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Research Article

Prediction of Morpho-Genetic Variability at Intra-Specific Level and Elite Line Selection in Black Henbane (*Hyoscyamus niger* L.)

Renu Yadav[1]* and Raj Kishori Lal[1] and M M Gupta[2]

[1]Department of Genetics and Plant Breeding, Central Institute of Medicinal and Aromatic Plants, P.O. CIMAP, Lucknow, Uttar Pradesh, India

[2]Department of Chemistry, Central Institute of Medicinal and Aromatic Plants, P.O. CIMAP, Lucknow, Uttar Pradesh, India

***Corresponding Author:** Renu Yadav, Department of Genetics and Plant Breeding, CSIR - Central Institute of Medicinal and Aromatic Plants, P.O. CIMAP, Lucknow, Uttar Pradesh, India.

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Abstract

The nature and amount of genetic variability, associations, co-heritability, and path coefficients were studied in the eleven qualitative and quantitative traits in twenty-nine genotypes of *Hyoscyamus niger.* The highest genotypic and phenotypic coefficient of variations was recorded for total crude tropane alkaloids (77.77) followed by hyoscine content (49.42) and hyoscyamine (32.313) content in percent and lowest for days to maturity. Total crude tropane alkaloids ((h^2_{bs}) = 92.94%, GA = 149.24%) showed high heritability in broad sense, as well as high genetic advance over mean in percent. Plant height, inflorescence length, total crude tropane alkaloids and hyoscyamine content were highly significantly and positively correlated hyoscine content at both genotypic and phenotypic level while, plant height was significantly negatively correlated with number of primary branches/plant. Fresh herb yield (g/plant) exhibited high co-heritability with inflorescence length and hence it may form a good selection criterion for valuable economic traits. The path coefficient under study revealed that the highest direct contribution to total crude tropane alkaloids was made by plant height (0.994) followed by hyoscyamine content (0.420) and number of branches/plant (0.393) in percent.

Keywords: Co-Heritability; Genetic Stocks; Direct Contributions; Heritability; Path Coefficient

Introduction

Black henbane (*Hyoscyamus niger* L.) also known as Khurassani ajwain was classified by [1], belongs to the solanaceae family, having diploid chromosome 2n = 34 [2]. *Hyoscyamus* niger contains pharmaceutically important narcotic alkaloids hyoscyamine, scopolamine and atropine extracted mainly from its whole aerial herb including dried leaves and flowering tops, used in folk, traditional and modern medicinal preparations in pharmaceutical industries in India and world [3]. The alkaloid content of the leaves increases with maturity and reaches the maximum at the time of flowering after which it decreases. Unripe fruits contain more alkaloids than ripe ones. Global trade of medicinal plants are more than a hundred billion dollars per year and annual growth rate is about 8 - 15% [4]. Synthetic productions of these alkaloids are difficult and global demand for scopolamine is tenfold higher than hyoscyamine [5].

The demand for tropane alkaloids in the international scenario is valued at US $ 100 million. Scopolamine (d-hyoscine), an important alkaloid of *Hyoscyamus niger,* acts similar to atropine as competitive antagonists of peripheral and central muscarinic cholinergic receptors [6]. Hyoscyamine and Scopolamine are widely used in medicine for their mydriatic, anticholinergic, antispasmodic, analgesic and sedative properties [7]. It is also applied as a premedication for anaesthesia for bronchial secretions reduction and blocking bradycardia accompanied by some anaesthetic drugs [8]. Hyoscyamine and hyoscine are used to treat motion sickness, stomach and intestinal such as irritable bowel syndrome, cramps, and Parkinson's disease. In first century A.D., Dioscorides had applied Black henbane for treatment of sleeplessness and pain [9].

