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Genetic variability, heritability and expected genetic gain for dry root yield in ashwagandha [*Withania somnifera* (L.) Dunal]

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ABSTRACT : Forty-six genotypes of ashwagandha were studied in a field experiment under North Gujarat condition. The observation on twelve morphological and biochemical traits were recorded. The analysis of variance indicated presence of considerable amount of variability in the population of genotypes studied. The highest GCV was observed for dry root yield per plant, total alkaloid content, number of primary and secondary branches and number of berries per plant. High heritability along with high genetic advance was observed for dry root yield per plant, total alkaloid content in roots and number of secondary branches. High heritability estimates along with high GA indicates that variation for these characters is due to additive gene effects and consequently the scope is more for improving dry root yield per plant and total alkaloid content through selection.

KEY WORDS : Ashwagandha, GCV, PCV, Heritability, Expected genetic advance

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Ashwagandha [*Withania somnifera* (L.) Dunal] is known with various names in different languages viz. Winter cherry in English, Asgandh in Hindi, Ashwagandha in Sanskrit and Aasod in Gujarati. The habit of the plants under *Withania* varies from herbaceous 30 cm height to under shrub with up to 210 cm height. The species is widely distributed in Africa (extending from the Canary Islands to Cape Province including East and West Tropical Africa) and Asia (Arabian Peninsula, Western Asia; tropical-Indian subcontinent) apart from its occurrence in Europe (Southeastern Europe-Greece and Italy; Southwestern Europe- Spain). In India wild and cultivated form of the species are reported from subtropical and semi-temperate regions but seldom occur in North Eastern parts (Datta *et al.*, 2011). It is extensively cultivated on marginal lands in Manasa, Neemuch and Jawad Tehsils of Mandsaur district of Madhya Pradesh. In Rajasthan, it is grown in Kota and Jhalawar districts (Sharma, 2004 and Anonymous, 1976). The annual demand of dried roots of this plant which increased from 7028 tonnes (2001-02) to 9127 tonnes (2004-05) necessitated the increase in its cultivation and higher production (Kubsad *et al.*, 2009).

This is an ancient medicinal plant with immense therapeutic uses in traditional (Ayurveda, Sidhdha and Unani) and modern system of medicine. Ashwagangha roots are used in ayurvedic and unani medicines. The roots contain withanolids and other alkaloids. The total alkaloids content of the roots varies from 0.16 to 0.66 per cent(Biennial Progress Report, 2006-08). As mentioned in ayurvedic texts including Charak Samhita and Sushrut Samhita, roots are used as general tonic as well as cure for morbidity arising from diseases such as pain, arthritis and inflammation (Dash and Junius, 1983). It acts mainly on the reproductive and nervous systems, having a rejuvenative effect on the body, and is used to improve vitality and aid recovery after chronic illness (Chevallier, 1996).

In India, very few cultivars are developed and a little research work has been done for the genetic improvement of this crop. Assessment of variability in available germplasm is most important as well as first step of any breeding programme. Greater the variability in the genetic material better are the chances of genetic improvement, provided the heritability is high and expected genetic gain under selection is more for the characters under study.

RESEARCH METHODS

Forty six genotypes along with two check entries *viz.*, JA-20 and JA-134 of ashwagandha (Table A) received from different sources were evaluated at the Botanical garden, C.P. College of Agriculture, Sardarkrushinagar, North Gujarat during *Kharif* season of 2011-12. The experiment was laid out in a Randomized Block Design with three replications. Each entry was planted in single rows of 1.0 meter length placed at 45cm apart. Five plants were randomly selected from each genotypes and observations were recorded for dry root yield per plant, plant height, number of berries per plant, number of primary branches, number of secondary branches, root diameter, root length, root branches, days to flowering, days to maturity and seeds per berry. Total alkaloid content was determined as per methodologies suggested by Mishra (1998).

Table A : List of ashwagndha (*Withania somnifera*) genotypes used in the research

Sr. No.	Genotypes	Sr. No.	Genotypes
1.	IC 286632	24.	RAS 23
2.	IC 283662	25.	RAS 15
3.	IC 283942	26.	RAS 33
4.	IC 283966	27.	RAS 67
5.	IC 310595	28.	RAS 11
6.	IC 310620-A	29.	RAS 29
7.	IC 310320-B	30.	RAS 32
8.	MWS 311	31.	RAS 57
9.	MWS 316	32.	RAS 55
10.	MWS 226	33.	RAS 65
11.	MWS 205	34.	MPAS-2
12.	MWS 322	35.	MPAS-3
13.	MWS 302	36	MPAS-4
14.	MWS 201	37.	MPAS-5
15.	MWS 217	38.	MPAS-6
16.	MWS 329	39.	MPAS-7
17.	MWS 309	40.	MPAS-10
18.	MWS 101	41.	MPAS-12
19.	MWS 204	42.	MPAS-15
20.	MWS 208	43.	MPAS-16
21.	RAS 18	44.	K-86
22.	RAS 16	45.	JA-134
23.	RAS 21	46.	JA-20

