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Genetic variability, path coefficient and association of bulb yield and its contributing traits in *rabi* onion under agro-climatic conditions of Meghalaya

M Bilashini Devi[1]* • AnjooYumnam • VKVerma • HD Talang • H Rymbai • Ruth Assumi • Vanlalruati • S. Hazarika • Priyajit Chaudhuri

ICAR Research Complex for NEH Region, Umiam-793103, Meghalaya

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ABSTRACT

The present study was conducted to estimate the genetic variability in twenty two genotypes of onion for eight yield and related traits at ICAR Research Complex for NEH Region, Umiam, Meghalaya during *rabi* season, 2018. The study revealed existence of significant variability amongst the evaluated genotypes for most of traits studied. High phenotypic and genotypic coefficient of variations was recorded for average bulb weight (g), number of leaves per plant, average leaf length (cm) and marketable bulb yield (t/ha). Marketable bulb yield, average bulb weight, number of leaves per plant and TSS (°B)exhibited high heritability associated with high genetic advance indicating the involvement of additive gene action for their expression and are likely to respond to selection for improvement of these traits. Correlation analysis revealed that marketable bulb yield (t/ha) had positive significant correlation with days to maturity (60-70% neck fall), average bulb weight (g) and average leaf length (cm). Path coefficient analysis revealed that days to maturity, average bulb weight (g) and average leaf length (cm) exhibited positive direct effect on marketable bulb yield. Hence, the genotypes viz., 15-27, 15-42, 15-20, 15-45 and 15-01 recorded highest bulb yield under Meghalaya condition.

1. Introduction

Onion (*Allium cepa*L.) is one of the oldest known vegetable crops grown in the history of human kind (Anonymous, 2021). It is consumed either as spring onion (green leaves) or as mature bulb in preparations of various dishes, soups, sauces, seasoning of foods and salad purpose. Botanically, it belongs to *Alliaceae* family and is grown in almost all parts of India. India ranks second after China in onion production. In India, onion is cultivated in an area of 1434 thousand ha with a production of 26738 thousand MT (Anonymous 2020).Maharashtra, Madhya Pradesh, Karnataka, Gujaratand Rajasthan are the leading onion producing state. In Meghalaya which is situated in north eastern part of India onion is grown in lesser extent as compared to other northern states of India. The total area and production of onion in Meghalaya is 0.56 thousand ha and 5.19 thousand MT, respectively (Anonymous 2018).Selection of the suitable crop variety is very important for realizing higher yield in a particular region. Yield is considered as a complex character which is dependent on a number of contributing traits. Mohammed et al. (2000) showed there was negative significant correlation among the total yield and the percentage of bolting. Many researchers revealed there was a positive significant correlation phenotypic and genotypic between the total yield of bulbs with number of leaves per plant (Rahmanet al., 2002; Wani 2004; Golanietet al., 2006; Meenaet al., 2007; Hosamaniet al., 2010; Singh et al., 2010; Morsy et al., 2011 and Akanksha et al., 2015). Goshua et al., (2013) noticed there is a positive significant correlation among the leaves number per plant with the percentage of bolting.So, its improvement requires thorough understanding of the nature and magnitude of association with its component traits. Correlation studies provide an opportunity to studythe magnitude and direction of association of one

*Corresponding author: bilashini1712@gmail.com

character with another, while path coefficient analysis gives the direct and indirect contribution of independent variables onyield (Katoch*et al.,* 2016). Hence, the present study was taken up to estimate the extent of genetic variability, path coefficient and correlation of bulb yield and its contributing traits.

2. Materials and Methods

The present experiment was conducted at the Experimental Farm, DSRE, ICAR Research Complex for NEH Region, Umiam, Meghalaya under All India Network Research Project on Onion and Garlic during *rabi* season, 2018. The experimental site is situated at an elevation of 950 m above the mean sea level (MSL) with 25°41'N latitude and 91°54'E longitude. The experimental material comprised of 22 genotypes of *rabi* onion. The seedlings of each genotype were transplanted in 3.0 x 2.0 m bed in Randomized Complete Block Design with three replications. The plant spacing was maintained at 15 cm between rows and 10 cm between plants and all the recommended agronomic practices were followed to raise a healthy crop. Observations on bulb yield and its contributing traits *viz.* days to maturity, days to harvest, average bulb weight (g), number of leaves per plant, average leaf length (cm), neck thickness (cm), TSS (ºB) were recorded on five randomly selected plants from each genotype and marketable bulb yield (t/ha) was calculated after discarding the double bulb/bolter bulb/diseased bulb from the total bulb yield per replication.