Genetic variability, heritability, and genetic advance are efficient selection practices for improvement of economic traits to predict gain from selection and to establish the relative importance of genetic effect. Currently, there is apparent lack of improved varieties of *Hyoscyamus niger* to make its cultivation more profitable. As varietal development depends upon existing and/or induced genetic variability, we examined genetic variation for different traits for a number of genotypes/accessions in order to understand genotypic association and contribution of various yield components with total crude tropane alkaloids content for crop improvement.

Material and Methods

Planting material and edapho-climatic conditions of experimental location

The seeds of 29 diverse accessions of *Hyoscyamus niger* collected from different places of India and abroad were included in this study (Table 1). All the accessions were grown in the randomized block design (RBD) with three replications during the first week of November and harvested at the end of April, were evaluated for the two consecutive years 2013 - 2014 and 2014 - 2015 at the research farm of the CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow (128m above MSL altitude, 26'8'N latitude and 80.9 E longitude). The temperature fluctuation is recorded 42ºC to 4ºC with an average temperature of 30ºC.

Experimental design and agricultural practices

The field experiment was carried out by employing good agricultural practices. The experiment was framed in the randomized block design (RBD) on well-drained soil, with three replications. Each treatment consisted of single row 5.00m long and 1.50m apart (The plant to plant distance was maintained = 60 cm). All the treatments in the experiment were received normal intercultural operations and irrigations. Since the nutrient requirement of the crop is high, 100 kg of N_2O h^{-1}, 85 kg of P_2O_5 h^{-1} and 80 kg of K_2O h^{-1} was applied during field preparation (as basal and top dressing). All the agronomical practices were adopted during the entire cropping season to ensure the good crop.

Extraction of total crude tropane alkaloids, hyoscyamine and hyoscine

Total crude tropane alkaloids, hyoscyamine, and hyoscine were determined in each sample by the HPLC procedure. For extraction of the crude drug, hyoscyamine and hyoscine, fresh biomass of three randomly chosen plants at the full flowering stage in each material was properly chopped into small pieces and shade dried. After complete drying, samples were finely powdered for alkaloid extraction. The crude drug, hyoscyamine and hyoscine (alkaloid content) analysis were carried out by the procedure as described by [10,11].

Sr. no.	Accession code	Origin/Places of collections
1.	HN -1	CSIR-CIMAP, Lucknow, U.P. (India)
2.	HN -2	Jammu, Jammu and Kashmir, (India)
3.	HN -3	Kashmir, Jammu and Kashmir, (India)
4.	HN -4	Local, Lucknow, U.P. (India)
5.	HN -5	CSIR-CIMAP, Lucknow, U.P. (India)
6.	HN -6	Chamoli, Uttarakhand, (India)
7.	HN -7	Bageshwar, Uttarakhand, (India)
8.	HN -8	Lucknow, U.P., (India)
9.	HN -9	Lucknow, U.P., (India)
10.	HN -10	CSIR-CIMAP, Lucknow, U.P., (India)
11.	HN -11	CSIR-CIMAP, Lucknow, U.P., (India)
12.	HN -12	CSIR-CIMAP, Lucknow, U.P., (India)
13.	HN -13	Kosesse, sitovalvia republic
14.	HN -14	Katra, Jammu and Kashmir, (India)
15.	HN -15	CIMAP, Lucknow, U.P., (India)
16.	HN -16	Palampur, Himachal Pradesh, (India)
17.	HN -17	U.S.A.
18.	HN -18	Pantnagar, Uttarakhand, (India)
19.	HN -19	Austria
20.	HN -20	Austria
21.	HN -21	Yugoslavia
22.	HN -22	Poland
23.	HN -22-Y	Poland
24.	HN -28	Germany
25.	HN -28-A	CSIR-CIMAP, Lucknow, (India)
26.	HN -29	Poland
27.	HN -29-Y	Germany
28.	HN -30	CSIR-CIMAP Lucknow, (India)
29.	HN -31	CSIR-CIMAP Lucknow, (India)