Analysis of variance in respect of various characters were estimated according to the formula given by Panse and Sukhatme (1978), PCV and GCV were computed based on the methods given by Burton (1952). The co-efficients of variation were categorized as proposed by Sivasubramanian and Madhava Menon (1973). The heritability was computed based on the method given by Allard (1960). Genetic advance and genetic advance as percentage of mean were estimated according to the formula given by Johnson *et al.* (1955).

RESEARCH FINDINGS AND DISCUSSION

Analysis of variance showed significant differences among the genotypes for all the characters studied. The variability parameters are presented in Table 1.

The phenotypic variance was partitioned into its genotypic and environmental components. Genotypic component of variance was higher than environmental component for the characters dry root yield per plant, number of berries per plant, number of primary branches and number of secondary branches, indicating phenotypic variability was a reliable measure of genotypic variability. Therefore, selection would be effective for these characters.

Genotypic co-efficient of variation (GCV) and

Table 1 : Estimates of variability and genetic parameters for twelve characters in ashwagndha

Characters	Dry root yield per plant (g)	Plant height (cm)	No. of berry per plant	No. of primary branches	No. of secondary branches	Root diameter (mm)	Root length (cm)	Root branches	Days to flowering	Days to maturity	Seed per berry	Total Alkaloid content
Mean	1.39	41.09	54.27	2.68	3.19	6.83	15.34	4.04	83.54	159.78	29.40	0.39
Range	0.62-	28.13-	30.67-	1.8-	1.47-	4.84-	11.21-	2.33-	77.67–	145.33-	22.07-	0.15-
	3.17	5.47	79.73	5.4	4.87	10.33	19.67	5.50	89.00	179.33	36.20	0.58
σ^2g	0.21	15.08	146.10	0.29	0.55	0.55	1.09	0.21	3.20	18.69	5.92	0.01
σ^2p	0.27	71.77	249.07	0.51	0.86	2.00	6.55	0.81	21.30	80.70	12.22	0.02
σ^2e	0.07	56.69	102.98	0.22	0.30	1.45	5.46	0.60	18.10	62.02	6.31	0.01
GCV (%)	32.62	9.45	22.27	19.94	23.35	10.91	6.80	11.21	2.14	2.71	8.27	26.40
PCV (%)	37.63	20.62	29.08	26.49	29.04	20.71	16.69	22.20	5.52	5.62	11.89	31.69
H^2	75.11	21.01	58.66	56.66	64.63	27.73	16.62	25.50	15.03	23.15	48.42	69.39
GA (% mean)	58.27	8.93	35.14	30.97	38.56	11.86	5.74	11.63	1.71	2.68	11.87	46.15
S.E. $\pm$	0.15	4.35	5.86	0.27	0.32	0.69	1.35	0.45	2.46	4.55	1.45	0.04
C.D. (P=0.05)	0.42	12.23	16.49	0.76	0.89	1.95	3.80	1.26	6.91	12.80	4.08	0.11
C.V.%	18.77	18.32	18.70	17.44	17.27	17.61	15.24	19.16	5.09	4.93	8.54	17.53

phenotypic co-efficient of variation (PCV) were computed to compare variability of various traits. The high GCV was observed for dry root yield per plant, total alkaloid content, number of secondary branches and number of berries per plant.

High heritability coupled with high expected genetic advance in percentage of mean (GA%) was observed for dry root yield per plant, total alkaloid content and number of secondary branches this result suggested that further improvement through individual plant selection would be effective. It indicated that these characters are governed by additive genes. Similar result was obtained by Dubey (2010) for dry root yield per plant and Das *et al.* (2011) for total alkaloid content. Thus, the substantial contribution of additives genetic variance in the expression of these traits is evident and, therefore, these traits could be improved through individual plant selection.

The characters such as dry root yield per plant, total alkaloid content, number of secondary branches, number of berries per plant and number of primary branches exhibited high GCV (%), heritability as well as genetic advance and hence, these characters being governed by additive gene action. The phenotypic selection which make use of additive genetic variance would be effective for genetic improvement of these traits (Poneleit and Bauman, 1970). Alternate systems like biparental mating (Moll and Robinson, 1967), crossing of selected sibs in early generation (Andrus, 1963) and diallel selective mating system (Jensen, 1970) followed by selection of individual plants may be adopted to improve the root yield in this species.

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