from -1 to + 1, with -1 indicating a perfect negative correlation between x's and y's and +1 indicating a positive correlation (Gomez and Gomez, 1984; Singh, 2001). When there is positive association of major yield characters, breeding would be very effective but when these characters are negatively associated, it would be difficult to exercise simultaneous selection for them in developing a variety.

Estimates of genotypic and phenotypic correlations among characters are useful in planning and evaluating breeding programs (Johnson *et al.,* 1955).

Path co-efficient analysis is a special of multi-variate analysis. This facilitates providing of correlation coefficients into direct and indirect contribution of various characters on yield. It measure the direct influence of one variable upon other, such information would be in enabling the breeder to specifically identify component traits of yield and utilize the genetic stock for improvement (Therthappa, 2005).

Amaranth species are cultivated and consumed as a grain and a leaf vegetable widely in the pastoralist area of the country, due to the fast growth nature, wide adaptable area and more production nature of the crop it can feel the gap of food security problem. Currently under Institute of Biodiversity Conservation (IBC), large number of amaranths accessions is collected. As far as association studies among characters in amaranths are concerned little or nothing has been done in the country (Kebu and Fassil, 2006). To do agronomic and other related research on this crop association studies for the genotypes was considered an important area of study.

Hence the present study was under taken, with to the following objectives: -

To estimate the extent of phenotypic and genotypic correlations between pairs of characters and there by compare the direct and indirect effects of certain characters on yield.

2. MATERIALS AND METHODS

2.1. Experimental Site

The experiment was conducted in two experimental sites in South Bench and Tepi National Spices Research Center. South Bench is found in Bench Magi Zone of SNNPRS and located at latitude from 5.33^{o} to 7.21^{o}N and longitudes from 34.88^{o} to 36.14^{o}E with an elevation ranging from 1200 to 1959 meters above sea level. The area receives mean annual rainfall ranging from 1500 to 1800mm (an average 1692mm) per year and has 15^{o}C to 27^{o}C range of temperature annually and the soil is loam or silty-loam soil type (SNNPR, 2009). The research site is located at 1280 meter altitude above sea level and 580 km away from Addis Ababa.

The second site is Tepe National Spices Research Center (TNSRC) is located in the South Western part of the country 611 km away from the capital city Addis Ababa. Tepe situated in Yeki woreda, Sheka zone of SNNPRS and located at approximate geographic coordinates of latitude 7°3' N and longitude of 35°E. It is is located an altitude of 1200 m.a.s.l. and it receives annual average rainfall of 1688 mm (ranging from 1560 to 1790 mm) and has mean maximum and minimum temperatures of 29.5 and 15.4^{0}C, respectively. The soil type is Distric Nitosoil with a pH ranging from 4.5–6.5 and the two sites are favorable for the fast growth and productivity of amaranths in the area for the year(TNSRC, 2010).

2.2. Experimental Materials

In this study thirty six accessions of amaranths were obtained from the Institute of Biodiversity Conservation of Ethiopia, these accessions were grown in the experimental sites during 2010 cropping season under rain fed condition. The details of the accessions used in the experiment are given in Table 1.

2.3. Experimental Design and plant Management

The experiment was carried out during 2010 cropping season in two locations in 6x6, simple Lattices design with two replications.

The experimental flied was well prepared by ploughing three times. Plot size of 3m length and 2.7m width and 0.5meter path between plot with one meter path between block and with a three meter distance between replication were prepared. Seeds of different accession were sown uniformly in rows at 40 cm and 30 cm distances between plants. The quantity of seed applied was calculated based on seed rate 2 kg/ hectare . Normal cultural practices such as 15 days interval weeding after germination were followed during the experimental period (Palada and Chang, 2010).

2.4. Data Collected

Quantitative data on plant basis were collected as per AVRDC (2007) procedures on the following characters:

Plant height (cm): Plant height was measured (Appendix plate 5) in centimeters from the ground level to the top of canopy of the plant at full flowering stage from October to December first week depends on accessions from the ten randomly taken plants and averaged.

Mean length of the basal, middle, top lateral branches and average total branch length (cm): Three branches per plant for each parameters (30 /plot) were taken from each basal, middle and top lateral branches of the ten randomly taken plants at full flowering stage (from October to December first depends on accessions) and length was measured and averaged. The total average branch taken as an average branch length and expressed in centimeters.

Stem diameter (cm): Stem diameter was measured at 10 cm above ground level from the ten randomly taken plants at full flowering stage by meter caliper and the average expressed in centimeters.

Internodes length (cm): The distance between any six successive nodes on the main axis on ten randomly taken plants at full flowering stage (from October to December first) were

International Journal of Research
International Journal of Research (IJR)
IJR e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 05, May 2015
Available at http://internationaljournalofresearch.org

measured in centimeter and averaged.

Primary branches per plant: The average number of primary branches arising from the main stem were counted at 50% of flowering stage from ten randomly taken plants and averaged.

Secondary branches per plant: The average number of secondary branches formed on primary branches on ten randomly taken plants were counted at 50% of flowering stage and averaged.

Number of leaf per plant: The average number of leaves per plant was counted from the ten randomly taken plants leaves at full flowering stage and averaged.

Leaf length (cm): It was measured in centimeter from the ten randomly taken plants at tip of the petiole to the leaf blade tip from the 6^{th} or 8^{th} leaves were measured at 50% of flowering stage (2/plant) from the main stem or first part primary branches and averaged.

Leaf width (cm): Measured in centimeter at half part of the leaf length from the ten randomly taken plants from the 6^{th} or 8^{th} leaves were measured at 50% of flowering stage (2/plant) from the main stem or first part primary branches and averaged

Leaf area (cm^2): The area of the leaf was measured in cm^2 using grid square from the ten randomly taken plants from the 6^{th} or 8^{th} leaves were measured at 50% of flowering stage (2/plant) from the main stem or first part primary branches and averaged.

Leaf yield (gm): The average leaf yields were obtained from ten randomly taken plants starting from 27.5 to 38.5 days after sowing depending on accession from each successive cutting was measured by digital balance and the average leaf yield per plant was expressed in gram.

Terminal inflorescence stalk length (cm): The averaged length of terminal inflorescence was measured in centimeter from the starting point of terminal flower to the tip of the ten randomly taken plants on the onset of seed formation.

Lateral inflorescence length from the terminal (cm): The length of lateral inflorescence arising from the terminal inflorescence stalk was measured in centimeter from the junction of the terminal to the tip points of the lateral from the ten randomly taken plants on the onset of seed formation and the average was expressed in centimeters.

Axillary inflorescence length (cm): It was measured in centimeter from the starting point of the axial to the end point of inflorescence from ten randomly taken plants on the onset of seed formation and the average was expressed in centimeters.

Biomass per plant (g): The total above ground fresh biological yield was measured in grams from ten randomly taken plants at full seed ripening stage (when the plants are still green) and averaged.

Seeds yield per plant (g): The average seed yield of the ten randomly taken plants measured by digital balances after harvest when the plants are changes leaf color and indicator seed starts to drop on the ground (locale trained of the farmers also employed) and the average was expressed gram.

Thousands seed weight (g): After the seed was harvested from the sampled plants, dried and adjusted to moisture content of 7% was measured by digital balance and the average weight expressed in gram.

