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Studies on genetic diversity in various quantitative characters in kalmegh (*Andrographis paniculata*) germplasm

■ DISHA NAGVANSHI AND ALICE TIRKEY[1]

AUTHORS' INFO

Associated Co-author :
[1]Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, RAIPUR (C.G.) INDIA

Author for correspondence:
DISHA NAGVANSHI
Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, RAIPUR (C.G.) INDIA
Email: dishanagvanshi11@gmail.com

ABSTRACT : *Andrographis paniculata* rank 17th placed among 32 prioritized medicinal plants in India. The areal parts of the plant are used as medicine for the treatment as antipyretic, antioxidant, hepatoprotective etc. The plants are directly harvested from the forest for sale and use by self in Chhattisgarh, therefore, the population of this species are reducing day by day. Identification of variability exist should be identified so that cultivation techniques may developed so that the species may be saved from continuous harvesting from the forest. With this objective twenty two kalmegh accessions with 2 checks Anand Kalmegh-1 (Directorate of Medicinal and Aromatic Plant Board) and Simmegha (CIMAP) were evaluated to study the PCV, GCV, GA per cent and diversity pattern among the collected accession. The analysis of variance revealed that the collected accessions have significant difference for all the characters which confirms the variability in the collected accessions. The PCV value was slightly higher than the GCV showed the slight influence of environment in the expression of the accessions. The high GCV, PCV, h^2 and GA per cent was observed for the characters number of tertiary branches with 49.72, 50.10, 98.80 and 99.82, respectively. Dry herbage yield with 44.87, 45.96, 95.30 and 90.24, respectively. The genotype was studied for the diversity and D^2 statistic was done and the accessions were grouped into five clusters. The distribution patterns indicate that the maximum number of genotypes (7) were grouped into cluster II, followed by 6 in cluster I. The inter - cluster distance was higher than intra cluster distance indicating wide genetic diversity among the genotypes. The highest inter-cluster distance was observed between cluster III and IV followed by IV and V showed wider diversity among the groups. The highest intra cluster distance was observed for cluster II followed by I. The accession with IKM-1, IKM-2, IKM-7, IKM-20, IKM-23, IKM-24 can be used as potential donors for hybridization programme to develop variety with higher yield potential.

KEY WORDS : Genetic divergence, Accession, Kalmegh

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Andrographis paniculata Wall. ex Nees, commonly known as king of bitters which belongs to family Acanthaceae. It is placed at 17th position among the 32 prioritized medicinal plants of India with a demand of 2,197.3 tonnes (2005-2006) and annual growth of 3.1 per cent (Mishra *et al*., 2001). It is distributed throughout Thailand, Peninsular Malaysia to Indonesia and in India it is found in the state of Madhya Pradesh,

Chhattishgarh, Orrisa, Maharashtra, Assam, Bihar, West Bengal, Uttar Pradesh, Tamil Nadu, Kerala (Pandey and Mandal, 2010). It has an important place in the Indian pharmacopoeia and is being prominently used in 26 Ayurvedic formulas. Leaves, stem, flower, seed, root of the plant is being used in various formulation of Indian system of medicine. The leaves and aerial parts of the plant are used in Indian traditional medicine for the treatment of fever, malaria, some throat infection (Shanker *et al.*, 2012), hepatoproatective, antioxidant (Lin *et al.*, 2009). Genetic diversity provides information to choice of genetically diverse parents for hybridization. Genetic parameters and character association provides information about expected response of various character and helps in developing suitable breeding procedure for their improvement nature and magnitude of variability in the existing plant material and the association among various character as per requisites for yield and selection of better plant type.