Statistical Analysis

The genotypic, phenotypicco efficients of variations and heritability were estimated as per the method of Burton and De Vane (1953). Phenotypic coefficient of variation (PCV) and Genotypic coefficient of variation (GCV)were classified as suggested by Sivasubramanian and Menon (1973) as follows:

Less than 10% = Low; 10-20% = Moderate; More than 20 % = High

Heritability (h2) was estimated as per the formulae suggested by Allard (1960) and is categorised as suggested by Johnson *et al.,* (1955) as follows:

0-30% = Low;31-60% = Medium;61% and above = High

The genetic advance as per cent over mean was categorized as suggested by Johnson *et al.,* (1955) as follows:

Less than 10% =Low; 10-20%=Moderate; More than 20 % =High

Coefficients of correlation were calculated as per the method suggested by Al-Jibouri *et al.,* (1958) and path coefficients of different traits with bulb yield were carried out by Dewey and Lu (1959). The statistical analysis was carried out using Statistical Package for Social Science (SPSS) software.

3. Results and Discussion

In the present study, analysis of variance revealed highly significant difference among the genotypes for most of the traits studied (**Table 1**). Among the yield and yield component traits evaluated, high GCV, PCV, heritability and GAM was observed for average bulb weight, number of leaves per plant and marketable bulb yield (**Table 2**). This result is in accordance with Ibrahim *et al.,* (2013), Santra *et al.,* (2017) and Pujar *et al.,* (2019). This indicated presence of additive gene effect for these traits and thus simple selection based on phenotype will be rewarding for improvement of these traits. Low GCV and PCV were observed for days to maturity and days to harvest. These results are in agreement with Gurjarand Singhania (2006); Yaso (2007); Hosamani *et al.,* (2010) and Aditika *et al.,* (2017). Narrow difference between GCV and PCV was observed in all the traits studied indicating lesser environmental effect and non additive gene action in the expression of the traits studied. TSS recorded moderate GCV and PCV, but high heritability and high GAM. This result was in consonance with earlier worker Gurjar and Singhania (2006), Yaso (2007), Dhotre et al., (2010). This suggests the preponderance of additive gene, so selection will be rewarding for improvement of this trait.

Estimates for phenotypic and genotypic correlation coefficient (**Table 2**) imply that genotypic correlation was of a higher magnitude than the corresponding phenotypic correlation for all the traits studied, thereby establishing a strong inherent relationship among the attributes studied. The marketable bulb yield showed a positive significant association with days to maturity, average bulb weight and average leaf length both at the phenotypic and the genotypic level (Hossain *et al.,* 2008; Marey *et al.,* 2012, Raghu Ram and Singh 2000; Mohanty and Prusti2001 and Lakshmi 2015).A negative correlation of marketable bulb yield was observed with days to harvest and TSS at both phenotypic and genotypic level. Earlier studies observed a negative association of bulb yield with TSS (Gurjar and Singhania2006).

Path coefficient analysis was performed to assess direct and indirect effects of various traits on bulb yield (**Table 3**). Even though correlation analysis can quantify the degree of association between two traits, it does not provide reasons for such an association. A simple linear correlation coefficient is designed for detecting the presence of linear association between two variables; it cannot detect any other type of variable association. Thus, non-significant correlation coefficient values cannot be taken to imply absence of any functional relationship between two variables. Path coefficient analysis partition the total correlation coefficient into components of direct and indirect effects. Days to maturity, average bulb-weight per plant and average leaf length exhibited positive direct effect on marketable bulb

yield. On the other hand, days to harvest, number of leaves per plant, neck thickness and TSS exhibited negative direct effect on marketable bulb yield. Earlier workers have reported a direct positive effect of bulb-weight and leave length on bulb-yield (Mohanty and Prusti 2001; Gurjar and Singhania 2006 and Sahu*et al.,* 2018).

