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Short Communication

Inheritance of stigma colour and branching habit in sunflower accession from North West Himalayas

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Primitive forms of crop species occurring or maintained in remote human settlements as ornamentals or for non-commercial purposes often possess traits that either are *per se* desirable or supportive as linked markers for other desirable trait(s). Recessive branching, for example, is essentially desired in sunflower restorer lines and pigmentation is reported to be linked to fertility [1]. The expression and inheritance of these traits in the primitive forms is quite often not the same as exhibited by their domesticated counterparts. Understanding these patterns, therefore, becomes imperative to formulate breeding strategies for their transfer to domesticated forms.

The accession (W-Kainchi) of sunflower (*Helianthus annuus* L.) collected from a near-uniform population at a village near Kainchi in Nainital (Uttarakhand) was observed by selfing one generation to ensure stability of the traits intended for study. The accession distinguished by its deeply pigmented stigma, profuse branching and tallness (over 3 m) was found uniform with respect to fertility, stigma pigmentation and branching habit, though it did exhibit little variation for plant height and days to maturity. APSH-11A, sharply contrasting (male sterile, uniform yellow stigma, unbranched) for the traits under study was chosen as the female parent to obtain unambiguous results. Observations were recorded on F_1 progenies which were selfed to obtain F_2 seed. The F_2 population individuals were grouped into different phenotypic classes and 'goodness of fit' tested on them using Chi-square test as per the standard procedure.

All the three F_1 plants of the cross between APSH-11A and W-Kainchi exhibited purple stigma and branching. The presence of purple stigma and branching in all three F_1 plants suggests that purple stigma colour is dominant over yellow colour and branching is dominant over non-branching. Similar observations have been reported for stigma colour [2, 3, 4, 5] and branching [6]. The designations Ps (for purple stigma) and ps (for yellow stigma) have been suggested, while designations proposed in a previous study [7] have been used for branching (Br) and non-branching (br).

In F_2, of the 36 plants scored for stigma colour, 27 were observed to have purple stigma and 9 yellow stigma (Table 1). The observed data showed good fit into 3:1 ratio for purple and yellow stigma, indicating monogenic inheritance with dominance of purple stigma colour. The dominant state (PsPs or Psps) conditions purple stigma colour, while yellow stigma colour is conditioned by homozygous recessive state of the two alleles (psps). Governance of stigma colour by single pair of alleles [3, 4], by four pairs of factors [5] and by three independent genes with cumulative effects has also been reported [2]. With respect to branching, 24 plants were found to be branched and branching was absent in 12 (Table 1). For this trait too, the observed ratio of branched and unbranched plants was statistically consistent with the expected ratio of 3:1 as suggested by a P-value of 0.50-0.30 considering one gene two alleles system. Monogenic inheritance of branching in most of the lines where BrBr and Brbr genotypes are branched and brbr genotypes are unbranched and expression of dominance of non-branching over branching in line 953-88-3 has also been observed [6]. Branching is also reported to be under recessive control [7]. Other studies suggest conditioning of the traits by

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Table 1. Segregation pattern for stigma colour and branching habit in sunflower cross APSH-11A x W-Kainchi

Parent/cross	Observed ratio				Genotype/ expected ratio		Chi-square		P-value	
	Stigma colour		Branching habit							
	Purple	Yellow	Branched	Unbranched	Stigma colour	Branching habit	Stigma colour	Branching habit	Stigma colour	Branching habit
APSH-11A (P_1)	-	10	-	10	Yellow	All branched	-	-	-	-
W-Kainchi (P_2)	10	-	10	-	Yellow	All branched	-	-	-	-
APSH-11A x W-Kainchi (F_1)	3	-	3	-	Purple	All branched	-	-	-	-
APSH-11A x W-Kainchi (F_2)	27	9	24	12	3: 1	3 : 1	0.036	0.925	0.90-0.70	0.50-0.30

four genes, two of which conditioned branching only when present in homozygous state [8] and by two alleles (*Ww* and *Tc*) at two loci [9].

When scored jointly for stigma colour and branching, 18 plants were found to possess both purple stigma and branching, 9 had purple stigma but were unbranched, 6 had yellow stigma with branching absent and the remaining 3 plants had yellow stigma and no branching (Table 2). Assuming a digenic model, the results were found to statistically fit into 9:3:3:1 ratio for purple stigma and branching, purple stigma and non-branching, yellow stigma and branching, and yellow stigma and non-branching classes. A collective analysis of the results suggest the possible genotypes of the male and female parent with respect to the two traits considering two allele system as :

Female parent (APSH-11 A) : *pspsbrbr* (yellow stigma, unbranched)

Male parent (W-Kainchi) : *PsPsBrBr* (purple stigma, branched).

Table 2. Joint segregation pattern for stigma colour and branching habit in sunflower cross APSH-11A x W-Kainchi

Parent/cross	Observed segregation				Genotype/ expected ratio	Chi-square	P-value
	Purple + branched	Purple + unranched	Yellow + branched	Yellow + unbranched			
APSH-11A (P_1)	-	-	-	10	All branched	-	-
W-Kainchi (P_2)	10	-	-	-	All branched	-	-
APSH-11A x W-Kainchi (F_1)	3	-	3	-	All branched	-	-
APSH-11A x W-Kainchi (F_2)	18	9	6	3	9:3:3:1	0.925	0.50-0.30

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