Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 4, No. 6, p. 46-52, 2014
http://www.innspub.net

RESEARCH PAPER | OPEN ACCESS

Intra species association of some yield parameters in half-sib families of *Allium cepa* L.

I.B. Gashua[*1,5], G.A. Gwayo[2], A. A. Oyedeji[1,3], J. T. Samaila[1,4]

[1] *University of Wolverhampton, School of Applied Sciences, Wulfruna. WV1 1SB, United Kingdom.*

[2] *Umar Suleiman College of Education, Gashua Biology Department, Yobe State. Nigeria*

[3] *Niger Delta University, Department of Biological sciences, Wilberforce Island, Bayelsa State, Nigeria*

[4] *College of Education, Hong Department of Agricultural Education, Adamawa State, Nigeria.*

[5] *The Federal Polytechnic Damaturu, Department of Science Laboratory Technology Damaturu, Nigeria*

Article published on June 05, 2014

Key words: Intra species, Half-sib, cultivars, correlation, yield parameters.

Abstract

Allium cepa L. is considered as one of the most widely consumed bulb vegetable in topical and sub-tropical regions of the world, because of its flavour, in addition to other dietic and medicinal values. Poor onion genotypes are among the major production constrains of this crop in Nigeria. Selection response and half sibs family intra class correlation were used to evaluate intra species interrelationship among some yield quantitative parameters which includes bulb yield per plant, number of leaves per plant, plant weight per plot, number of bolters per plot, bulb yield per plot and soluble solid contents of 30 half sibs families in a local onion cultivated variety. Result indicated that the families differ considerably for most of the traits with wide range of mean and variation in mean performance, there by indicating great variation among the families. The association of characters among these families was good with yield being highly significant and positive while for soluble solid content, although found to be negative for all traits but was also very significant. Heritability was generally high for all traits (above 50%), except for bolter which is very low with value of 0.1444 (14%), showing that the traits within these families have a great potential for breeding and that improvement can be achieve through selection.

***Corresponding Author:** Gashua ✉ i.b.gashua@wlv.ac.uk

Introduction

Allium cepa L. is a monocotyledon, which belongs to the family *Alliaceae*. It is often cultivated for its bulb/leaves. The bulb varies in size and shape, and range in colour from red, white, yellow, purple and pink among others (Dawar, *et al*., 2007). Although it serves as a seasoning vegetable, it contributes significantly as a source of vitamins, macro and micro elements and has been characterised for its flavonol, quercetine, and quercetine derivatives (Roldan, *et al.,* 2008).

Longer and Hill, (1991), described onions as world culinary herbs with both dietic and medicinal values. They are known to be effective against common cold, heart diseases, diabetes and osteoporosis. It is also used in many parts of the world to cure blisters and boils. According to USDA Nutrient Database (2007), the percentage nutritional values of 100g onion were: carbohydrate, 93.4g; saturated fat, 0.042g and protein, 1.1g. Others are vitamins which includes: vitamins C,7.4mg; B_1, 0.04mg; B_2, 0.027mg; B_6, 0.12mg and minerals which are: Fe, 0.21mg; K, 146mg; Mg, 0.129mg; Na, 4mg and Zn, 0.17mg.

According to Curray and Proctor (1990), the sahelian part of West Africa is a region where varieties of Red, Purple, Pink and white onions are found which are mostly round or flat in shape (colour being one potential means of classification). These are grown mostly in the savannah belt between the Sahara and the wetter equatorial coast. In Northern Nigeria, bulb onions are grown under irrigation during the dry period of the year.

However, the recent histories of attempts to improve onion cultivars have demonstrated the need for continued and persistent selection pressure to maintain quality in the selected strain.

From the variability and correlation studies of the yield and yield components of onion, Kadams and Nwasike, (1986), reported that there are highly significant differences from cultivars in the different traits studied. The understanding of the relationship among various traits and their relative contribution to yield is useful for any multiple trait selection.