Table 1: Geographical distribution of twenty nine genetic stocks/ their codes and origin of *Hyoscyamus niger L.*

Statistical analysis

The triplicate data obtained from the all observed parameters was subjected to the statistical analysis. Variance component method was applied to estimate variability, heritability in broad sense and genetic advance of yield and yield related attributes. The mean and ANOVA was analyzed based on the formula [12,13] applicable to randomized block design [14]. The genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV) and genetic advance (GA) were computed according to [15] and path coefficient analysis as per [16,17]. Heritability in broad sense was estimated as the ratio of genotypic to phenotypic variance and expressed in % [18]. The genetic advance was estimated as per [17,19].

Results and Discussion

Analysis of variance among the pooled mean of accessions (29 diverse collections for the eleven morpho- economic traits in the two consecutive years of *Hyoscyamus niger*) was highly significant ($p < 0.05$) for all the eleven traits examined denoting a considerable amount of genetic variability for each trait. The relative values in respect of GCV, PCV, heritability on broad sense (h┴^2) and GA are shown in the table (Table 2) representing important information on the extent of variation. High genotypic variability facilitates selection for improvement and widens the possibility of heritability of characters from parent to offspring. Correlation and Path coefficient study revealed that the highest direct contribution to total crude tropane alkaloids content was made by the plant height and hyoscyamine content followed by number of primary branches, dry herb yield (g/plant) and inflorescence length (cm). The direct contribution of other traits to total crude tropane alkaloids content was negative, but their indirect contribution was invariably large via plant height and number of primary branches/plant. These are also reinforced by high values of co-heritability (Tables 3). Broad-sense heritability (ĥ2bs %) and the genetic advance over mean in percent (GA) were relatively high for total crude tropane alkaloids and hyoscine content (Table 2). Thus, two traits should be very amenable to selection. Selection should be successful because variation among accessions for these two traits was relatively high as revealed by genotypic (GCV) and phenotypic (PCV) coefficients of variations. In addition to heritability in broad sense (ĥ2bs) and genetic advance over mean in percent (GA), the genotypic and phenotypic correlations among traits also have a direct bearing on success of selection. The genotypic correlations were large than phenotypic correlations for almost all traits examined (Table 3).

Maximum GCV incorporated with highest heritability for total crude tropane alkaloids content followed by moderate GCV and heritability for hyoscine and hyoscyamine content may provide good amount of advance to be expected from the selection. The lowest GCV and PCV values indicate poor improvement for the traits through selection. In the present study, in most of the traits GCV was near to PCV (Table 2), indicating a highly significant effect of genotype on phenotypic expression with little effect of environment.

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Notwithstanding, the choice of most economic traits the high heritability in broad sense ($\hat{h}^2_{(bs)}$%) and genetic advance over mean in percent were observed for the total crude tropane alkaloids ($\hat{h}^2_{(bs)}$ = 92.94% and GA over mean = 149.24%) followed by medium heritability in broad sense ($\hat{h}^2_{(bs)}$) and GA over mean – hyoscine content (($\hat{h}^2_{(bs)}$ = 64.82% and 37.88%). However, medium heritability in broad sense ($\hat{h}^2_{(bs)}$) were for the characters number of branches/plant ($\hat{h}^2_{(bs)}$ = 74.66%) and days to 50% flowering ($\hat{h}^2_{(bs)}$ = 67.40%) were also observed. Hence, these characters may be used as better selection criterion for genetic improvement of total crude tropane alkaloids content in *H. niger*. Other characters studied low heritability with low genetic advance over mean. Selection of these characters was not easy.

