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Clustering of knolkhol (*Brassica oleracea* var. *gongyloides* L.) genotypes for various quantitative and quality traits

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Abstract

The investigation comprising of thirty genotypes of knolkhol was carried out at Vegetable Research Farm, SKUAST-J, Main campus, Chatha, J & K to study the extend of genetic divergence for various quantitative and quality traits of knolkhol during the year 2016-17. Based on the performance of genotypes in the main season thirty genotypes grouped into six clusters of which cluster I accommodated 12 genotypes, while cluster V and VI were solitary. Intra cluster distance was maximum for cluster III (122.44) followed by cluster IV (104.23) and the maximum inter cluster distance was observed between cluster II and cluster IV (1182.73) followed by cluster I and IV (723.99). A considerable genetic difference for cluster means of genotypes was observed between the groups during main season. The genotypes falling in cluster IV recorded maximum cluster mean value for number of leaves per plant (11.18), marketable knob diameter (7.37 cm), marketable knob weight/plant (380.29 g/plant) and yield/plot (5.11 kg/plant); cluster I gave minimum value for days to marketable maturity (50.10) and cluster VI gave maximum cluster mean for most of the quality traits such as beta carotene contents of knob and leaves, ascorbic acid contents of knob, calcium content of knob and leaves, potassium content of knob and leaves and phosphorous content of knob and leaves. Hence, crosses between genotypes selected from these clusters may be used to generate knolkhol genotypes with good yield and quality traits.

Key words: Quantitative traits, genetic constellation, divergent, knolkhol, quality

Introduction

Knolkhol (*Brassica oleracea* var. *gongyloides* L., 2n=2x=18) belongs to family *Brassicacea* is a cool season crop. It has its primary centre of origin in Northern Europe. The tender fleshy enlarged stem formed just above ground is known as knob is edible, which arises from thickening of stem tissue above the cotyledon and consumed as cooked and raw vegetable and also value addition in pickle. In India it is widely grown in Jammu and Kashmir, West Bengal and to a limited extent as a rare exotic vegetable in some parts of Maharashtra, Assam, Uttar Pradesh and Punjab and Himachal Pradesh (Thamburaj and Singh 2010). Of late, demand for knolkhol has gained momentum in National Capital Region of Delhi and adjoining states because of its wholesome utility as fresh vegetable and value addition products which support the food needs of the people. In Jammu and Kashmir it is a popular vegetable both among rich and poor and grown in almost all kitchen gardens and also as a commercial crop around cities and towns. In Jammu knolkhol is grown over an area of about 1961 ha and with a production of 54977.60 mt Anonymous (2014) and is in great demand throughout the year for its varied size of coloured knobs and leaves. Cole crops, including knolkhol are very good source of antioxidant, vitamins C, E and carotene and are good source of dietary fibre (Singh et al. 2011). It also contains sulphoraphanes and other isothiocyanates, which are believed to stimulate the production of protective enzymes in the body. Knolkhol extracts (Juice) proved that it has hypoglycemic effect and antioxidant activity in type 2 diabetic patient (Selvakumar et al. 2017). It is also rich source of minerals such as calcium, phosphorous, potassium, magnesium (Thamburaj and Singh 2010).

There is a scanty literature available regarding genetic diversity in knolkhol, so it becomes imperative to access the diversity and to execute a breeding programme for scientific utilization of allelic resources present in elite gene pool of knolkhol through hybridization and subsequent selection of recombinants possessing high yield potential together with abiotic resistance and quality. To identify potential parents for such programmes, it is imperative to estimate genetic divergence in the available

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germplasm resources for yield and yield attributing traits. The importance of conservation and characterization of available germplasm of knolkhol has now become imperative from the point of view of conservation of plant biodiversity and their utilization in crop improvement programme.

Materials and Methods

The investigation was carried out under subtropical conditions at Vegetable Experimental Farm, Division of Vegetable Science and Floriculture, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Main Campus, Chatha, Jammu (J&K) during (Sept–Oct) of the year 2016-17.The experimental field is situated at 32° 40'N latitude and 74° 58' E longitude and has an elevation of 332 m above mean sea level. The experimental material comprised of 30 genotypes of knolkhol collected from diverse agro-climatic regions of J&K along with two genotypes from IARI, Katrain, one from CSKHPKV, Palampur and three hybrids. The details of the genotypes along with their source are given below in Table 1. The experimental was laid out in Randomized Block Design with three replications during (Sept–Oct) of the year 2016-17. The sowing of all genotypes was done in nursery bed and 25 days old seedlings were transplanted at the spacing of 30 cm between rows and 30 cm between plants within the rows. The package and practices to raise successful crop of knolkhol was followed. Five plants were randomly selected from each replication per genotype for recording the various growth and yield attributing traits.