Earlier studies by Dowker, *et al*., (1976), separated phenotypic correlation into additive, genetic and residual or environmental components so as to test whether variation in certain vegetative traits of Onions was correlated with variation in Onion bulb yield.

One of the most common cultivated varieties of Onion in Nigeria is the Local Red, which is very popular with wide acceptability to the local consumers/populace and well adopted to the environment, but poor genotype has been identified as one of the major production constrain of this crop, thus the (great) need for improvement. This can only be achieved through this type of studies which focus on assessing the interrelationship between different characters within families of a species, through estimate of correlation between different pair of traits and genetic variability within characters of interest. The study is further aimed to look at the genetic factors and nature of relationship among yield and yield components within half-sib families and too, the variability thereof.

Materials and methods

Experimental material

One hundred bulbs of Local Red Onion cultivar (*Allium cepa L.*) were collected from local farmers' seed production stock and analysed for soluble solids in the Horticultural Laboratory of Federal University of Technology, Yola, Nigeria using Bellingham and Stanley (London) refractometer as outlined by (Nieuwhof, *et al*., 1973). Thirty bulbs with highest amount of soluble solid were then selected and planted in isolation, free from other onion fields for the production of maternal half sibs family seeds. Each plant was given equal opportunity to serve as a pollen parent to each family through open pollination system.

Evaluation of progenies

Thirty half sib family seeds were raised from the mother bulbs and sown in the nursery beds in rows 30 cm apart with each row representing a family. Dry grasses were used as light mulch on top of the seedbeds to protect them from being washed by watering and the emerging seedlings from overheating. These were removed when the seedlings got established. The seedlings were nursed for a period of six weeks and then transplanted unto sunken beds measuring 2m long by 1.5 m wide with 20 cm spacing between rows and 15 cm within rows using onion markers locally constructed according to (Kadams and Amans, 1991).

From each of the families, forty seedlings were randomly picked and transplanted into plots representing each family. Thus, each of the 30 half sib families was evaluated in a replicate trial using Randomised Complete Block Design (RCBD) with three replications. All agronomic practices were carried out accordingly and crops were considered matured when the tops became withered and began falling off.

Data collection/recording

Alternate plants from within each central row of each plot were randomly chosen for the measurement of quantitative characters for this study in which the following were considered; number of leaves per plant (NLP), number of bolters per plot (NBP), bulb yield per plant (BYP), bulb yield per plot (BPP), plant weigh per plot (PWP), soluble solid content (SSC)

Data analysis

Data for this experiment were analysed (Analysis of variance) using Wall *et al.*, (1996), model for analysing of half-sib family (HSF), in which the expected mean squares from half sibs analysis were used to determine the components of variance. Details were described in Gashua, *et al.*, (2013) which include □^{2}B, □^{2}P, □^{2}W and □^{2}T.

Where □^{2} B=Variance among HSF

□^{2}P=Variance due to interaction of HSF within replication

□^{2} W=Variance within HSF lines

□^{2} T= Total genetic variance

The level of interrelationship between any two characters within the families studied were estimated using correlation coefficient by applying the method described by Dowker, *et al.,* (1976) and too, using the formula: $r_{1.2} = cov_{(1.2)} / MS(1) X \sqrt{MS(2)}$

Where $r_{1.2}$ = Correlation Coefficient between characters 1 and 2, MS = Mean Square, and cov = Mean Product.

The performance of all traits by mean, were assessed and estimated. The Statistical Analysis software (SAS) for windows was also used for the analysis of the data by adopting the method of Steel and Torrie (1984) and the mean separated by least significant difference (LSD) then declared significant at $p \leq 0.05$ level.