Inter relationships between different characters are due to the occurrence of linked and epistatic effect of various genes. The genotypic (r_g) and phenotypic (r_p) correlation coefficients between quantitative and qualitative traits in *Hyoscyamus niger* are presented in the (Table 3). A deeply perusal of results indicated that the genotypic correlations were large than phenotypic correlations for all the traits except two traits - days to 50% flowering with hyoscine content and number of primary branches/plant with total crude tropane alkaloids, respectively examined (Table 3). Genotypic (r_g) and phenotypic (r_p) correlation coefficients among the eleven traits revealed that plant height, inflorescence length, crude tropane alkaloids and hyoscyamine was highly significant and positively correlated with hyoscine content in percent at both genotypic and phenotypic level of significance. The total crude tropane alkaloids (%) were also highly significantly positively correlated with hyoscyamine content at both genotypic and phenotypic level. Hence, these traits were found to be good criteria for selection. The trait plant height was highly significant and negatively correlated with number of branches/plant whereas, number of branches/plant was highly significant and negatively correlated with hyoscine content at both genotypic and phenotypic level. Other traits were weakly correlated with each other (Table 3).

Parameters and traits	Days to 50% flowering	Plant height (cm)	Number of branches/ plant	Inflorescence length (cm)	Days to maturity (days)	Fresh herb yield (g/plant)	Dry herb yield (g/ plant)	Seed yield (g/ plot)	Total crude tropane alkaloids (%)	Hyoscyamine (%)	Hyoscine (%)
GEN variation $\hat{\sigma}^2_g$	8.691	152.708	1.559	76.307	8.481	12362.67	103.859	27.430	0.0087	0.00036	0.00028
PHE variation $\hat{\sigma}^2_p$	12.895	348.566	2.088	152.915	20.186	27797.31	328.473	214.109	0.0094	0.00082	0.00043
GCV	3.879	7.419	17.280	9.247	2.038	21.623	18.261	19.383	77.77	32.313	49.419
PCV	4.725	11.209	20.00	13.090	3.145	32.424	32.475	54.153	80.67	48.481	61.380
GA	4.093	11.153	1.920	8.98	2.520	101.867	6.638	1.382	0.179	0.0175	0.02236
Mean	76.01	166.50	7.23	94.47	142.77	514.20	55.83	27.02	0.12	0.034	0.059
G.A. over mean (%)	5.39	6.70	26.57	9.51	1.77	19.81	11.89	5.11	149.24	51.65	37.88
Heritability $\hat{h}^2_{(bs)}$ %	67.40	43.81	74.66	49.90	40.01	44.47	31.62	12.81	92.94	44.42	64.82

Table 2: Estimates of elite genetic parameters of eleven different traits of Hyoscyamus niger accessions.

Where, $\hat{\sigma}^2_g$, $\hat{\sigma}^2_p$ - genotypic and phenotypic variance; GCV and PCV = Genotypic and phenotypic coefficient of variance; $\hat{h}^2_{(bs)}$ % = Heritability in broad sense in percent; GA = Genetic advance over mean in percent.