Leaf and knob sample of each genotype in replication was taken at fresh marketable stage and used to estimate ascorbic acid content of knob and leaves as per method suggested by (Sadasivam and Theymoli 1987) and beta carotenet content of knob and leaves by as per method of (Sadasivam and Manickam 1992). The fresh marketable knob and leaves was chopped, air dried and kept in hot air oven at 60-65 ºC for drying. These dried samples were powdered by using stainless steel blade mixer and and finally stored in airtight container for the analysis of minerals. 0.5 g of dried tissues was digested with a mixture of perchloric acid and nitric acid (1: 4).

Table 1: List of the genotypes with source

S. No.	Genotype code	Genotype name	Source
Released varieties and advance breeding lines of SKUAST- J and SKUAST- K			
1.	G1	G40	SKUAST-J
2.	G2	SJKK-02	SKUAST-J
3	G3	SJKK-03	SKUAST-J
4	G4	SJKK-04	SKUAST-J
5	G5	SJKK-05	SKUAST-J
6	G6	SKKK-01	SKUAST-K
7	G7	SKKK-02	SKUAST-K
8	G8	SKKK-03	SKUAST-K
Public Sector Varieties			
9	G9	Early White Vienna	Directorate of Agriculture ,Jammu
10	G10	King of Market-I	Directorate of Agriculture ,Jammu
11	G11	Early Super White Vienna	National Food Control Commision, Jammu
12	G12	Kargil Local	Kargil
13	G13	Purple Vienna-I	JK Krishi Vikas Cooperative Ltd, Pulwama
14	G14	Knolkhol White	JK Krishi Vikas Cooperative Ltd, Pulwama
15	G15	King of Market-II	Sultan Seeds, Munwarabad
16	G16	Purple Vienna-II	Sultan Seeds, Munwarabad
17	G17	Pusa Virat	IARI, Katrain (HP)
18	G18	White Vienna	IARI, Katrain (HP)
19	G19	Palam Tender Knob	CSKHPKV,Palampur
Local Germplasm of J &K			
20	G20	Farashi Lajwari Local	Sopore
21	G21	Farashi Safed Local	Sopore
22	G22	Sopore Local	Sopore
23	G23	Baramullah Local	Baramullah
24	G24	Ganderbal Local	Ganderbal
25	G25	Leh Local	Leh
26	G26	Rajouri Local	Rajouri
27	G27	Nowpora Local	Nawpora
Private sector hybrids			
28	G28	Mamta	Crop Life Hybrid Seeds, Punjab
29	G29	Green Gold	Indus Seeds, Banglore
30	G30	C-2002	Century Seeds, New Dehli

Dried tissues (0.5 g) and 10 ml of acid mixture were put in 100 ml conical flask, allowed over-night for pre-digestion, and then heated at 100 ºC for an hour and 250 ºC until the solution turned colourless and volume was reduced to 2-3 ml. The digested plant material was made up to 50ml with double distilled water and filtered. The filtrate was used for determination of calcium, potassium and phosphorous concentration as per the methods suggested by (Prasad et al. 2006). The mean value was used as the replicated data and was subjected to statistical analysis using window stat software package. The genetic constellation among the knolkhol lines was estimated by using D^2 statistics Mahalanobis (1936). All genotypes were clustered into different groups accomplished by Tocher's method Rao (1952). The average distance between the cluster and within the cluster was calculated by the statistical procedure given by (Singh and Choudhary 1985).