Results and discussion

Selection response

The response to selection of some yield parameters from different population types in Onion within half sib families is presented in table 1. There is general reduction in the value of bulb weight of the different populations as the selection progresses with increase in soluble solid content. This trend could be explained (on) by the fact that the parents were selected based on high dry matter content which in turn have been known to be negatively correlated with bulb weight. The highest value for soluble solid was therefore obtained within the half sibs, indicating good response to selection within families. This improvement is as a result of 30% selection pressure exerted from the 30 mother bulbs obtained from 100 randomly selected bulbs. Similar development was monitored for range and coefficient of variability for the characters, further showing the positive effect of selection on the traits. This finding agrees with results obtained by Gashua, *et al* (2013) on the inheritance studies of onion quantitative traits. The essence of estimating genetic coefficient of variation is to indicate the genetic variability that exist in the trait of interest and be used in conjunction with heritability to predict resultant effect for selection of best individual in a population.

Table 1. Selection response from different population types in Onion

Trait	Population	Mean	Range	CV	SE
Bulb weight	100 RSB	257.0	90 – 361	33.0	8.40
	30 MB	144.0	90 – 216	27.0	7.80
	HSF	118.0	80 – 168	17.0	3.70
Soluble solids	100 RSB	7.0	4.0 – 9.0	23.0	0.15
	30 MB	8.0	7.0 – 9.0	8.0	0.12
	HSF	9.0	7.0 – 12.0	13.0	0.22

RBS= Randomly Selected Bulbs, MB= Mother Bulbs, HSF= Half Sibs Family, SE= Standard error, CV= Coefficient of variability.

Analysis of variance

From the analysis of variance in table 2, the populations studied revealed high significant dissimilarity in all traits. This is an indication of the presence of high genetic variability within the studied trait, thus giving good opportunity for selection and room for improvement. Since all traits showed highly significant mean squares among half sib families, it follows that they will all give good response to selection. The positive components of variance (□^{2}B) recorded among half sib families during the trials could be attributed to plant vigour which can subsequently result in variation in yield. The component of variance for bolters was negative and insignificant. Since variance theoretically cannot be zero, it is assumed that such estimate is either zero or very small. Similar result was obtained by Kadams and Wagiga (2000) in their experiment with Onions.

Table 2. Analysis of variance showing mean squares and component of variance estimates for HSF

			Mean Squares				
SOV	**DF**	**NBP**	**NLP**	**BPP**	**PWP**	**SSC**	**BYP**
Among HSF	29	37.073**	10.641**	1750764.8**	10028757.1**	3.3358**	1122.1**
Reps in family	2	17.644^{ns}	0.8921^{ns}	25371.6*	268825.7^{ns}	0.4538^{ns}	23.705*
Within reps in HSF	58	15.138	0.6656	242323.8	441817.2	0.3011	150.04
			Components	**Of**	**Variance**		
□^{2} B		-0.6476	0.3250	57513.1	325331.1	0.0961	36.613
□^{2} P		0.2506	0.0227	-21695.2	-17299.2	0.0153	-12.635
□^{2} W		-15.138	0.6656	242323.8	441817.2	0.3011	150.04
□^{2} T		16.036	1.0133	278141.7	749849.1	0.4125	174.02

SOV=Source of variation, DF=Degree of freedom, ** Significant value at p=≤0.01, *Significant value at p≤0.05, ^{ns}Not significant.

Mean performance

The mean performance estimate within the 30 half sib families for six different traits studied indicate significant variation within the families with some being superior over others (table 3). Good performance in terms of soluble solid contents with the highest values within the families in the range of 9.00–9.33 recorded in families 2, 3,4,5,6,7,10 and 18, unfortunately, all families showed high bolting rate which is an undesirable quality in onions. This can be considered when selection is to be carried out with varieties of low bolters and careful timing of planting season as bolting is known to be associated with low temperature and delayed transplanting in most onion cultivars. Families 8,9,11,15,19,25 and 27 exhibited the highest mean performance for bulb yield per plot and bulb yield per plant. This indicates that these lines have high yielding potentials which can be exploited by selecting them as parents for breeding programmes especially with families that have high soluble solids so that they can complement each other, thereby obtaining off springs with high yield and high dry matter contents, which are two among the most important qualities of good onion breeds. Singh *et al.*, (1997), reported very good bulb yield performance using the selection of more productive genotypes.