Traits		Days to 50% flowering	Plant height (cm)	Number of branches/ plant	Inflores-cence length (cm)	Days to maturity (days)	Fresh herb yield (g/ plant)	Dry herb yield (g/ plant)	Seed yield (g/ plant)	Total crude tropane alkaloids (%)	Hyoscyamine (%)	Hyoscine (%)
Days to 50% flowering	r_g r_p	--	0.112 0.0937	0.0666 0.0268	0.236 0.0584	0.313 0.166	0.530** 0.254	0.405* 0.0631	-0.163 -0.0513	-0.206 -0.165	-0.220 -0.123	0.020 0.083
Plant height (cm)	r_e co-Her$_{(bs)}$	0.0767 0.650	--	-0.923** -0.569**	0.516** 0.303	0.096 0.061	-0.063 -0.007	0.131 0.051	-0.548** -0.102	0.716** 0.390*	0.554** 0.313	0.882** 0.541**
Number of branches/plant	r_e co-Her$_{(bs)}$	0.258 -1.761	-0.110 0.927	--	-0.507** -0.267	0.015 -0.071	0.329 0.173	0.302 0.0683	0.638** 0.248	-0.582** -0.361	-0.386* -0.228	-0.766** -0.629**
Inflorescence length (cm)	r_e co-Her$_{(bs)}$	-0.193 2.339	0.117 0.795	0.120 1.160	–	-0.711** -0.169	-0.217 -0.0137	0.170 0.059	-0.800** -0.255	0.731** 0.366*	0.706** 0.352	0.734** 0.528**
Days to maturity (days)	r_e co-Her$_{(bs)}$	-0.003 1.007	0.035 0.673	-0.207 -0.114	0.290 1.926	–	0.364* 0.263	0.0895 -0.024	0.111 0.068	-0.0284 -0.0764	-0.0597 -0.163	-0.139 -0.083
Fresh herb yield (g/plant)	r_e co-Her$_{(bs)}$	-0.0846 1.142	0.0624 4.072	-0.043 1.093	0.168 7.453	0.185 0.599	–	0.995** 0.553	0.681** 0.0764	-0.0787 0.0072	-0.281 -0.048	-0.033 -0.013
Dry herb yield (g/plant)	r_e co-Her$_{(bs)}$	-0.262 2.963	0.004 0.957	-0.188 2.149	-0.014 1.138	-0.090 -1.364	0.265 0.705	–	0.997** 0.072	0.238 0.095	-0.042 -0.0143	0.268 0.133
Seed yield (g/ plot)	r_e co-Her$_{(bs)}$	-0.007 0.932	0.004 1.274	0.107 0.797	-0.079 0.794	0.059 0.383	-0.24 2.125	-0.249 3.686	–	-0.534** -0.0412	-0.464** -0.222	-0.512** -0.190
Total crude tropane alkaloids (%)	r_e co-Her$_{(bs)}$	-0.0847 0.826	0.020 0.978	0.144 1.120	-0.117 1.134	-0.136 0.194	0.112 -5.880	-0.026 1.135	0.204 3.750	–	0.989** 0.553**	0.778** 0.609**
Hyoscyamine (%)	r_e co-Her$_{(bs)}$	-0.0066 0.977	0.122 0.782	-0.015 0.975	0.037 0.945	-0.241 0.159	0.139 2.607	0.0022 1.096	-0.159 0.500	0.0165 0.987	–	0.714** 0.478**
Hyoscine (%)	r_e co-Her$_{(bs)}$	0.0527 -0.084	-0.113 1.042	0.068 1.014	0.153 0.946	0.0215 1.053	0.0430 1.671	-0.055 1.090	-0.055 0.928	0.0291 0.993	0.0977 0.960	–

Table 3: Genotypic (r_g), Phenotypic (r_p) and environmental correlation (r_e) and Co-heritability in broad sense (CO-$H_{(bs)}$) among eleven traits of Hyoscyamus niger accessions. Genotypic correlation = Upper values above diagonal; Phenotypic correlation = Lower values above diagonal; Environmental correlation = Upper values below diagonal; Co -heritability in broad sense = Lower values below diagonal. *, ** = $p < 0.05$ and $p < 0.01$, respectively.

Nevertheless, it is well known that correlation analysis can estimate only the degree of association between two traits, while, path coefficient analysis has been utilized to examine the comparative strength of direct and indirect relationship among dependent and independent variables for efficient selection in plant breeding programmes (Kumar., *et al.* 2014). The path coefficient under study revealed that the highest direct contribution to total crude tropane alkaloids was made by plant height at full maturity (0.994) followed by hyoscyamine content (0.420), number of primary branches/plant (0.393), dry herb yield/plant (0.113), inflorescence length (0.085) and days to 50% flowering (0.0613). Direct contribution of other four traits namely, seed yield (-0.018), fresh herb yield/plant (-0.199), days to maturity (-0.136) and hyoscine content (-0.227) was negative but their indirect contribution was invariably large via number of branches (0.251); (0.129), plant height (0.095); (0.551), respectively although residual effect was 0.3547 (Table 4, Figure 1). These traits were also reinforced by high values of co-heritability (Table 3). Since higher co-heritability value of a character contribution suggests that the increases in one of the characters of those contributions will be coupled in the increasing trend in its co-heritable character [20-24].