Keeping in view the estimates for correlation coefficients and direct / indirect contribution of component traits to average bulb yield, selection should be done on the basis of average bulb weight, as it has a positive direct effect and a high indirect effect via several other traits. Days to maturity and average leaf length are other important contributing traits and should be given due consideration during improvement programme of onion.

4. Conclusion

Analysis of variance revealed highly significant difference among the genotypes for most of the traits studied. Environmental influence was very less on expression of all the traits studied as it was evident by narrow gap between genotypic and phenotypic coefficients of variation. Heritability, genetic advance as per cent of mean, genotypic and phenotypic coefficients of variation were moderate to high, for all the traits studied except for days to maturity and days to harvest. This indicates that phenotypic selection based on bulb yield and its correlated traits especially days to maturity, average bulb weight and average leaf length would help in identifying the suitable high yielding variety/genotype of onion. Among the evaluated germplasm, genotypes viz., 15-27, 15-42, 15-20, 15-45 and 15-01 showed significant higher bulb yield in Meghalaya condition and needs further evaluation by multi-location and or multiyear trial in the region.

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6. References

Aditika, Priyanka, DodVN and Monika Sharma (2017).Variability studies in Rabi onion (*Allium cepa*var*cepa*L) for yield and yield contributing traits. International Journal of Farm Sciences 7(1):123-126

Akanksha S,Slive C and Kumar TD (2015).Character association and path coefficient analysis in kharif onion (*Allium cepa* L.) genotypes. Trends in Biosciences 8(6):1473-1476

Al-Jibouri HA, Millar PA and Robinson HF (1958). Genotypic and environmental variances and covariances in an upland cotton cross of interspecific origin. Agronomy Journal 50:632-636

Allard RW (1960). Principles of Plant Breeding. John Wiley and Sons, Inc., New York, pp. 89-98

Anonymous (2018).Horticulture Statistics at a Glance. Government of India Ministry of Agriculture and Farmers' Welfare. Department of Agriculture, Cooperation and Farmers' Welfare

Anonymous (2020). First Advance Estimates (Horticulture Crops for 2019-20). Department of Agriculture and Farmers' Welfare.Government of India. Ministry of Agriculture and Farmers Welfare

Anonymous (2021).Vegetable Facts.http://www.vegetablefacts.net/vegetable-history/history-of-onions/ dated 21st Sept.,2021

Burton GW and DeVaneEHD (1953). Estimating heritability in tall fescue (*Fescue arundinaceae*) from replicated clonal material. Agronomy Journal54: 478-481

Dewey DR and Lu KH (1959). A correlation and path analysis of components of crested wheat-grass seed production. Agronomy Journal 51:515-518

Dhotre M, Allolli TB, Athani SI, andHalemani LC (2010). Genetic variability, character association and path analysis studies in *Kharif* onion (*Allium cepa* var. *cepa* L.). Asian Journal of Horticulture 5(1): 143-146

Golani IJ, Vadoria MA, Mehta DR, Nallyadhara MV and Dabariya KL (2006).Analysis of yield components of onion. IndianJournal of Agricultural Research 40(3):224-227

Goshu IB, Simon SY, Bashir LU and Kadam AM (2013).Inheritance of some quantitative traits in onion (*Allium cepa* L.).International Journal of Bio Sciences 3(4):135-141

Gurjar RSS and Singhania DL (2006).Genetic variability, correlation and path analysis of yield and yield components in onion. Indian Journal of Horticulture 63(1): 53-58

Hosamani RM, Patil BC and Ajjappalavara PS (2010).Genetic variability and character association studies in onion (*Allium cepa* L.). Karnataka Journal of Agricultural Science 23(2): 302- 305.