Table 3. Mean performance of six quantitative traits of 30 HSF.

HSF	NBP	NLP	BPP	PWP	SSC	BYP
1	33.00^{ab}	10.00^{cdefg}	2367.7^{defghi}	5892.7^{hijk}	8.73^{abcde}	58.00^{efghij}
2	26.00^{bcdef}	6.00^{m}	1763.3^{ij}	4090.3^{nmop}	9.33^{a}	44.50^{ij}
3	29.00^{bcde}	7.00^{ijklm}	1948.3^{hij}	4007.0^{nop}	9.07^{abcd}	49.57^{hij}
4	29.00^{bcde}	11.00^{abc}	2144.7^{fghij}	8398.3^{bcd}	9.20^{ab}	53.53^{ghij}
5	37.00^{a}	12.00^{abc}	2433.7^{cdefghi}	8922.3^{ab}	9.07^{abcd}	60.90^{defghi}
6	25.00^{bcdef}	10.00^{bcde}	1975.3^{ghij}	8404.0^{bcd}	9.07^{abcd}	48.80^{hij}
7	32.00^{abc}	9.00^{fghi}	2201.3^{efghij}	6130.0^{ghij}	9.07^{abcd}	54.47^{fghij}
8	29.00^{bcde}	10.00^{cdefg}	3267.3^{bcd}	7208.7^{defg}	7.20^{fgh}	80.80^{cde}
9	25.00^{bcdef}	12.00a	3370.7^{bc}	7819.7^{cbde}	7.07^{ghi}	86.23^{bc}
10	31.00^{abcd}	7.00i^{jklm}	2003.3^{ghij}	4578.0^{lmh}	9.07^{abcd}	49.67^{hij}
11	30.00^{abcde}	10.00^{cde}	3228.3^{cd}	7165.0^{efgh}	7.80dfg	81.80^{cde}
12	26.00^{bcdef}	9.00^{fghi}	3146.0^{cde}	8722.7^{bc}	8.00^{defg}	77.87^{cdef}
13	27.00^{bcde}	9.00^{fghi}	2032.0^{ghij}	3960.3^{nop}	9.13^{abc}	50.80^{hij}
14	29.00^{bcde}	11.00^{bcde}	3303.3^{bcd}	7559.7^{cdef}	7.07^{ghi}	84.47^{bcd}
15	29.00^{bcde}	11.00^{bcde}	4368.0^{a}	1002.0^{a}	6.07^{i}	108.2^{a}
16	29.00^{bcde}	7.00^{klm}	1398.0^{j}	2922.^{op}	6.13^{i}	34.13^{j}
17	25.00^{bcdef}	10.00^{efgh}	1700.7^{ij}	3244.0^{op}	8.13^{bcdef}	41.97^{ij}
18	24.00^{def}	10.00^{efgh}	2450.7^{cdefghi}	4381.3^{lmno}	9.00^{abcd}	61.57^{defghi}
19	26.00^{bcdef}	12.00^{ab}	33.0.3^{bcd}	5288.0^{jklm}	8.53^{abcde}	81.80^{cde}
20	29.00^{bcde}	6.00^{lm}	2098.3^{fghij}	5895.0^{hijk}	8.53^{abcde}	53.33^{ghij}
21	24.00^{cdef}	12.00^{a}	2163.7^{fghit}	4415.7^{lmno}	8.20^{bcdef}	54.87^{fghij}
22	31.00^{abcde}	11.00^{bcde}	2405.0^{cdefghi}	4881.7^{klmn}	8.13^{bcdef}	61.63^{defghi}
23	23.00^{ef}	7.00^{jklm}	2380.3^{defghi}	6810.0^{efgh}	8.20^{bcdef}	60.93^{defghi}
24	30.00^{abcde}	8.00^{hijk}	2747.0^{cdefgh}	6514.7^{fghij}	7.67^{efg}	68.93^{cdefgh}
25	30.00^{abcde}	10.00^{defg}	4154.0^{ab}	6915.7^{efgh}	6.40^{hi}	105.03^{ab}
26	27.00^{bcde}	10.00^{defg}	2948.0^{cdefg}	6597.7^{efghi}	7.73^{efg}	75.43^{cdefg}
27	25.00^{cdef}	7.00^{klm}	4313.0^{a}	6453.3^{fghij}	6.13^{i}	109.17^{a}
28	30.00^{abcde}	7.00^{klm}	2436.3^{cdefghi}	3870.0^{nop}	7.20^{fgh}	61.47^{defghi}
29	27.00^{bcde}	9.00^{ghij}	3049.7^{cdef}	5351.7^{ijkl}	6.13^{i}	77.07^{cdef}
30	19.00^{f}	8.00^{ijkl}	2543.7^{cdefghi}	6147.3^{ghij}	8.07^{cdefg}	65.10^{cdefghi}