Days to 50% emergence: The number of days from planting to 50% of seedlings germinates in each plot was recorded and expressed in days.

Days to 50% of the plant flowering : The number of days from planting to the date on which 50% of plants in each plot had one or more flowers was recorded and expressed in days.

Days for green harvest: The number of days from the date of sowing to a stage when 90% of plants were reached for the first green harvest was counted. The first green harvest cutting was done at a height of about 25-30 cm after attained marketable size and subsequent cuttings were done at interval of 15 days until the branches starts to flower and expressed in days.

Days to seed harvest: Seed harvesting was don when the plants are changes leaf color and indicator seed start to drop on the ground (locale trained of the farmers also employed) and the average was expressed in days.

International Journal of Research
International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 05, May 2015
Available at http://internationaljournalofresearch.org

Table 1. List of Amaranths germplasm accessions that were used in the study

No	Accessions	Species	Region	Zone	Woreda	Locality	Latitude	Longitude	Altitude(m)	Source
1	Am.91001	*A.tricolor*	SNNPRS	Konso	Konso	Fesha	05-17-00-N	37-20-00-E	1890	IBCE
2	Am91002	*A.tricolor*	Oromiya	East Wellga	Gida kiramu	Atera, South Alibo	09-49-00N	37-00-00-E	2480	IBCE
3	Am 91003	*A.tricolor*	Oromiya	East Wellga	Diga leka	Tolle kebele	09-02-00-N	37-04-00-E	1200	IBCE
4	Am.91005	*A.tricolor*	Oromiya	Jimma	Seka Chekorsa	AlroTebara Kebele	07-33-00-N	36-35-00-E	2040	IBCE
5	Am.202108	*A.tricolor*	Oromiya	Jimma	Sokoru	Keshe	-	-	-	IBCE
6	Am.204644	*A.tricolor*	SNNPRS	North Omo	Arbaminch	Siele kebele	-	-	1200	IBCE
7	Am204645	*A.tricolor*	SNNPRS	Konso	Konso	Konso town	--	--	1600	IBCE
8	Am.205139	*A.tricolor*	SNNPRS	North Omo	Sodo	Dalbow agna	-	-	2240	IBCE
9	Am208025	*A.tricolor*	Amhara	North Gonder	Dmbia	Gorgora Town	12-15-00-N	37-10-00-E		IBCE
10	Am 208683	*A.tricolor*	Oromiya	East Harrga	Deder	Gende Osman	09-26-00-N	41-21-00-E	2270	IBCE
11	Am.208764	*A.tricolor*	Oromiya	West wellga	Sayo	Dembi Delo	---	--	1850	IBCE
12	Am209057	*A.tricolor*	SNNPRS	North Omo	Sodo	Wachi	----	--	1660	IBCE
13	Am209057	*A.tricolor*	SNNPRS	North Omo	Offa	Sere Esho	----	--	1580	IBCE
14	Am.211455	*A.tricolor*	SNNPRS	North Omo	Arba Minch	Sele	05-50-00-N	37-27-00-E	1150	IBCE
15	Am.211456	*A.tricolor*	SNNPRS	North Omo	Bonke	Arfiti	----	---	1570	IBCE
16	Am211457	*A.tricolor*	SNNPRS	Konso	Konso	Durayie	----	--	1560	IBCE
17	Am.212581	*A.tricolor*	Amhara	South Wolo	Werebabu	Hadeeno	11-16-00-N	39-45-00-E	2920	IBCE
18	Am.212582	*A.tricolor*	Amhara	South Wolo	Tehuledere	Wune	11-10-00-N	39-40-0–E	1840	IBCE

IBCE= Institute of Biodiversity Conservation of Ethiopia
SNNPRS= Southern Nation Nationalities and Peoples Regional State

International Journal of Research
International Journal of Research (IJR)
IJR e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 05, May 2015
Available at http://internationaljournalofresearch.org

Table1. (Continued)

No	Accessions	Species	Region	Zone	Woreda	Locality	Latitude	Longitude	Altitude(m)	Source
19	Am.212583	*A.tricolor*	Amhara	South Wolo	Tehuledere	Abasomile	----	---	1640	IBCE
20	Am212890	*A.tricolor*	SNNPRS	Kebatatembro	Kedid	Hambo	37-56-00-N	07-12-00-E	2180	IBCE
21	Am212892	*A.tricolor*	SNNPRS	Dierashe	Dierashe	Afya	37-20-00-N	05-38-00-E	2200	IBCE
22	Am.212893	*A.tricolor*	SNNPRS	Dierashe	Dierashe	Gato	37-25-00-N	05-41-00-E	1380	IBCE
23	Am. 202109	*A.tricolor*	SNNPRS	Kefiecho	Melgewa	-	07-08-00-N	36-11-00-E	1940	IBCE
24	Am.214617		SNNPRS	North Omo	Damote dale	-	-	-	-	IBCE
25	Am215560	*A.tricolor*	SNNPRS	Gedeo	Yirgacifa	Deboca	06-07-00-N	38-13-00-E	2080	IBCE
26	Am215567	*A.tricolor*	SNNPRS	North Omo	Damot	Gidiobodti	06-57-00-N	37-51-00-E	2100	IBCE
27	Am215567	*A.tricolor*	SNNPRS	North Omo	Blososori	Arka road	07-05-00-N	37-43-00-E	1750	IBCE
28	Am219284		SNNPRS	North Omo	Borda abaya	Sodo road	06-17-00-N	37-47-00-E	1300	IBCE
29	Am225712	*A.tricolor*	SNNPRS	North Omo	Arbaminch	Kemba	05-45-00-N	37-22-00-E	1100	IBCE
30	Am225713	*A.tricolor*	SNNPRS	North Omo	Zalau baamale	Kemba	06-18-00-N	37-00-00-E	1600	IBCE
31	Am225714	*A.tricolor*	SNNPRS	North Omo	Gofa zuria	Sawla road	06-17-00-N	36-53-00-E	1570	IBCE
32	Am225715	*A.tricolor*	SNNPRS	North Omo	Gofa zuria	Bulki road	06-18-00-N	36-49-00-E	1780	IBCE
33	Am225716	*A.tricolor*	SNNPRS	North Omo	Kucha	Selamber	06-28-00-N	37-30-00-E	-	IBCE
34	Am240812	*A.tricolor*	SNNPRS	North Omo	Damote dale	Koysha	-	-	1880	IBCE
35	Am240815	*A.tricolor*	SNNPRS	Gurage	Sodo	Shola	-	-	950	IBCE
36	Am242530	*A.tricolor*	Benishangule	Asosa	Kurmuk	Sheflyul	10-33-18-N	34-30-94-E	1250	IBCE

IBCE= Institute of Biodiversity Conservation of Ethiopia
SNNPRS= Southern Nation Nationalities and Peoples Regional State

2.5. Statistical Analysis

2.5. 1. Analysis of variance

To perform a combined statistical analysis across location, testing for homogeneity of error variance (Bartlett, 1937a) test was carried out.

The data collected for each quantitative character were subjected to analysis of variance (ANOVA) for simple lattices design. The relative efficiency of simple lattice design over RCBD (Randomized Complete Block Design) was estimated and found that the use of the 6x6 simple lattice design estimated had increased the experimental precision over that of RCB design. Analysis of variance was done by Statistical soft ware SAS Version 9.2(SAS Institute, 2008). LSD was used to separate means with the significance difference by using 5% probability levels of significance for the characters studied.