Hosamani RM, Patil BCand Ajjappalavora PS (2010). Genetic, variability and characters association studies in onion (*Allium Cepa* L.).Karnataka Journal of Agricultural Science 23(2): 02- 305

Hossain M.S, Khalekuzzaman M, Rashid MHandRahman MS (2008). Variability and interrelationshipamong yield and yield contributing characters in onion (*Allium cepa*L.). *Journal of Bio-Science*16:85-88

Ibrahim BG, Simon SY, Bashir LU and Kadams AM (2013). Inheritance studies of some quantitative traits in onion (*Allium cepa* L.). International Journal of Bioscience 3(4): 135-141

Johnson HW, Robinson HF and Comstock RE (1955).Estimates of genetic and environmental variability in soyabean. Agronomy Journal 47: 314-318

Katoch V, Singh P, Devi MB, Sharma A, Sharma GD and Sharma JK (2016). Study of genetic variability, character association, path analysis and selection parameters for heterotic recombinant inbred lines of garden peas (*Pisumsativum* var. *hortense* L.) under mid-hill conditions of Himachal Pradesh, India. Legume Research39 (2): 163-169

Lakshmi RR (2015). Studies on genetic variability, correlation and path analysis of yield and yield components in onion. Journal of HorticulturalScience10(2): 237-241

Marey RA, Abo Dahab AMA and Karam SS (2012).Phenotypic correlation and path coefficient analysisin some onion genotypes grown in upper Egypt. Journal of Agricultural Research Kafer EI-Sheikh Univ., 38:154-156

Meena SS, Jalwania R and Sing RK (2007).Correlation and path coefficient studies for bulb yield in kharif onion. Abstracts of International Conference on Sustainable Agriculture for Food, Bioenergy and Livelhood Security, JNKVV, Jabalpur pp 360

Mohammed BM, Ganiger and Naik BH (2000). Correlation and regression study of bulb yield and its attributes in onion. Karnataka Journal of Agriculture Science 13(4): 975- 977

Mohanty BK and Prusti AM (2001). Studies on variability, heritability, correlation and path coefficients in *kharif*onion. The Orissa Journal of Horticulture29:75-78

Morsy MG, Marey RA and Genies LSM (2011). Genetic variability, heritability, genetic advance and phenotypic correlation in some onion variaties. Journal of Agricultural Research KafrElShekh Univ. 37(1):57-72

PujarUU, Jagadeesha RC, Gangadharappa PM, Chavan ML, Shankarappa Sand JayappaJ (2019). Assessment of Genetic Variability in Onion (*Allium cepa* L.) genotypes. Indian Journal of Pure and Applied Bioscience 7(6), 152-156.

Raghu Ram N. and Singh N (2000).Studies on genetic variability in onion. Natational Symposium Onion-Garlic production and post harvest management – challenges and strategies. 19-21 November 2000, Nasik, Maharashtra, India, pp. 188

Rahman MA, Saha SR, Salam MA, Marun AS and Choudhury SS (2002).Correlation and path analysis in onion (*Allium cepa* L.).Journal of Biological Science 2(8):533-534

Sahu K, Sharma PK, Dixit A and Nair SK. (2018).Correlation and path coefficient analysis in *kharif* onion (*Aillumcepa* L.) genotypes for chhattisgarh plains. International Journal of Current Microbiology and Applied Science 6: 256-263

Santra P, Manna D, Sarkar HK and Maity TK (2017). Genetic variability, heritability and genetic advance in *kharif* onion. Journal of Crop and Weed 13(1): 103-106

Singh RK,Dubey BK,Bhonde SR. and Gupta RP (2010).Variability studies for some quantitative characters in white onion (*Allium cepa*L.) advancelines. Vegetable Science, 37(1): 105–107

SivasubramanianS and MenonM (1973). Heterosis and inbreeding depression in rice. Madras Agriculture Journal60: 1139

Wani MA (2004). Correlation and regression studies in garlic (*Allium sativum*). Horticulture Journal 17 (2):155-159

Yaso AA (2007). Performance and genetic parameters for six onion genotypes in Nubaria area. Egyptian Journal of Plant Breeding 11(3): 307-318

Table 1. Analysis of variance for marketable yield and related traits

Source of variation	df	MSS							
		Days to maturity	Days to harvest	Average Bulb Weight (g)	No. of leaf per plant	Average Leaf length (cm)	Neck thickness (cm)	TSS (ºB)	Marketable bulb yield (t/ha)
Replication	2								
Genotypes	21	5.24	9.74	364.76*	64.83*	6.39*	12.12	8.20*	456.10*
Error	44	6.31	10.38	12.97	0.05	0.05	8.02	0.31	4.33