Means with the same superscripts are not significantly different

Genetic parameters

The genetic parameters considered in this study are phenotypic variance, genotypic variance, phenotypic coefficient of variation and genotypic coefficient of variation and heritability (table 4). These parameters are considered very important when making decision on the interrelationships that exists in a population and predicting suitable selection programmes for a desirable trait during breeding trails. High GCV values of 273.14, 159.31 and 130.32 were observed for soluble solid content, bulb yield per plot and bulb yield per plant. While the plant weight per plot had the lowest of 32.19. It was also generally observed that the PCV values were higher than GCV in all traits studied which is an indication that environmental influence might have played a role in the expression of the phenotypes. The high heritability also recorded for soluble solid content, bulb yield per plot and bulb yield per plant, when combined with the high genotypic coefficient of variation suggests an additive gene effect which makes them a trait of choice for selection among these families. The very low heritability for number of bolters per plot supports the analysis of variances and mean performance results obtained and suggests that, the components of variance for bolters was either negative or insignificant and that this trait can be controlled to a larger degree by choosing the right timing for environmental conditions during planting. Phenotypic variance, genotypic variances were determined and the phenotypic variance were seen to generally, but slightly higher than the genotypic variances (table 4). The same explanation could be advanced as the coefficient of variability above, since it follows similar trend.

Table 4. Estimate of genetic parameters for six quantitative traits of HSF in Onion

Traits	□^{2} P	□^{2} G	PCV	GCV	H^2
NBP	37.3	35.23	98.50	95.40	0.1444
NLP	105.0	104.60	99.60	98.70	0.6538
BPP	163172.4	160127.7	177.12	159.31	0.5105
PWP	431.31	373.19	34.65	32.19	0.7540
SSC	37.1346	35.7210	282.1	273.14	0.5485
BYP	111214.0	110100.3	135.44	130.32	0.5159

□^{2} P=phenotypic variance, □^{2} G=Genotypic variance, PCV=Phenotypic Coefficient of Variation, GCV=Genotypic Coefficient of Variation, H^2=Heritability

Association of characters

The knowledge of interrelationship between various traits within half sib families and their effect on yield is very important in determining suitable genotype for selection. The estimate of correlation within traits of the 30 half sib families studied is presented in table 5 and showed that the magnitude of genotypic is mostly more than the phenotypic correlations indicating a leading heritable influence. Genotypic and phenotypic correlation for yield per plot was high and significantly positive in all traits except for soluble solid which was also high and very significant in all traits but negative table 5. The interrelationship between numbers of leaves with bulb yield was also positive and very significant. The same applies to bulb weight per plant and yield per plot in both genotypic and phenotypic correlations. The number of bolters for all yield components was negative and encouraging, meaning that controlling this trait will significantly improve yield in all the families.

According to Asish, *et al.,* (2008), information on the amount and direction of association between yield and yield related characteristics is important for rapid progress in selection and genetic improvement of a crop.