RESEARCH PROCEDURE

The experimental materials comprised of 22 kalmegh germlpasm accessions collected from different district of C.G. along with 2 checks in Anand Kalmegh-1 (Directorate of Medicinal and Aromatic Plant Board) and Simmegha (CIMAP). These genotypes were evaluated in Randomized Blocked Design during *Kharif* 2014 at Research Farm, Indira Gandhi Krishi Vishwavidyala (IGKV), Raipur, Chhattishgarh (situated at $21^0$41' N latitude,$81^0$21,E longitude and at the height of 289.60 meters above the mean sea level). Twenty five days old seedlings from the nursery were transplanted. Each plot consisted of six rows. The spacing was maintained at 5x5 cm and the recommended practices were followed during crop season. Three plants from middle of the row of each entry were randomly taken for observation on various15 quantitative character *viz.*, days to 50 per cent flowering, plant height (cm), number of secondary branches plant^{-1}, number of tertiary branches plant^{-1}, internode length (cm), pod length (cm), seed number pod^{-1}, leaf length (cm), leaf width (cm), chlorophyll content, petiole length (cm), canopy temperature, collar girth (cm), dry herbage yield (g), fresh herbage yield (g). D^2 statistic was employed to measure the genetic distance between genotype (Mahalanobis, 1928).

RESEARCH ANALYSIS AND REASONING

A clear understanding of the extent of variability prevailing for each trait in germplasm is essential for the improvement of character through selection. In hybridization programme, selection of genetically diverse parent is important to get wide range of recombinants.

The analysis of variance (ANOVA) revealed significant differences among the genotype (Table 1) for all characters studied showed considerable variability in the study material. The magnitude of variation between genotypes study was reflected by high mean value and range of genotype traits studied (Table 2 and Fig. 1).

On the basis of divergence and cluster mean it may be suggested that maximum heterosis and good recombinants could be obtained in crosses between cluster II, III, IV and IV in varietal improvement in specific trait with IKM-16 for days to 50 per cent flowering. IKM-5 for plant height, IKM-9 for number for secondary branches, IKM-1 tertiary branches, IKM-2 for internode length, IKM-24 for pod length, IKM-5 for seed no., IKM-21 for leaf length, IKM-14 for leaf width, IKM- 23 for chlorophyll content, IKM-5 for petiole length, IKM-15 for canopy temperature, IKM-1 for collar girth, IKM-1

Table 1 : Analysis of variance for fresh herbage yield and its components in kalmegh

Source of variation	DF	Days to 50% flowering	Plant height (cm)	No. of secondary ranches plant^{-1}	No. tertiary branches plant^{-1}	Internode length (cm)	Pod length (cm)	Seed No. pod $^{-1}$	Leaf length (cm)	Leaf width (cm)	Chlorophyll content	Petiole length (cm)	Canopy temperature	Collar girth (cm)	Fresh herbage yield (g)	Dry herbage yield (g)
Replication	1	15.1	58.29	3	0.015	0.008	0.025	2.08	0.42	0.003	80.3	0.003	0.13	0.13	4.68	9.01
Treatment	23	156.4 **	184.9 **	27.33 **	2048 **	0.305	0.046	0.44	0.72	0.31 **	15.9	0.037 *	0.13	0.13**	77.4 **	19.4 **
Error	23	8.97	1.22	6.17	12.15	0.417	0.031	0.38	0.46	0.06	8.4	0.014	0.008	0.008	1.05	0.47

DF = degree of freedom

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 2 : Estimation of genetic parameter for different traits in kalmegh

Characters	Mean	Range		GCV (%)	PCV (%)	h^2 (%)	Genetic advance	GA as % of mean
		Min.	Max.					
Days to 50% flowering	153.18	122.00	167.50	5.61	5.94	0.891	16.70	10.90
Plant height (cm)	57.30	43.70	72.50	16.19	17.30	0.875	17.90	31.23
Number of secondary branches	26.08	20.00	32.50	12.47	15.69	0.631	5.32	20.39
Number of tertiary branches	64.18	31.00	159.50	49.72	50.10	0.988	65.35	101.82
Internode length (cm)	3.46	2.60	4.25	0.91	18.69	0.002	0.00	0.00
Pod length (cm)	2.32	2.05	2.70	3.70	8.47	0.191	0.08	3.44
Seed number/pod	10.87	10.50	11.50	1.57	5.94	0.070	0.09	0.82
Leaf length (cm)	8.15	7.10	9.15	4.43	9.43	0.221	0.35	4.29
Leaf width (cm)	2.30	1.75	2.65	15.33	18.66	0.675	0.60	26.08
Chlorophyll content	37.54	32.30	43.45	5.18	9.30	0.310	2.23	5.94
Petiole length (cm)	0.91	0.70	1.15	11.60	17.62	0.434	0.14	73.68
Canopy temperature	30.65	29.00	31.75	0.10	4.33	0.001	0.00	0.00
Collar girth (cm)	1.63	1.35	2.30	15.22	16.23	0.880	0.48	29.44
Fresh herbage yield (g)	16.92	8.15	30.50	36.51	37.01	0.973	12.56	77.53
Dry herbage yield (g)	6.87	3.05	13.60	44.87	45.96	0.953	6.20	90.24