3. RESULTS AND DISCUSSION

The computed homogeneity error variance test and the combined analysis of variance for the two locations showed no significant differences between two locations. This indicated that genotype by environment interactions are not important sources of variation for the tested germplasm accession of amaranths. As the result the combined analysis of variance was computed for two location showed highly significant difference ($P<0.01$) among amaranths accessions for all the characters studied except thousand seed weight which was non significant (Table 2).This indicated that the existence of genetic variability among the tested germplasm accession of amaranths.

Fig. 1. Plant height

Fig.2.Terminal inflorescence

Fig.3. Amaranths seed

Table 2. Analysis of variance (Pooled) for 24 quantitative characters of in 36 Amaranths accessions tested at Mizan and Tapi (2010)

Table 2. (Continued)

Source of variation	Degree of freedom	Mean square							
		Dyes to emergence	Days to green harvest	Green leaf yield	Stem Diameter	Biomass per plant	Internode length	Plant height	Length of basal branch
Replications	3	7.2477	37.21	2977.8	0.346	1409523	1.3437	5777.7	1523.6
Blocks within Replications (Adj.)	20	0.4125	1.336	63.879	0.122	17287.0	0.2541	86.939	30.689
Component A	10	0.4681	2.530	5.2757	0.212	16660.0	0.1427	103.86	26.928
Component B	10	0.3569	0.1375	122.48	0.033	17914.0	0.3656	70.02	34.450
Treatments (Unadj.)	35	7.9165	45.39	4220.5	1.45	462955	2.8578	1624.4	2579.6
Treatments(Adj.)	35	7.1214**	41.80**	3758.9**	1.36**	399327.4**	2.40**	1529.7**	2344.7**
Location x Treatment	35	1.2878 ns	2.340 ns	7.300ns	0.185 ns	2.91ns	0.2010ns	97.53ns	39.88ns
Intra block Error	85	0.7030	0.781	59.25	0.103	12102.0	0.1499	96.720	21.630
Randomized Complete block error	105	0.6477	0.886	60.130	0.106	13089	0.1698	97.860	23.35
Efficiency Relative to RCBD		105.12	106.9	104.30	105.6	109.70	105.85	105.07	106.6

**=Highly significant at 1%, and ns= Non significant at 5% probability level

International Journal of Research

International Journal of Research (IJR)

e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 05, May 2015

Available at http://internationaljournalofresearch.org

** = Highly significant at 1% and ns= Non significant at 5% probability level.

Source of variation	Degree of freedom	Mean square							
		Length of middle branch	Length of top branch	Average branch branch	Primary branch per plant	Secondary branch per plant	Leaf length	Leaf width	Leaf area
Replications	3	608.09	200.69	575.70	32.300	210.73	35.365	11.517	2301.8
Blocks within									
Replications (Adj.)	20	28.050	26.70	21.890	1.6246	25.810	4.2874	0.6633	103.50
Component A	10	20.967	10.62	10.020	0.6894	6.8179	1.9457	0.3304	85.620
Component B	10	35.138	42.78	33.750	2.5590	44.813	6.6291	0.9962	121.30
Treatments (Unadj.)	35	2568.8	859.22	1213.8	63.058	126.76	15.155	7.5706	988.89
Treatments(Adj.)	35	162.46**	38.04**	1114.7**	55.230**	116.70**	14.35**	6.950**	949.08**
Location x Treatment	35	27.93 ns	14.38 ns	34.96 ns	0.763 ns	3.128 ns	0.840 ns	0.437 ns	52.07 ns
Intra Block Error	85	16.827	18.865	24.050	0.8025	13.220	2.0732	0.5915	62.496
Randomized complete block error	105	18.965	20.357	23.630	0.9588	15.620	2.4949	0.6052	70.306
Efficiency relative to RCBD		108.60	106.62	105.29	107.1	106.34	107.56	100.17	103.50

Table 2. (Continued)

		Number of leaf per plant	Days to flowering	Terminal inflorescence length	Lateral inflorescence length	Axilary inflorescence length	Days to Seed harvest	Thousand seed weight	Seed yield
Replications	3	4908.8	21.71	5.109	1.270	0.127	6.50	0.0018	14.10
Blocks within replications (Adj.)	20	390.05	1.720	2.040	1.170	0.223	1.14	0.0012	2.410
Component A	10	292.78	3.067	0.612	0.534	0.018	2.273	0.0012	1.770
Component B	10	487.31	0.379	3.470	1.800	0.428	0.007	0.0012	3.060
Treatments(Unadj.)	35	14879	444.7	215.9	169.9	13.33	499.7	0.008	66.00
Treatments(Adj.)	35	13210**	413.4**	205.1**	159.2 **	11.77**	458.5**	0.008^{ns}	64.5**
Location x Treatment	35	406.95^{ns}	4.31^{ns}	0.64 ^{ns}	0.494 ^{ns}	0.024 ^{ns}	470.9*	0.003 ^{ns}	2.62 ^{ns}
Intra block error	85	269.62	1.990	1.643	0.883	0.110	1.060	0.008	1.720
Randomized complete block error	105	292.56	1.930	1.710	0.930	0.130	1.078	0.009	1.860
Efficiency Relative to RCBD		108.83	107.4	110.6	111.1	107.3	111.1	106.30	101.6

** = Highly significant at 1% , *= significant at 5% probability level and ns= Non significant at 5% probability level

e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 05, May 2015
Available at http://internationaljournalofresearch.org

3.1. Characters Association Studies

3.1.1. Correlation of green leaf and seed yield with other component characters

The phenotypic and genotypic correlation coefficients between different characters were presented in Tables 3 and 4. The values of phenotypic correlation coefficients in most of the characters in this observation were less than the values of genotypic correlation coefficients. This indicated that the correlations were more due to hereditary. The higher magnitude of genotypic correlation coefficients than respective phenotypic correlations coefficient between various characters in different genotypes of amaranths have also been reported by Shukla and Singh (2002) and Shukla *et al*. (2006).

Green leaf yield per plant showed a positive and significant association with plant height, internode length, average branch length and highly significant relation with days to emergence, days to green harvest, number of leaf per plant, biomass per plant, days to seed harvest, leaf width, leaf area, primary and secondary branch per plant at both in phenotypic and genotypic levels. This indicted that selection based on these parameters would considerably enhance green leaf yield. Similar findings were reported by Edema and Fakorede (2003) and Shukla *et al*.(2006) in amaranths.

Green leaf yield had negative and significant correlation with lateral inflorescences length at phenotypic and genotypic level. This indicated selection based on this character seems to be practically difficult to improve green leaf yield.

Green leaf yield had positive and non significant association with seed yield but also had negative and non significant correlation with terminal inflorescences length, lateral inflorescence length and length of auxiliary inflorescence in both phenotypic and genotypic associations.