Table 5. Phenotypic (Upper) and genotypic (Lower) correlation coefficients among yield parameters of HSF in Onion

SOV	NBP	NLP	BPP	PWP	SSC	BYP
NBP		0.473160*	0.221987^{ns}	0.973015**	-0.15371^{ns}	0.312166*
NLP	0.421415**		0.532316**	0.653176**	-0.63158**	0.412127*
BPP	-0.57322**	0.314712*		0.356310*	-0.73156**	0.819132**
PWP	0.413152**	0.679311**	0.797863**		-0.41311*	0.739219**
SSC	-0.25150^{ns}	-0.51361**	-0.70154**	-0.43021*		-0.66164**

BYP	-0.53173**	0.437316*	0.713452**	.0771301**	-0.72157**

SOV= Source of variation (Yield parameters)

Conclusion

The efficiency of any improvement programme depends on the knowledge of the extent of genetic variability and the rate of transmissibility of the trait of interest. The overall results shows great genotypic and phenotypic variability that existed in the different half sibs families studied and the sensitivity of the traits within the individuals to improvement.

Acknowledgement

The financial and technical support given by the management of Federal Polytechnic Damaturu, Nigeria, for this research is greatly acknowledged.

References

Asish K, Manivannan N, Varman PV. 2008. Character association and path analysis in sunflower. Madras Agricultural journal **96**(7), 425–428.

Curray L, Procter, FJ. 1990. Onions in Tropical regions. Natural resources institute. bulletine. No. 35. Xiii, 232.

Dowker BD, Hardwirk, RC, Fennell, JFM, Andrews, DJ. 1976. Genotype and environmental correlations between leaf growths and bulb size in Onions. Annals of Applied Biology. **82**(2), 341–348. http://doi:10.1111/j.1744-7348.1976.tb00569.x

Dawar NM, Wazir FK, Dawar M, Dawar SH. 2007. Effect of plant population density on growth and yield of Onion varieties under climatic conditions of Peshawar. Sarhad Journal of Agriculture **23**(4), 912-917.

Gashua IB, Simon SY, Bashir LU, Kadams AM. 2013. Inheritance studies of some quantitative traits in onion (*Allium cepa* L.). International Journal of Biosciences **3**(4), 135–141. http://dx.doi.org/10.12692/ijb/3.4.135-141.

Kadams, AM, Amans EB. 1991. Onion seed production in relation to field management in Nigeria. Onion Newsletter for the Tropics 3, 47–49.

Kadams, AM, Nwasike CC. 1986. Heritability and correlation studies on some vegetative traits in Nigerian white Onion (*Allium cepa* L.). Plant Breeding **97**(3), 193–284. http://doi:10.1111/j.1439-0523.1986.tb01058.x.

Kadams, AM, Wajiga, G. 2000. Genotype X environment interaction in onion genotype of Northern Nigeria. **Annals of Borno. 15/16** (1998-99), 237–245.

Longer. RH, Hill GD. 1991. Agricultural plants. Cambridge University press. Cambridge. pp. 33–39.

Nieuwhof M, DE Bruyn JW, Frieda G. 1973. Methods to determine solidity and dry matter content of onion (*Allium cepa* L.). **Euphitica 22,** 39–45.

Roldan E, Sanchez-Moreno C, De Ancos B, Cano MP. 2008. Characterisation of Onion (Allium cepa L.) by-products as food ingredients with antioxidant and antibrowning properties. Food Chemistry **108,** 907–916. http//dx.doi.org/10.1016/j/foodchem.2007.11.058

Singh BB, Mohan Raj DR, Dashiell KE, Jackai LEN. 1997. Advances in cowpea research. Co-publication of International Institute of Tropical Agriculture (IITA) and Japan International Research Centre for Agricultural Sciences (JIRCAS). IITA, Ibadan, Nigeria.

Steel RGD, Torrie JH. 1984. Principles and procedures of statistics. 2nd ed. Mc Graw Hills books co. Singapore. 172–180.

United States Department of Agriculture, Agricultural Research Service. 2007. USDA National Nutrient Database for Standard Reference.