Table 3 : Average intra-cluster and inter cluster distance (D values) among the 5 cluster in kalmegh

Cluster	I	II	III	IV	V
I	2.833	3.544	3.601	5.933	3.526
II		2.952	4.154	5.219	3.229
III			2.353	6.394	3.688
IV				2.037	5.545
V					2.659

Table 4 : Genotypes of 24 kalmegh included in different clusters

Cluster number	Number of genotype included	Genotypes
I	7	IKM-10, IKM-11, IKM-12, IKM-13, IKM-17, IKM-18, IKM-19
II	6	IKM-3, IKM-4, IKM-5, IKM-9, IKM-21, IKM-24
III	4	IKM-8, IKM-14, IKM-15, IKM-16
IV	2	IKM-1, IKM-2
V	5	IKM-6, IKM-7, IKM-20, IKM-22, IKM-23

Table 5 : Mean performance of genotype in individual cluster for different yield traits

Clusters	Characters															
	Entries	Days to 50 % flowering	Plant height (cm)	No. secondary branches	No. of tertiary branches	Internode length(cm)	Pod length (cm)	Seed no. pod^{-1}	Leaf length(cm)	Leaf width (cm)	Chlorophyll content	Petiole length (cm)	Canopy temperature	Collar girth	Dry fresh herbage yield(g)	Herbage yield(g)
I	7	150.21	47.93	24	48.14	3.51	2.24	10.71	7.85	2.01	36.31	0.97	30.75	1.56	4.59	13.05
II	6	151.92	65.74	26.42	61.67	3.51	2.52	10.58	8.63	2.33	39.17	0.94	30.09	1.7	6.83	16.03
III	4	160.88	81.71	26.75	74.12	3.12	2.29	11.25	8.26	2.95	35.34	0.87	31.58	1.61	5.4	13.62
IV	2	149	66.57	29.5	131.25	4.2	2.12	10.5	7.9	2.33	38.33	1.03	30.45	2.25	12.27	25.85
V	5	154.4	61.44	26.7	54.9	3.3	2.31	11.3	8.1	2.17	38.76	0.78	30.56	1.44	9.14	22.51

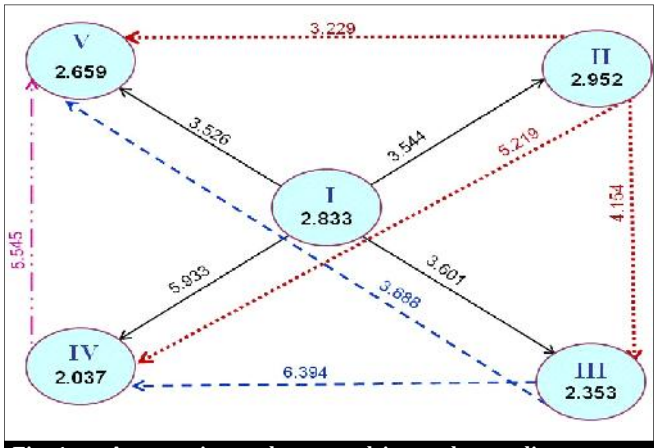

Fig. 1 : Average intra-cluster and inter cluster distance (D values) among the 5 cluster in kalmegh

for dry herbage yield and fresh herbage yield could be considered in *Andrographis paniculata* improvement programme (Table 3,4,5 and 6).