Results and Discussion

Based on the performance of genotypes in the main season thirty genotypes grouped into six clusters as per the Mahalanobis D2 analysis. The perusal of data (Table 2 and Fig.1) depicted that cluster I accommodated maximum number of genotypes (12) *viz.* G-40, SJKK-02, SJKK-03, SJKK-04, SJKK-05, SKKK-01,SKKK-03, Kargil Local, Knolkhol White, Leh Local, Ganderbal Local and Baramullah Local followed by cluster IV with seven genotypes (King of Market -II, Early Super White

Table 2: Clustering of thirty genotypes of knolkhol (*Brassica oleracea* var. *gongyloides* L.) based on D^2 statistics

Cluster	No. of genotypes	Name
I	12	G-40, SJKK-03, SJKK-02, SJKK-04, SKKK-01, SJKK-05, SKKK-03, Kargil Local, Knolkhol White, Leh Local, Ganderbal Local and Baramullah Local
II	6	SKKK-02, Purple Vienna-I, Purple Vienna-II, Sopore Local, Nawpura Local, and Mamta
III	3	Early White Vienna, White Vienna and Farashi Lajwari Local
IV	7	King of Market-I, Early Super White Vienna, King of Market -II, Palam Tender Knob, Farashi Safed Local, Green Gold and C-2002
V	1	Rajouri Local
VI	1	Pusa Virat

Table 3: Average intra (bold) and inter cluster (D^2 Values) distance values

Cluster	I	II	III	IV	V	VI
I	**69.45**	161.05	136.30	198.13	249.55	723.99
II	161.05	**74.44**	311.43	452.81	452.83	**1182.73**
III	136.30	311.43	**112.44**	151.52	241.37	544.52
IV	198.13	452.81	151.52	**104.23**	290.25	360.47
V	249.55	452.83	241.37	290.25	**0.00**	503.12
VI	723.99	118.73	360.47	360.47	503.12	**0.00**

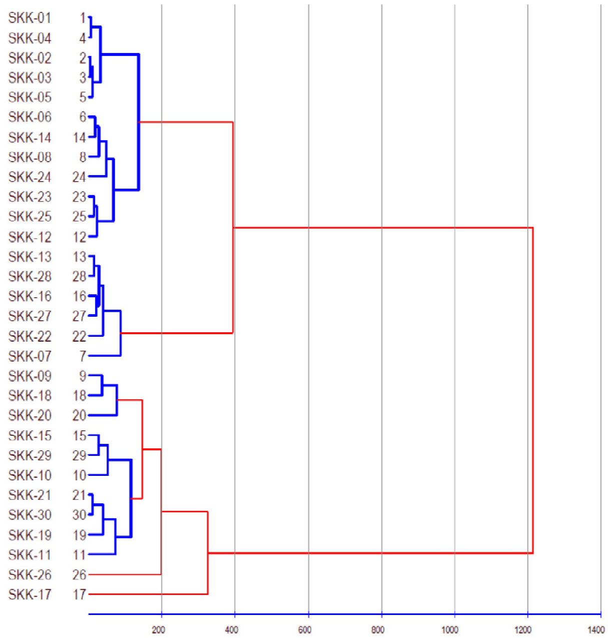

Fig.1: Dendrogram based on Mahalnobis D^2 statistics on thirty genotypes of knolkhol (*Brassica oleracea* var. *gongyloides* L.)

1. G-40 11. Early Super White Vienna 21. Farashi Safed Local
2. SJKK-02 12. Kargil Local 22. Sopore Local
3. SJKK-03 13. Purple Vienna-I 23. Baramullah Local
4. SJKK-04 14. Knolkhol White 24. Ganderbal Local
5. SJKK-05 15. King of Market-1 25. Leh Local
6. SKKK-01 16. Purple Vienna-II 26. Rajouri Local
7. SKKK-02 17. Pusa Virat 27. Nawpura Local
8. SKKK-03 18. White Vienna 28. Mamta
9. Early White Vienna 19. Palam Tender 29. Green Gold
10. King of Market-II 20. Farashi Lajwari Local 30. C-2002

Vienna, King of Market-I, Palam Tender Knob, Farashi Safed Local, Green Gold, C-2002); cluster II with six genotypes (SKKK-02, Purple Vienna-I, Purple Vienna-II, Sopore Local, Nawpura Local, Mamta), cluster III consisted of 3 genotypes namely Early White Vienna, White Vienna, Farashi Lajwari Local and cluster V and VI consisted of one genotype each namely Rajouri Local and Pusa Virat, respectively. Using Mahalanobis D^2 clustering, (Kumar et al. 2017) reported eight clusters in seventy five genotype of cauliflower; (Santhosha et al. 2011) reported14 clusters in 51 genotypes of cauliflower; (Dey et al. 2010) grouped 52 cauliflower genotypes into ten clusters; (Meena et al. 2013)) reported three clusters in thirty accessions of cabbage; (Khan et al. 2009) grouped fourty genotypes of kale into four clusters. The intra and inter cluster D^2 values (Table 3) for thirty genotypes of knolkhol under study revealed that maximum intra cluster distance was recorded for cluster III (122.44) followed by cluster IV (104.23. The maximum inter cluster distance was observed between cluster II and cluster IV (1182.73) followed by cluster I and IV (723.99). The grouping of genotypes