Seed yield per plant also significant and positively correlated with days to emergence, length of middle branch, leaf length, leaf area, primary branch per plant and number of leaf per plant
but negative and non significant association with days to green harvest and days to 50% of flowering while non significant but positively correlation with the rest at both in phenotypic and genotypic levels. This finding is similar with Edema and Fakored (2003) conclusion on variability of amaranths

3.1.2. Correlation among other component characters

3.1.2.1. Phenotypic correlation

3.1.2.1..1. Correlation of days to 50% emergence with other characters

Days to 50% emergence was significantly and positively association with days to green harvest, stem diameter, days to flowering, biomass per plant, leaf width, leaf area and primary branch per plant. It was non significantly associated with the rest of the characters (Table 4).

3.1.2.1.2. Correlation of vegetative characters with other characters

Days to green harvest was also significantly and positively interrelated with days to flowering, biomass per plant, days to seed harvest, leaf width, leaf area, primary branch per plant, secondary branch per plant, number of leaf per plant whereas it was significantly and negatively correlated with lateral inflorescence length but insignificant with the rest of the characters (Table 3). Similar findings were reported by Katiyar *et al.*(2000) in amaranths.

Biomass per plant had significant and positive association with days to seed harvest, leaf width, primary branch per plant, secondary branch per plant, number of leaf per plant, thousand seed weight and negative but non significant correlation with terminal and lateral inflorescence lengths (Table 3). The positive significant correlation indicated that, improvement of the related characters facilitated improvement in biomass per plant. Similar finding was reported by Ana *et al.* (2009) on biomass yield of amaranths.

Plant height had a positive significant association with internod length, leaf length and leaf area but non significant association with the rest of the charactres (Table 3).This is in agreement with the findings of Oboh (2007) in amaranths.

Length of basal branch had a significant association with length of middle branch, average branch length, leaf length, lateral inflorescence lengths and axilary inflorescence length but non significant with the other characters. Length of middle branch was also significantly associated with length of top branch, average branch length, and terminal and lateral inflorescence length but non significant with the rest of the characters. Length of top branch was only significantly correlated with average branch length but insignificant with the rest of the characters. Average branch length also significantly correlated with leaf length, terminal inflorescence length, lateral inflorescence length and axilary inflorescence length, while non significant with the rest of the characters. Internode length displayed positive and significant association with leaf area and green leaf yield, but non significant with the rest of the characters (Table 4). Brenner (1994) reported similar findings in amaranths.

Leaf length had a positive phenotypic significant correlation with leaf area but non significant with the rest of the traits. The other characters, leaf width was also positively correlate with leaf area, number of leaf per plant and primary branch per plant while non significant with the others characters. Even though some characters lack significant association with leaf area but had positive significant association with primary branch per plant and number of leaf per plant. Primary and secondary branches per plant was also significantly and positively interrelated with each other and seed yield, however, a negative significant correlation was observed with lateral inflorescence length. Lateral, terminal and axilary inflorescence length had non significant correlation with most characters except middle branch length with positively significant correlation with terminal and lateral inflorescence length and average branch length positively significantly associated with, lateral, terminal and axilary inflorescence length (Table 3). This finding was comparable to the report of Vesnas (2005), Edema and Fakored (2003) and Xiao *et al.* (2000) in amaranths.

3.1.2.1.3. Correlation of inflorescence characters with other characters

Days to flowering had significant and positive association with biomass per plant, days to seed harvest, leaf width, leaf area, primary branch per plant, secondary branch per plant, number leaf per plant, thousand seed weight and negatively and significantly correlated with terminal and lateral inflorescence lengths but non significant with the rest of the traits. Terminal inflorescence length positively and significantly correlated with axilary and lateral inflorescence length but non significant with the rest of the traits. The lateral inflorescence length positively and significantly associated only with axilary inflorescence length were found (Table 3). This is similar with the findings of Rubaihayo (1995) in vegetable amaranths.

3.1.2.1.4. Correlation of days to seed harvest with other characters

Days to maturity of seed harvest was significantly correlated with, leaf width, leaf area, primary branch per plant, secondary branch per plant, number of leaf per plant, while negatively and significantly correlated with terminal and lateral inflorescence lengths but non significant with the rest of the characters (Table 3). This finding is in agreement with the findings of Shukla and Singh (2002) in amaranths.

Table 3 . Phenotypic (r_p) correlation matrix for the 24 quantitative characters of amaranths at Tapi and MIzan

Ch	DEM	DGH	DOF	S D	BMP	DSH	PH	LBB	LMB	LTB	LAB	INL	LL	LW	LA	PMB	SB	NOP	TIFL	LIL	AXL	TSW	SY	GLY
DEM		0.51**	0.58**	0.31*	0.52**	0.55**	-0.11	0.18	-0.15	-0.17	0.01	-0.09	0.09	0.36*	0.39**	0.32*	0.18	0.22	-0.26	-0.19	-0.21	-0.25	0.30*	0.438**
DGH			0.78**	0.27	0.64**	0.79**	0.15	0.04	-0.04	-0.15	-0.05	0.11	0.17	0.48**	0.49**	0.58**	0.47**	0.46**	-0.24	-0.34*	-0.25	-0.28	-0.14	0.642**
DOF				0.27	0.74**	0.95**	0.21	0.04	-0.23	-0.16	-0.09	0.08	0.18	0.35*	0.40**	0.61**	0.54**	0.52**	-0.39**	-0.48*	-0.15	0.31*	-0.22	0.74**
SD					0.36*	0.29 *	0.01	0.16	-0.15	-0.16	0.01	0.05	0.30*	0.34*	0.42**	0.14	0.07	0.19	-0.29*	-0.31*	-0.29	-0.14	0.31*	0.2461
BMP						0.72**	0.05	0.13	0.32*	-0.26	0.01	0.09	0.08	0.35**	0.26	0.64**	0.49**	0.45*	-0.21	-0.25	-0.28	0.51**	0.12	0.659**
DSH							0.08	0.07	-0.18	-0.15	-0.08	0.07	0.14	0.42**	0.44**	0.62**	0.62*	0.56**	-0.29*	-0.39**	-0.13	0.12	-0.11	0.745**
PH								0.26	0.12	-0.04	0.13	0.61*	0.28*	0.03	0.31 *	0.13	-0.10	-0.07	-0.01	0.12	0.06	-0.15	0.11	0.315*
LBB									0.64**	0.26	0.81**	-0.02	0.36*	0.12	0.21	0.02	-0.06	0.02	0.23	0.41**	0.29	-0.26	0.21	0.240 ns
LMB										0.39	0.83**	-0.21	0.20	-0.01	-0.03	-0.14	-0.16	-0.08	0.29*	0.31*	0.21	0..25	0.37*	0.33*
LTB											0.42*	-0.15	0.14	-0.04	-0.04	-0.05	-0.13	0.01	0.28	0.15	0.22	0.12	0 .21	0.222 ns
LAB												0.16	0.30*	0.08	0.0 8	-0.05	-0.08	0.03	0.38*	0.43**	0.40**	0.15	0.2.2	0.32*
INL													0.18	0.05	0.17	-0.02	0.10	0.06	0.11	0.05	0.02	0.12	0.05	0.33*
LL														0.25	0.65**	0.09	-0.21	0.01	-0.02	0.08	0.02	0.21	0.3*	0.166 ns
LW															0.72**	0.51**	0.08	0.41**	0.05	-0.18	-0.24	0.24	0.28	0.433**
LA																0.39*	-0.02	0.29*	-0.10	-0.19	-0.21	0.31*	0.31*	0.437**
PMB																	0.39*	0.42**	-0.25	-0.31	-0.27	0.13	0.3*	0.636**
SB																		0.49**	-0.11	-0.32	-0.02	0.14	0.25	0.454 **
NOP																			0.01	-0.25	-0.18	0.12	0.29*	0.50 **
TIL																				0.61*	0.35*	0.26	0.11	-0.17 ns
LIL																					0.38*	0.21	0.12	-0.40**
AXL																						0 .12	0.03	-0.21 ns
TSW																							0.27	0.11 ns
SY																								0.28 ns
GLY																								1.00