Total	65								

***Significant at P = 0.05**

Table 2. Genetic parameters in quantitative and quality traits in onion genotypes

Sl. No.	Characters	Mean	Genotypic variance	Phenotypic variance	Genotypic coefficient of variance (GCV in %)	Phenotypic coefficient of variance (PCV in %)	Heritability (h2 in %)	Genetic Advance (GA)	Genetic Advance as % of mean
1.	Days to maturity	155.24	0.35	2.46	0.385	1.01	14.53	0.53	1.88
2.	Days to harvest	171.69	0.20	3.65	0.26	1.11	5.52	0.66	2.89
3.	Average Bulb Weight (g)_	35.13	117.26	121.58	30.82	31.38	96.44	2.23	50.51
4.	No. of leaves	7.91	156.27	158.22	51.42	51.73	98.77	1.47	33.79
5.	Average Leaf length (cm)	24.31	2.11	2.13	159.47	160.20	99.09	6.71	16.93
6.	Neck thickness(cm)	11.06	1.36	4.04	10.56	18.16	33.86	1.87	3.55
7.	TSS (Total soluble solids) (ºB)	8.36	2.62	2.73	19.38	19.77	96.11	0.66	49.33
8.	Marketable bulb yield (t/ha)	12.83	150.58	152.03	95.58	96.04	99.04	8.77	56.78

Table 3. Correlation relation between marketable yield and related traits

Traits		2	3	4	5	6	7	Marketable bulb yield
1	P	0.122	-0.036	-0.065	0.034	-0.374**	-0.076	**0.411****
	G	0.145	-0.069	-0.088	-0.046	-1.077**	0.0421	**0.684****
2	P		-0.004	-0.072	-0.052	0.094	0.035	-0.036
	G		0.114	0.331	-0.633	0.233	0.362	-0.801
3	P			0.256*	0.213	0.001	0.391**	**0.395****
	G			0.281*	0.233	0.172	0.491**	**0.693****
4	P				-0.125	0.098	-0.033	0.011
	G				0.222	0.233*	-0.111	0.126
5	P					-0.061	0.133*	**0.336****
	G					-0.086	0.248*	**0.467****
6	P						-0.201*	0.114
	G						0.301*	-0.213
7	P							-0.172
	G							-0.200

*Significant at 5%; **Significant at 1%

1. Days to maturity 2. Days to harvest 3. Average Bulb Weight (g) 4. No. of leaves
5. Average leaf length (cm) 6. Neck thickness (cm) 7. TSS (Total soluble solids) (ºB)

P: Phenotypic correlation; G; Genotypic correlation

Table 4. Path coefficient analysis showing direct and indirect effects of contributing traits on marketable yield

Traits	1	2	3	4	5	6	7
1	**0.398**	-0.00683	-0.02608	0.000715	0.012478	0.029546	0.003724
2	0.048556	**-0.056**	-0.00151	0.000792	-0.01908	-0.00743	-0.00172
3	-0.02746	0.000224	**0.378**	-0.00282	0.085511	-0.01359	-0.02406
4	-0.02587	0.004032	0.096768	**-0.011**	-0.04588	-0.00774	0.001617
5	0.013532	0.002912	0.088074	0.001375	**0.367**	0.00632	-0.01215
6	-0.14885	-0.00526	0.065016	-0.00108	-0.02936	**-0.079**	-0.01475
7	-0.03025	-0.00196	0.185598	0.000363	0.091016	-0.02378	**-0.049**

1. Days to maturity 2. Days to harvest 3. Average Bulb Weight (g) 4. No. of leaves

5. Average leaf length (cm) 6. Neck thickness (cm) 7. TSS (Total soluble solids) (^{o}B)

Table 5. Top five promising genotypes under Meghalaya conditions

S.No.	Genotypes	Marketable bulb yield (t/ha)
1.	15-27	32.01
2.	15-42	31.89
3.	15-20	28.05
4.	15-45	23.30
5.	15-01	23.25