Table 4: Cluster mean for various quantitative and quality traits in knolkhol (*Brassica oleracea* var.*gongyloides* L.)

Cluster	Plant height (cm)	Plant frame (cm)	Petiole length (cm)	Number of leave per plant	Leaf length (cm)	Leaf width (cm)	Stalk length (cm)	Gross weight/plant (g)	Marketable knob weight/plant	Marketable knob diameter (cm)	Harvest index (%)	Days to marketable maturity	Yield/ plot (kg)
I	45.26	54.19	20.60	11.15	23.43	15.88	2.17	455.31	367.65	6.95	80.67	50.10	4.66
II	51.03	61.14	21.63	9.83	27.97	20.15	2.88	486.16	360.69	6.85	74.40	56.39	4.47
III	34.74	43.39	17.26	9.59	17.88	13.13	1.92	378.37	332.72	6.52	88.30	53.22	4.40
IV	43.89	48.69	19.50	11.18	21.76	15.04	2.00	443.90	380.29	7.37	85.72	51.33	5.11
V	45.29	49.17	21.33	8.78	26.94	15.72	1.22	383.89	300.19	4.63	78.16	56.00	3.60
VI	31.41	46.33	12.22	10.94	18.05	15.67	0.50	332.29	281.90	5.40	85.46	59.33	3.81

Continued...

Cluster	Beta -carotene content (mg/100g)		Ascorbic acid content (mg/100g)		Calcium content (mg/100)		Potassium content (mg/100g)		Phosphorous content (mg/100g)	
	Knob	Leaves	Knob	Leaves	Knob	Leaves	Knob	Leaves	Knob	Leaves
I	1.96	7.12	53.14	92.02	59.22	98.44	353.72	266.53	33.12	50.37
II	1.75	7.25	50.27	86.80	53.52	91.85	348.44	265.45	31.08	48.53
III	2.23	7.35	54.54	93.36	63.17	107.67	354.49	267.68	33.40	50.30
IV	2.60	7.56	57.07	96.75	62.09	109.24	356.75	271.02	35.45	52.71
V	1.97	7.95	55.83	100.37	65.00	115.67	358.44	253.37	35.17	50.76
VI	3.47	8.37	57.83	98.00	69.33	117.43	360.07	272.40	39.08	56.80

into different clusters in the present study, suggested that geographical distribution was not an essential factor to group the genotypes into one particular cluster. Parent selection from highly divergent cluster is expected to manifest high heterosis in hybridization (Khan et al. 2013). Genotypes belonging to clusters separated by maximum genetic distance may be used in hybridization programme to obtain a wide spectrum of variation among the seggregants (Doddabhimappa et al. 2010). Genotypically distant parents are able to exert high heterosis (Farhad et al. 2010 and Dar et al. 2010).

A considerable genetic difference for cluster means of genotypes was observed between the groups during main season (Table 4). The genotypes falling in cluster II registered the maximum mean value for plant height (51.03 cm), leaf length (27.97 cm), leaf width (20.15 cm), stalk length (2.88 cm), gross weight/plant (486.16 g/plant), petiole length (21.63 cm), plant frame (61.14 cm); cluster IV for number of leaves per plant (11.18), marketable knob diameter (7.37 cm), marketable knob weight/plant (380.29 g/plant) and yield/plot (5.11 kg/ plant); cluster I gave minimum value for days to marketable maturity (50.10) and cluster VI gave maximum cluster mean for most of the quality traits as beta carotene contents of knob and leaves, ascorbic acid contents of knob, calcium content of knob and leaves, potassium content of knob and leaves and phosphorous content of knob and leaves. Hence, crosses between genotypes selected from these clusters may be used to generate knolkhol genotypes with good yield and quality traits. Similar comparison of clusters based on the range of mean value of each character had been done by (Kumar et al. 2017), (Meena et al. 2013), (Dey et al. 2010) and (Khan et al. 2009). While selecting genotypes from distant cluster the mean values for different trait should be given importance to generate promising breeding material (Hazara et al. 2002). The present investigation depicted that the traits contributing maximum (upto 90%) towards divergence (Table 5) were gross weight/plant followed by yield/plot, marketable weight per plot, plant height, potassium contents of knob and leaves, harvest index, plant frame, petiole length, leaf length and leaf width.