**=Highly significant at 1% level (r > 0.387), l*=Significant at 5% level (r > 0.289) , ns=Non significant at 5% level, DEM =Days to emergence, DGH=Days green harvest, DOF=Days to flowering, BMP =Biomass per plant, DSH =Days to seed harvest, PH=Plant height, LBB=Length of basal branch, LMB=Length of middle branch, LTB=Length of top branch, LAB =Length of average branch, INL=Internode length, LL=Leaf length, LW =Leaf width, LA = Leaf area, PMB=Primary branch per plant, SBP= Secondary branch per plant, NLP =Number of leaf per plant, TIL= Terminal inflorescence stalk length, LIL=Lateral inflorescence length, AXL=Axilary inflorescence lengths, SD= Stem diameter, GLY=Green leaf yield, TSW=Thousand Seed weight, SY=Seed yield

International Journal of Research
International Journal of Research (IJR)
IJR e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 05, May 2015
Available at http://internationaljournalofresearch.org

3.1.2.2. Genotypic correlation

3.1.2.2.1. Correlation of days to emergence with other characters

Days to emergence had also positive significant correlation with days to green harvest, days to seed harvest, leaf area, leaf width, primary and secondary branch per plant and not significantly correlated with the rest of the characters (Table 4). This is similar with the findings of Brenner (1994) in amaranths.

3.1.2.2.2. Correlation of vegetative characters with other characters

Biomass per plant was significantly and positively associated with days to green harvest, days to emergence, stem diameter, primary branch per plant, secondary branch per plant, thousand seed weight and number of leaf per plant whereas negatively but significantly correlated with lateral and terminal inflorescence length (Table 4).This finding in agreement with Edema and Fakorede (2003) considering association of biomass with days to emergence, stem diameter and primary branch per plant.

Stem diameter showed positive and significant association with biomass per plant, days to seed harvest, leaf length, leaf width and leaf area whereas it was significantly and negatively correlated with axilary, lateral and terminal inflorescence length (Table 4). This finding is agreeing with Vesnas (2005) on morphological and productive characteristics of species of amaranths.

Days to green harvest had positively and significantly association with days to seed harvest, leaf width, leaf length, primary and secondary branch per plant and number of leaf per plant but negatively and significantly associated with lateral inflorescence length (Table 4). Similarly Shukla *et al*. (2010) and Oboh (2007) reported the positive correlation of days to green harvest with secondary branch per plant and number of leaf per plant.

Plant height was significantly and positively associated with internode length, leaf length, leaf width and leaf area but non significant with the rest of the characters.

Length of basal branch had positive and significant relationships with length of middle branch, length of top branch, average branch length, leaf width, leaf area, lateral and axillary inflorescence length but had non significant with the rest of the characters. Length of middle branch was also positively and significantly associated with length of top branch, average branch length, terminal and lateral inflorescence length and had non significant association with others traits (Table 4).

Length of top branch had a positive and significant association with average branch length, leaf length, terminal inflorescence lengths, lateral inflorescence length and axilary inflorescence length whereas the rest were non significantly associated with this character. Average branch length also manifested positive and significant correlation with leaf length, terminal inflorescence lengths, lateral inflorescence length and axilary inflorescence length. Internode length also had positive and significantly association with leaf length and leaf area, while insignificant association with others. Leaf length had positive and significant correlation with leaf area, but non significant with the rest of characters. Leaf width displayed positive and significant association with leaf area, primary branch per plant and number of leaf per plant. Leaf area had positive and significant association with primary branch per plant, thousand seed weight and seed yield (Table 4). This character had a positive impact to green foliage yield. This was most likely due to the increment of photosynthetic efficiency due to more carbon dioxide assimilation effect. Similar investigation was reported by Shukla *et al.* (2010) and Vesnas (2005) in amaranths.

Primary branch per plant had positive and significant relationship with secondary branch per plant and number of leaf per plant. However it had non -significant association with the rest of the traits. Secondary branch per plant showed significant and positive relationship with number of leaf per plant but significantly and negatively correlated with lateral inflorescence lengths (Table 4). This is in agreement with the observation of Joshi (1986) in grain amaranth.

3.1.2.2.3. Correlation of inflorescence characters with other characters

Days to flowering showed significant and positive correlation with days to emergence, days to green harvest, biomass per plant, days to seed harvest, leaf width, leaf length, leaf area, primary branch per plant, secondary branch per plant and number of leaf per plant and thousand seed weight while it displayed negative and significant correlation with lateral inflorescence length and terminal inflorescence length but none significant with the rest of the characters. This indicated that selection based on days to flowering complimentarily increases these positively and significantly correlated characters. In addition selection based on days to flowering consequently increases the number of harvesting cycle due to the longevity of vegetative period; as result of this the green foliage yield would increase. Lateral inflorescence and axilary inflorescence length showed significant positive association with terminal inflorescence length and among themselves (Table 4). This result is in agreement with the finding of Xiao *et al.* (2000) who report positive and significant correlation among different characters of amaranths.

3.1.2.2.4. Correlation of days to seed harvest with other characters

Days to maturity seed harvest had positive and significant correlation with leaf length, leaf area, primary branch per plant and secondary branch per plant and number leaf per plant but negative and significant correlation with terminal and lateral inflorescence length (Table 4).

This indicated that the yield and other related characters improvement amaranths can be achieved by indirect selection through other observable character and positively associated traits.

International Journal of Research
International Journal of Research (IJR)
IJR e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 05, May 2015
Available at http://internationaljournalofresearch.org

Table 4.Genotyipic (r_g) correlation matrix for the 24 quantitative characters of amaranths at Tapi and MIzan