S. No.	Path ways of associations	Direct effects (P)	Indirect effects (P×r)	Correlations (r_g) total crude tropane alkaloids
1.	Days to 50% flowering			
	(a) **Direct effect**	**0.0613**		
	(b) Indirect effect via			
	Plant height (cm)		0.111	
	Number of branches/plant		0.026	
	Inflorescence length (cm)		0.020	
	Days to maturity (days)		-0.043	
	Fresh herb yield (g/plant)		-0.106	
	Dry herb yield (g/plant)		0.046	
	Seed yield (g/plot)		0.001	
	Hyoscyamine (%)		-0.086	
	Hyoscine (%)		0.050	
	Total effect			0.083
2.	Plant height (cm)			
	(a) **Direct effect**	**0.994**		
	(b) Indirect effect via			
	Days to 50% flowering		0.007	
	Number of branches/plant		-0.362	
	Inflorescence length (cm)		0.0438	
	Days to maturity (days)		-0.013	
	Fresh herb yield (g/plant)		0.013	
	Dry herb yield (g/plant)		0.015	
	Seed yield (g/plot)		0.0096	
	Hyoscyamine (%)		0.301	
	Hyoscine (%)		-0.1255	
	Total effect			0.882
3.	Number of branches/plant			
	(a) **Direct effect**	**0.393**		
	(b) Indirect effect via			
	Days to 50% flowering		0.004	

	Plant height (cm)		-0.917	
	Inflorescence length (cm)		-0.0436	
	Days to maturity (days)		-0.002	
	Fresh herb yield (g/plant)		-0.066	
	Dry herb yield (g/plant)		0.034	
	Seed yield (g/plot)		-0.0112	
	Hyoscyamine (%)		-0.244	
	Hyoscine (%)		0.087	
	Total effect			-0.765
4.	Inflorescence length (cm)			
	(a) **Direct effect**	**0.085**		
	(b) Indirect effect via			
	Days to 50% flowering		0.014	
	Plant height (cm)		0.513	
	Number of branches/plant		-0.199	
	Days to maturity (days)		0.097	
	Fresh herb yield (g/plant)		0.0432	
	Dry herb yield (g/plant)		0.0191	
	Seed yield (g/plot)		0.014	
	Hyoscyamine (%)		0.307	
	Hyoscine (%)		-0.16	
	Total effect			0.734
5.	Days to maturity (days)			
	(a) **Direct effect**	**-0.136**		
	(b) Indirect effect via			
	Days to 50% flowering		0.019	
	Plant height (cm)		0.095	
	Number of branches/plant		0.006	
	Inflorescence length (cm)		-0.060	
	Fresh herb yield (g/plant)		-0.0725	
	Dry herb yield (g/plant)		0.010	
	Seed yield (g/plot)		-0.002	
	Hyoscyamine (%)		-0.012	
	Hyoscine (%)		0.01352	
	Total effect			-0.139
6.	Fresh herb yield (g)			
	(a) **Direct effect**	**-0.199**		
	(b) Indirect effect via			
	Days to 50% flowering		0.033	
	Plant height (cm)		-0.063	
	Number of branches/plant		0.129	
	Inflorescence length (cm)		-0.018	
	Days to maturity (days)		-0.049	