Table 5: Percent contribution of various quantitative and qualitative traits towards divergence in knolkhol (*Brassica oleracea* var.*gongyloides* L.)

S.No.	Trait(s)	Percent(%)
1.	Plant height (cm)	6.40
2.	Plat frame (cm)	3.84
3.	Petiole length (cm)	3.20
4.	Number of leaves /Plant	0.69
5.	Leaf length (cm)	2.84
6.	Leaf width (cm)	2.61
7.	Stalk length (cm)	2.50
8.	Gross weight/plant (g)	20.10
9.	Marketable knob weight/plant (g)	17.93
10.	Marketable knob diameter (cm)	1.40
11.	Harvest index (%)	4.50
12.	Days to marketable maturity	2.45
13.	Yield per plot (kg)	18.30
14.	Beta carotene contents of knob (mg/100g)	0.01
15.	Beta carotene contents of leaves(mg/100g)	0.01
16.	Ascorbic acid contents of knob (mg/100g)	0.01
17.	Ascorbic acid contents of leaves (mg/100g)	0.01
18.	Calcium contents of knob(mg/100g)	1.45
19.	Calcium contents of leaves (mg/100g)	1.49
20.	Potassium contents of knob (mg/100g)	4.50
21.	Potassium contents of leaves (mg/100g)	5.34
22	Phosphorous contents of knob (mg/100g)	0.30
23.	Potassium contents of leaves (mg/100g)	0.21

सारांश

यह अनुसंधान गांठगोभी के तीस अनुवांशिक प्रभेदों के साथ सब्जी अनुसंधान प्रक्षेत्र, शेर–ए–कश्मीर कृषि एवं प्रोद्योगिकी विश्वविद्यालय, (जम्मू एवं कश्मीर) के परिसर में वर्ष 2016–17 में अनुवांशिक प्रभेदों के मात्रात्मक एवं गुणात्मक लक्षणों के अध्ययन के लिए किया गया। मुख्य मौसम के अनुवांशिक प्रभेदों के आधार पर इन तीस प्रभेदों को छः समूहों में बाँटा गया, जिसमें समूह 1 में बारह अनुवांशिक प्रभेद थे, जबकि समूह V व VI में कोई प्रभेद नहीं थे। एक समूह से दूसरे समूह में अधिकतम दूरी समूह III (122.44) में तथा उसके बाद समूह IV (104.23) में थी और समूह के अन्दर अधिकतम दूरी II व IV (1182.73) में तथा उसके बाद समूह 1 व IV (723.99) में देखी गयी। मुख्य मौसम के दौरान समूहों के बीच अनुवांशिक प्रभेदों के समूहों के लिए पर्याप्त अनुवांशिक अंतर पाया गया। समूह IV के अनुवांशिक प्रभेदों में पत्तियों की संख्या के लिए अधिकतम समूह माध्य (11.18), विपणन योग्य गांठ की गोलाई (7.37 सेमी.) विपणन योग्य गांठ का प्रति पौध वजन (380.29 ग्राम प्रति पौध) व प्रति प्रखण्ड उपज (5.11 किग्रा./प्रखण्ड) दर्ज किया गया। समूह में I विपणन योग्य परिपक्वता के लिए न्यूनतम (50.10 दिन लगे जबकि समूह IV में अधिकतम समूह मध्य गुणवत्ता के लक्षण जैसे पत्तियों व गांठ में बीटा कैरोटीन, पोटाश, फास्फोरस व कैल्शियम तथा गांठ में एस्कार्बिक अम्ल के लिये पाया गया। इसलिये इन समूहों से चुने गए अनुवांशिक प्रभेदों के बीच संकरण का उपयोग अच्छी उपज व गुणवत्तापूर्ण लक्षणों को समाहित करके गांठगोभी के नये अनुवांशिक प्रभेद बनाये जा सकते हैं।

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