Ch	DEM	DGH	DOF	S D	BMP	DMS	PH	LBB	LMB	LTB	LAB	INL	LL	LW	LA	PMB	SB	NOP	TIFL	LIL	AXL	TSW	SY	GLY
DEM		0.69**	0.66**	0.52**	0.62**	0.64**	-0.05	0.18	-0.06	-0.67**	0.02	-0.17	0.14	0.42**	0.48**	0.38*	0.34*	0.26	-0.21	-0.12	-0.24	-0.24	0.33*	0.560**
DGH			0.89**	0.28	0.76**	0.88**	0.14	0.02	-0.05	-0.42**	-0.07	0.12	0.23	0.55**	0.54**	0.65**	0.53**	0.54*	-0.26	-0.36**	-0.26	-0.25	-0.11	0.733**
DOF				0.30**	0.76**	0.95**	0.12	0.03	-0.13	-0.36**	-0.09	0.08	0.20	0.38**	0.44**	0.63**	0.57**	0.53**	-0.38*	-0.47**	-0.14	0.32*	-0.21	0.792**
SD					0.43**	0.34*	-0.01	0.15	-0.06	-0.362*	0.02	0.06	0.34*	0.43**	0.45**	0.15	0.10	0.23	-0.33*	-0.35*	-0.32*	0.23	0.24	0.325*
BMP						0.74**	0.06	0.14	0.38*	0.24	0.03	-0.08	0.09	0.38*	0.27	0.66**	0.53**	0.46**	-0.22	-0.39*	-0.35*	0.56**	0.14	0.712**
DMS							0.11	-0.17	-0.33*	-0.09	0.09	0.15	0.46**	0.46**	0.6**	0.66**	0.58**	-0.30*	-0.39*	-0.13	0.12	0.13	-0.12	0.751**
PH								0.27	-0.12	0.16	0.17	0.69*	0.33*	0.36*	0.34*	-0.12	0.07	-0.02	0.23	0.06	-0.16	0.13	0.28	0.35*
LBB									0.64**	0.52**	0.8**	-0.03	0.39**	0.15	0.34*	0.03	-0.05	0.11	0.24	0.42**	0.33*	-0.23	0.21	0.269 ^{ns}
LMB										0.77**	0.87**	-0.21	0.21	-0.06	-0.045	-0.13	-0.14	-0.08	0.29**	0.31**	0.21	0.27	0.38*	0.347*
LTB											0.86*	-0.27	0.28	-0.06	-0.09	-0.14	-0.20	0.03	0.57**	0.32*	0.44**	0.12	0.24	0.282 ^{ns}
LAB												-0.15	0.31*	0.09	0.08	-0.06	-0.09	0.09	0.40**	0.46**	0.48**	0.15	0.22	0.328*
INL													0.28*	0.11	0.325*	0.08	0.12	0.02	0.14	0.06	0.12	0.24	0.22	0.365*
LL														0.27	0.69**	0.09	-0.22	0.04	-0.02	0.08	0.11	0.21	0.29*	0.170 ^{ns}
LW															0.79**	0.54**	0.10	0.45**	0.06	-0.19	-0.25	0.25	0.21	0.519**
LA																0.42*	-0.01	0.33*	-0.11	-0.20	-0.22	0.32*	0.31*	0.486**
PMB																	0.40**	0.44**	-0.26	-0.27	-0.28	0.13	0.35*	0.694*
SB																		0.54*	-0.11	-0.31*	-0.01	0.26	0.27	0.499**
NOP																			0.01	-0.26	0.19	0.15	0.33*	0.587**
TIL																				0.61**	0.30*	0.22	0.15	-0.185 ^{ns}
LIL																					0.38*	0.21	0.15	-0.423**
AXL																						0.12	0.01	-0.221 ^{ns}
TSW																							0.27	0.21 ^{ns}
SY																								0.28 ^{ns}
GLY																								1.00

**=Highly significant at 1% level (r > 0.387), l*=Significant at 5% level (r > 0.289) , ns=Non significant at 5% level, DEM =Days to emergence, DGH=Days green harvest, DOF=Days to flowering, BMP =Biomass per plant, DSH =Days to seed harvest, PH=Plant height, LBB=Length of basal branch, LMB=Length of middle branch, LTB=Length of top branch, LAB =Length of average branch, INL=Internode length, LL=Leaf length, LW =Leaf width, LA = Leaf area, PMB=Primary branch per plant, SBP= Secondary branch per plant, NLP =Number of leaf per plant, TIL= Terminal inflorescence stalk length, LIL=Lateral inflorescence length, AXL=Axilary inflorescence lengths, SD= Stem diameter, GLY=Green leaf yield, TSW=Thousand Seed weight, SY=Seed yield

3.2. Path Coefficient Analysis

Character like green leaf yield is dependent on several mutually associated characters and hence change in any one of the components is likely to affect the whole net work of cause and effect. This in turn might affect the true association of characters and tend to affect the association of yield and yield attributes. Hence, it is necessary to partition the correlation of component characters into direct and indirect effects. The result of path coefficient analysis is presented in Table 5.

The highest positive direct effect on green leaf yield was exerted by biomass per plant which had positive significant correlation with green leaf yield. The indirect effect via other characters was negligible or negative and hence the correlation it had with green leaf and hence the correlation it had with green leaf yield was largely due to the direct effect. This character also had good genetic gain and high heritable value and hence selection can be made directly by using this character to improve green leaf yield. This indicates more biomass per plant is important to increase green leaf yield. This finding is in agreement with the report of Pandey and Rekha(2010) on genetic studies in grain amaranths.

Average branch length had the next higher direct effect on green leaf yield. Its indirect effects via other traits were mostly negative. Therefore, the correlation coefficient it had with green leaf yield was mainly because of the direct effect. The third high direct effect on green leaf yield was exerted by leaf area which had positive and significant correlation with green yield. This indicated that the correlation explained the true relation.

Plant height had a positive direct effect which was equivalent to the correlation coefficient it had with green leaf yield. This suggests the correlation revealed the true relationship and direct selection through these characters will be effective.

Days to flowering and leaf width had a positive direct effect and their correlations were positive. Hence the correlation with green leaf yield were largely due to the direct effect.

Length of middle branch had the highest negative direct effect but it was significantly and positively associated with green leaf yield. This showed the indirect was the cases of correlation.

Lateral inflorescence length had negative direct effect. The genotypic correlation coefficient it had with green leaf yield been significant and negative. The indirect effects it had with other characters were mostly positive. Hence the correlation coefficient it had with green leaf yield was mainly due to the direct effect.

Days to emergence, length of basal branch, secondary branch per plant and primary branch per plant had negative direct effects. The genotypic correlation coefficients they had with in green leaf yield were positive and significant. The indirect effect they had with other characters been mostly positive. Therefore, the correlation coefficient they had with green leaf yield been mainly due to indirect effects. This finding similar with the report of Shukla *et al*.(2010) on heritability of amaranths and Deshmukh *et al*.(2005) on ground nut.

The path analysis revealed the residual value of 0.252 which means the characters in this path analysis expressed the variability in green leaf yield by 75%.

Generally, characters that exerted positive direct effect and positive and significant correlation coefficients with green leaf yield were known to affect green leaf yield in the favorable direction and needs much attention during the process of selection for the traits biomass per plant length of average branch length and leaf area.