Conclusion :

The experimental materials comprised of 22 kalmegh germlpasm accessions collected from different district of C.G. along with 2 checks in Anand Kalmegh-1 (Directorate of Medicinal and Aromatic Plant Board) and Simmegha (CIMAP). These genotypes were evaluated for genetic diversity in various quantitative characters. High GCV and PCV value were observed for number of tertiary branches (49.72 and 50.10, respectively), dry herbage yield (44.87 and 45.96, respectively) and estimation of heritability and genetic advanced per cent were high for internode length (98.8 and 99.82, respectively) and dry herbage yield (95.3 and 90.24, respectively) in genotypes indicating the predominance of additive gene action for these traits, hence, direct selection may be highly effective. On the basis of divergence and cluster mean it may be suggested that maximum heterosis and good recombinants could be obtained in crosses between cluster II, III, IV and IV in varietal improvement in specific trait with IKM-16 for days to 50 per cent flowering. IKM-5 for plant height, IKM-9 for number for secondary branches, IKM-1 for tertiary branches, IKM-2 for internode length, IKM-24 for pod length, IKM-5 for seed number, IKM-21 for leaf length, IKM-14 for leaf width, IKM- 23 for chlorophyll content, IKM-5 for petiole length, IKM-15 for canopy temperature, IKM-1 for collar girth, IKM- 1 for dry herbage yield and fresh herbage yield could be considered in *Andrographis paniculata* improvement programme.

Table 6 : Desirable genotype for different traits

Sr.No.	Character	Desirable genotype with accession number
1.	Daye to 50% flowering	IKM-15(161.00), IKM-16(167.50), IKM-18(160.50), IKM-19(160.50), IKM-20(160.00), IKM-24(160.50).
2.	Plant height (cm)	IKM-2(71.95), IKM-5(72.50), IKM-9(72.30), IKM-21(70.95).
3.	Number of secondary branches	IKM-1(31.50), IKM-6(30.00), IKM-9(32.50), IKM-14(31.50), IKM-17(30.00), IKM-21(31.50).
4.	Number of tertiary branches	IKM-1(159.50), IKM-2(103.00), IKM-9(124.50), IKM-14(103.50).
5.	Internode length(cm)	IKM-1(4.15), IKM-2(4.25), IKM-13(4.00).
6.	Pod length (cm)	IKM-5(2.55), IKM-6(2.50), IKM-21(2.55), IKM-24(2.70).
7.	Seed number per pod	IKM-5(11.50), IKM-6(11.50), IKM-7(11.50), IKM-8(11.50), IKM-15(11.50), IKM-18(11.50), IKM-20(11.50).
8.	Leaf length (cm)	IKM-2(8.40), IKM-3(8.75), IKM-4(9.10), IKM-8(8.80), IKM-9(8.40), IKM-14(8.55), IKM-17(8.00). IKM-18(8.70), IKM-20(9.00), IKM-21(9.15), IKM-22(8.35), IKM-24(8.70).
9.	Leaf width (cm)	IKM-8(2.50), IKM-9(2.65), IKM-13(2.70), IKM-14(3.20), IKM-15(3.00), IKM-16(3.10).
10.	Chlorophyll content	IKM-9(40.60), IKM-22(41.90), IKM-23(43.45), IKM-24(40.95).
11.	Petiole length(cm)	IKM-5(1.95), IKM-8(1.60), IKM-9(1.60), IKM-13(1.60), IKM-14(1.75), IKM-15(1.55), IKM-16(1.55). IKM-17(1.85), IKM-18(1.70), IKM-19(1.60), IKM-22(8.35), IKM-24(8.70).
12.	Canopy temperature	IKM-1(30.65), IKM-2(30.25), IKM-3(30.65), IKM-5(30.60), IKM-6(30.15), IKM-7(31.60), IKM-8(30.50), IKM-9(30.65), IKM-10(30.60), IKM-13(31.55), IKM-14(31.55), IKM-15(32.25), IKM-16(30.00), IKM-17(30.90), IKM-18(31.75), IKM-19(30.55), IKM-20(30.50), IKM-22(30.60).
13.	Collar girth (g)	IKM-1(2.30), IKM-2(2.20).
14.	Dry herbage yield (g)	IKM-1(13.60), IKM-2(10.65), IKM-7(12.85), IKM-24(12.00).
15.	Fresh herbage yield (g)	IKM-1(30.50), IKM-2(21.20), IKM-7(30.50), IKM-20(25.90), IKM-21(21.60), IKM-23(20.80), IKM-24(22.75).

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