	Dry herb yield (g)		0.117	
	Seed yield (g/plot)		-0.012	
	Hyoscyamine (%)		-0.033	
	Hyoscine (%)		0.064	
	Total effect			-0.033
7.	Dry herb yield (g/plant)			
	(a) **Direct effect**	**0.113**		
	(b) Indirect effect via			
	Days to 50% flowering		0.025	
	Plant height (cm)		0.130	
	Number of branches/plant		0.119	
	Inflorescence length (cm)		0.014	
	Days to maturity (days)		-0.0121	
	Fresh herb yield (g/plant)		-0.207	
	Seed yield (g/plot)		-0.023	
	Hyoscyamine (%)		0.100	
	Hyoscine (%)		0.00948	
	Total effect			0.268
8.	Seed yield (g/plot)			
	(a) **Direct effect**	**-0.018**		
	(b) Indirect effect via			
	Days to 50% flowering		-0.010	
	Plant height (cm)		-0.544	
	Number of branches/plant		0.251	
	Inflorescence length (cm)		-0.068	
	Days to maturity (days)		-0.0152	
	Fresh herb yield (g/plant)		-0.1356	
	Dry herb yield (g/plant))		0.148	
	Hyoscyamine (%)		-0.225	
	Hyoscine (%)		0.105	
	Total effect			-0.512
9.	Hyoscyamine			
	(a) **Direct effect**	**0.420**		
	(b) Indirect effect via			
	Days to 50% flowering		-0.013	
	Plant height (cm)		0.712	
	Number of branches/plant		-0.228	
	Inflorescence length (cm)		0.062	
	Days to maturity (days)		0.0039	
	Fresh herb yield (g/plant)		0.01568	
	Dry herb yield (g/plant)		0.027	
	Seed yield (g/plot)		0.009	
	Hyoscine (%)		-0.230	

	Total effect			0.778
10.	Hyoscine			
	(a) **Direct effect**	**-0.227**		
	(b) Indirect effect via			
	Days to 50% flowering		-0.014	
	Plant height (cm)		0.551	
	Number of branches/plant		-0.152	
	Inflorescence length (cm)		0.060	
	Days to maturity (days)		0.0081	
	Fresh herb yield (g/plant))		0.0559	
	Dry herb yield (g/plant))		-0.0047	
	Seed yield (g/plot)		0.008	
	Hyoscyamine (%)		0.427	
	Total effect			0.714
Residual effects (R) = 0.3546776				

Table 4: Direct (bold) and Indirect effects in details for different yield traits on total crude tropane alkaloids of Hyoscyamus niger accessions.

Figure 1: Path diagram of eleven morpho- metric traits in Hyoscyamus niger L. genetic stocks.

Figure 2: Extreme diversity in Hyoscyamus niger L. accessions.

Conclusion

Hyoscyamus niger is grown for the extraction of pharmaceutically valuable tropane alkaloids, mainly hyoscyamine and hyoscine. This study may be an imperative initiative for many agro-environments and that there is possibility for breeders and farmers to ameliorate the cultivation dry herb yield and alkaloids yield of this crop. The logic of present investigation could be extended to develop strategies for enhancement of tropane alkaloids yield in *Hyoscyamus niger* and would be ameliorated by an understanding of how agro-morphic traits interact with each other in affecting the alkaloid yield. The traits having positive direct effects on total crude tropane alkaloids are considered to be suitable selection criteria for evolving high yielding genotypes. Analyses for important traits like showed high GCV and PCV values for total crude tropane alkaloids (77.77) followed by hyoscine content (49.42) and hyoscyamine (32.313) content in percent and significant positive correlation from low to high degree of broad sense heritability, genetic advance and positive direct effect on oil yield. Thus, proper attention should be given to these most preferred characters of interest in selection programmes for genetic gain in the *Hyoscyamus niger* genotypes for the improvement of alkaloids yield.

Highlights

- *Hyoscyamus niger* is pharmaceutically valued for hyscyamine and hyoscine.
- The nature and amount of genetic variability, associations, co-heritability, and path coefficients were studied.
- High GCV and PCV values for total crude tropane alkaloids, hyoscine and hyoscyamine content.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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Volume 2 Issue 9 September 2018