Table 5. Effect of the characters on green leaf yield (direct effect = bold face and diagonal, and indirect effect = off diagonal) at genotypic level of 36 accessions of Amaranths at Tapi and Mizan Condition

Ch	**r_g**	DEM	DGH	DTF	SD	BMpP	DSH	PH	LBB	LMB	LTB	LaB	INL	LL	LW	LA	PMB	SBP	NL	TIFL	LIFL	AXL	TSW	SY
DEM	0.561**	**-0.126**	0.037	0.26	0.02	-0.51	0.125	0.01	-0.07	0.05	-0.08	0.07	0.01	-0.03	-0.13	0.26	-0.06	-0.05	-0.05	-0.12	0.02	0.04	0.15	0.19
DGH	0.733**	-0.18	**0.164**	0.35	0.01	0.67	0.16	-0.04	-0.06	0.02	-0.05	-0.05	-0.04	-0.04	-0.20	0.30	-0.01	-0.11	-0.10	-0.10	0.05	0.03	0.21	0.23
DTF	0.792**	-0.07	0.047	**0.398**	0.07	0.68	0.17	-0.04	-0.24	0.07	-0.04	-0.07	-0.03	-0.02	-0.14	0.24	-0.02	-0.13	-0.19	-0.14	0.07	0.01	0.05	0.09
SD	0.325 *	-0.05	0.014	0.119	**0.03**	-0.36	0.06	0.03	-0.06	0.04	-0.04	0.06	-0.02	-0.06	-0.16	0.25	-0.02	-0.02	-0.04	-0.13	0.05	0.04	0.126	0.09
BMpP	0.712**	-0.07	0.04	0.30	0.01	**1.93**	0.13	-0.02	0.45	0.41	0.562	0.02	0.03	-0.07	-0.14	0.15	-0.02	-0.19	-0.08	-0.16	0.05	0.04	0.38	0.15
DSH	0.751**	-0.07	0.04	0.37	0.08	-0.62	**0.18**	-0.02	-0.02	0.10	-0.04	-0.06	-0.03	-0.02	-0.17	0.26	-0.01	-0.14	-0.18	-0.11	0.06	0.08	0.17	0.11
PH	0.35* *	0.01	0.07	0.09	-0.02	-0.05	0.01	**0.345**	-0.10	-0.07	-0.01	0.12	0.02	-0.05	-0.14	0.08	-0.02	0.02	0.03	-0.05	-0.02	-0.08	0.16	0.16
LBB	0.279 ns	-0.02	0.09	0.04	0.03	0.51	0.01	-0.09	**-0.396**	-0.37	0.06	0.66	0.01	-0.07	-0.05	0.12	-0.05	0.01	-0.03	0.09	-0.06	-0.04	0.04	-0.15
LMB	0.347 *	0.08	-0.02	-0.05	-0.01	0.48	-0.03	-0.04	-0.25	**-0.596**	0.11	0.67	0.08	-0.09	0.02	-0.02	0.02	0.03	0.05	0.11	-0.04	-0.08	0.07	-0.12
LTB	0.28ns	0.07	-0.02	-0.14	-0.09	0.42	-0.06	0.04	-0.2	-0.45	**0.13**	0.65	0.02	-0.05	0.02	-0.05	0.02	0.04	-0.05	0.21	-0.05	-0.01	0.15	0.04
LaB	0.32*	-0.01	-0.01	-0.03	0.05	-0.02	-0.01	-0.05	-0.34	-0.51	0.16	**0.769**	0.05	-0.06	-0.03	0.04	0.09	0.01	-0.08	0.15	-0.07	-0.05	0.04	-0.02
INL	0.365*	0.09	0.06	0.03	0.07	0.06	0.07	-0.24	0.09	0.12	-0.08	-0.16	**0.103**	-0.05	-0.04	0.12	-0.01	-0.08	-0.05	0.05	-0.07	-0.02	0.22	0.03
LL	0.197 ns	-0.01	0.01	0.08	0.08	-0.08	0.02	-0.12	-0.15	-0.13	0.04	0.25	-0.01	**0.182**	-0.11	0.39	-0.01	0.05	-0.07	-0.08	-0.03	-0.01	0.12	0.02
LW	0.519**	-0.04	0.02	0.14	0.01	-0.32	0.08	-0.01	-0.06	0.03	-0.08	0.06	-0.04	-0.05	**0.37**	0.44	-0.09	-0.02	-0.08	0.02	0.03	0.03	0.01	0.02
LA	0.486**	-0.05	0.03	0.17	0.01	0.28	0.08	-0.05	-0.09	0.04	-0.01	0.06	-0.08	-0.13	-0.29	**0.558**	-0.07	0.01	-0.06	-0.04	0.03	0.03	0.03	0.23
PMB	0.694**	-0.04	0.03	0.25	0.03	0.55	0.12	-0.05	-0.01	0.08	-0.01	-0.04	-0.03	-0.02	-0.21	0.23	**-0.018**	-0.09	-0.08	-0.10	0.05	0.04	-0.11	0.35
SMB	0.499 **	-0.02	0.03	0.22	0.02	0.45	0.12	0.04	0.08	0.07	-0.03	-0.06	-0.04	0.04	-0.04	-0.03	-0.07	**-0.22**	-0.10	-0.04	0.05	0.02	-0.05	0.13
NL	0.587**	-0.02	0.03	0.21	0.05	0.38	0.11	0.03	-0.01	0.05	0.03	0.07	-0.01	-0.07	-0.17	0.18	0.08	-0.12	**0.185**	0.05	0.04	0.03	-0.14	0.27
TIFL	-0.185ns	0.03	-0.04	0.14	-0.08	0.35	-0.64	-0.05	0.04	-0.09	-0.16	0.07	0.30	-0.04	0.03	-0.02	-0.06	0.04	0.02	**-0.388**	-0.09	-0.05	0.06	0.24
LIFL	-0.423**	0.01	-0.09	-0.19	-0.08	0.29	-0.07	-0.05	-0.16	-0.19	0.04	0.35	-0.02	-0.02	0.07	-0.11	0.05	0.07	0.05	0.24	**-0.155**	-0.05	0.15	0.17
XIL	-0.21ns	0.03	-0.03	-0.05	-0.08	0.25	-0.03	-0.02	-0.12	-0.12	0.05	0.32	-0.08	-0.02	0.09	-0.12	0.05	0.04	0.03	0.13	-0.059	**-0.13**	0.24	0.22
TSW	0.21 ns	0.15	0.19	0.01	0.19	0.12	0.62	0.16	0.03	0.06	0.14	0.04	0.22	0.11	0.01	0.02	-0.02	-0.04	-0.13	0.05	0.121	0.22	**0.19**	0.29
SY	0.28 ns	000.17	0.27	0.08	0.08	0.08	0.18	0.12	-0.16	-0.13	0.04	-0.24	0.02	0.12	0.21	0.28	0.34	0.12	0.26	0.22	0.131	0.11	0.15	**0.25**

Residual effect =0.252

C=Charactres,**r_g** =Genotypic direct effect,**=Highly significant at 1%level,*=Significant at 5% level, ns=Non significant at 5% level,DEM = Days to emergence, DGH =Days to green harvest , DTF = Days to flowering, BMpP=Biomass per plant, DSH =Days to seed harvest, PH=Plant height, LBB =Length of basal branch, LMB = Length of middle branch, LTB =Length of bop branch, LaB =Length of average Branch, INL=Internode length, LL=Leaf length, LW =Leaf width, LA = Leaf area, PMB=Primary branch per plant,SBP =Secondary branch per plant,NL=Number of leaf per plant, TIFL= Terminal inflorescence stalk length, LIFL= Lateral inflorescence length, AXIL =Axially inflorescence length, SD =Steam diameter, TSW=Thousand seed weight and SY=Seed yield.

4. SUMMARY AND CONCLUSION

The progress of crop improvement program like amaranths depends on the choice of parental lines, the extent of *Interrelationship between characters* present and the knowledge quantitative characters with green leaf yield and among themselves. The present study comprises 36 Amaranths germplasm accessions that were evaluated at Tapi and Mizan locations in 6x6 simple lattices design with the objective of assessing the characters association for 24 characters.

The ANOVA showed highly significant difference (p<0.01) among amaranths germplasm accessions for all the characters studied except thousand seed weight which was none significant (P>0.05). The range of mean values for most of the characters showed the existence of variation among the tested germplasm accessions.
Green leaf yield per plant showed positive and significant relationship with stem diameters, plant height, inter nod length, top branch and average branch length and highly significant relation with days to emergence, days to green harvest, days to flowering, number of leaf per plant, biomass per plant, days to seed harvest, leaf width, leaf area, primary and secondary branch per plant. Seed yield per plant also significant and positively correlated with days to emergence, length of middle branch, leaf length, leaf area, primary branch per plant and number of leaf per plant at both in phenotypic and genotypic levels. This indicted that selection based on these positive and significantly associated traits would considerably enhance seed and green leaf yield.

Path coefficient analysis revealed that the highest and positive direct effect was exerted by biomass per plant followed by average branch length and characters had significant correlations with green leaf yield. Hence in the process of selection much attention should be given to them as the traits are helpful for indirect selection.

It was concluded from the present investigation that there were association between two characters that can be directly observed is the phenotypic correlation and is determined from measurements of two characters in a number of individuals of the population. The values of phenotypic correlation coefficients in most of the characters in this observation were less than the values of genotypic correlation coefficients, among the accessions for most of the 23 characters. This indicated that the correlations were more due to hereditary.

Biomass per plant has showed positive and significant effect and positive highest direct effect, it will be useful traits for indirect selection to increases green leaf yield.

This primary investigation was an indicator but we cannot reach at definite conclusion therefore, further studies related to this neglected but high value crop are advisable for several years and locations.

5. REFERENCES

[1.] Allard, R.W.,1999. Principles of Plant Breeding. Second edition, John Willey and Sons Inc., New York, pp.254.

[2.] Ana P., P. Milan, M.Dubravko and S. Zlatko, 2009.Yield and quality of forage sorghum and different *Amaranth* species (*Amaranthus* spp.) biomass. University of Zagreb, Faculty of Agriculture, Department of Field Crops, Forage and Grass lands, Svetosimunska cesta Zagreb, Croatia.13p.

[3.] Asian Vegetable Research and Development Center (AVRDC), 2007. Characterization record sheet. Available at: htpp:// *www.avrdc.org*. Acessed 15 July, 2010.

[4.] Bartlett, M. S., 1937a. Some examples of statistical methods of research in agriculture and applied biology. *J. Roy. Statist. Soc. Suppl***. 4:** 137-170.

[5.] Brenner, D.,1994. Characterizing system for amaranth*s* germplasm. Available at: *www.hort.purdue.edu/newcrop/proceedings.html.* Acessed 12 October, 2010.

[6.] Bressani,R.,1990.Chemical composition and nutritive value of grain amaranths. pp22. Proceeding of fourth Amaranth Symposium Minnesota. Minnesota Agricultural University, 21-22 October 1990, Folwell Avenue, Saint Paul.

[7.] Deshmukh, S.N., M.S.Basu and P.S.Reddy, 2005.Genetic variability, characters association and path coefficient analysis of quantitative traits in viginia bunch varieties of ground nut. *Indian journal of Agricultural Science*, **56:** 515-558.

[8.] Edema, A, A.O. and M.A.B. Fakorede, 2003.Genetic variability of seedling emergence in *Amaranthus* species and its correlation with other traits. *Int. J. Plant Breed.* **14:**1-15.

[9.] Falconer, D.S., 1981.Introduction to Quantitative Genetics. Second edition. Longman Inc., New York.

[10.] Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedure for Agricultural Research. Second edition. John Wiley and Sons.inc., New York.

[11.] Johnson,H.W., H.F. Robinson and R.E.Comstock, 1955. Estimates of genetic an environmental variability in soybean. *Agron. J*., **47:** 314-318.

[12.] Joshi, B.D. 1986. Genetic variability in grain amaranth. *Indian J. Agr. Sci*. **56:**574–576.

[13.] Katiyar, R.S., S.Shukla and S. Rai, 2000. Varietals performance of grain amaranth *(A. hypochondriacus*) on sodic soil. Proc Nat Acad. Sci., India. **70:** 185–187.

[14.] Kebu Balemie and Fassil Kebebew, 2006. Ethno botanical study of wild edible plants in

[15.] Derashe and Kucha Districts, *Journal of Ethnobiology and Ethnomedicine*, Addis Ababa, Ethiopia. **2**:53.

[16.] Ministry of Agriculture (MoA), 2000. Agro ecological zonations of Ethiopia. Addis Ababa, Ethiopia.

[17.] Oboh, B., 2007. Multivariate analysis of the diversity among some Nigerian accessions of *Amaranthus hybridus*. *Int. J. Plant Breed*. **1:** 89-94.

[18.] Palada , M.C. and L.C. Chang, 2003. Suggested cultural practices for vegetable amaranth. AVRDC *International Cooperators Guide,* **3:** 552.

[19.] Pandey, R.M. and S P. Rekha, 2010. Genetic studies for biochemical and quantitative characters in grain amaranth (*Amaranthus hypochondriacus* L.). Division of Genetics, Plant Breeding and Agro-technology, National Botanical Research Institute, Lucknow, India

[20.] Rubaihayo, E.B., 1995. Selection criteria for yield of leafy amaranths. Kawanda Agricultural Research Institute. *African Crop Science Journal,* No. **4,** Vol. 3.

[21.] Statistical Analysis System (SAS), 2008. STAT users guide (Version 9.2). SAS Institute, Cary, N. Carolina, USA.

[22.] Shukla, S. and S.P.Singh, 2002. Varietals performance and foliage yield in vegetable amaranth. *J.South Indian Horticulture*, **50:** 241-244.

[23.] Shukla, S., A.Bhargava, A. Chatterjee and S.P.Singh, 2006. Genotypic variability in vegetable amaranth (*A. tricolor*) for foliage yield and its contributing traits over successive cuttings and years. *J Genet Breed.* **151:** 103-110.

[24.] Shukla,S., A.Bhargava, A.Chatterjee, and A.P.Chandra, 2010.Genetic interrelationship among nutritional and quantitative traits in the vegetable amaranth. *Journal of Crop Breeding and Applied Biotechnology,* **10:**16-22.

[25.] Singh, B. D., 2001. Plant Breeding Principles and Methods. Kalyani Publishers, Ludhiana, India. pp. 97-105.

[26.] Southern Nation Nationalities and Peoples Regional State (SNNPR), 2009. Annual report of Bureau of Finance and Economic Development SNNPR. Hawassa, Ethiopia.

[27.] Therthappa, B.S, 2005. Application of multivariate techniques in evaluation of sunflower (*Helianthus annuus*) genotypes. An M. Sc Thesis presented to the School of Graduate Studies of Dharwad University of Agricultural Sciences, Dharwad.

[28.] Tepe National Spices Research Center (TNSRC), 2010.Tepi National Spice Research Center annual Rain full Data report, Tapi, Ethiopia.

[29.] Vesnas,V.,2005.Variability and factor analysis of morphological and productive characters of the genus *Amaranthus*. *J. Genetika,* Vol. 37, No. 1, 1-13 Anuja.

[30.] Xiao ,S.G.,Z.M. Liu, Y. Song and G. Yang, 2000. Classification of vegetable amaranth variety resources. *Journal of Hunan Agricultural University,* **26:**274–27.