SELECTION OF POLYVOLTINE BREEDS AND POLYVOLTINE × BIVOLTINE HYBRIDS OF THE SILKWORM, *BOMBYX MORI* L.

Ravindra Singh* and D. Gangopadhyay**

*Silkworm Seed Technology Laboratory, Kodathi, Bangalore - 560 035, Karnataka, INDIA.
**National Institute of Science Technology & Development Studies, New Delhi - 110012, INDIA.

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ABSTRACT: Identification of promising silkworm breeds and polyvoltine × bivoltine hybrids was carried out utilizing three statistical tools *viz.,* multiple traits evaluation indices, combining ability and hybrid vigour. Out of four polyvoltine silkworm breeds, DNP_1 was found promising based on its performance and multiple traits evaluation indices exhibiting maximum values for seven characters v*iz.,* pupation rate, cocoon yield/10,000 larvae by weight, cocoon shell weight, cocoon shell %, filament length, raw silk percentage and neatness followed by DNP_3 which exhibited higher values for three characters *viz.*, fecundity, cocoon weight and reelability. DNP_1 exhibited maximum general combining ability (GCA) effects for five characters *viz.*, pupation rate, cocoon shell weight, cocoon shell %, raw silk % and neatness. Out of sixteen polyvoltine × bivoltine hybrids, DNP_1 × CSR_2 recorded maximum values for four characters *viz.*, cocoon shell weight, cocoon shell %, raw silk % and neatness analyzed through their rearing performance and evaluation indices followed by DNP_3 × CSR_{17} which exhibited maximum values for three characters namely, cocoon yield/10,000 larvae by weight, cocoon weight and reelability. DNP_4 × CSR_4 expressed maximum specific combining ability (SCA) effects for three characters namely, cocoon yield/10,000 larvae by weight, reelability and raw silk % whereas DNP_2 × CSR_4 manifested higher hybrid vigour for three characters *viz.*, pupation rate, reelability and neatness.

KEY WORDS: *Bombyx mori,* hybrid vigour, combining ability, multiple traits evaluation indices, rearing performance, polyvoltine silkworm breeds / hybrids.

Cumulative effects of several characters have been employed in silkworm breeding for the identification of promising silkworm breeds as well as hybrids (Narayanaswamy et al., 2002). Several attempts have been made to select silkworm breeds / hybrids on the basis of multiple traits evaluation indices (Vidyunmala et al., 1998; Ramesh Babu et al., 2002; Kariappa & Rajan, 2005; Gangopadhyay et al., 2006; Choudhary & Singh, 2006a; Rao et al., 2006; Nirupama et al., 2008a,b) and through analysis of combining ability and hybrid vigour (Datta et al., 2001; Choudhary & Singh, 2006b; Ravindra Singh et al., 2000, 2001, 2010). Of late, polyvoltine silkworm breeds and polyvoltine × bivoltine hybrids (Singh & Nirupama, 2012) and bivoltine silkworm breeds and hybrids (Singh & Gangopadhyay, 2013) have been short listed through various statistical tools. The present study has been undertaken to identify promising polyvoltine breeds and polyvoltine × bivoltine hybrids based on their rearing performance as well as through different statistical methods.

MATERIALS AND METHODS

Four polyvoltine silkworm breeds namely, DNP_1, DNP_2, DNP_3 and DNP_4 and sixteen polyvoltine × bivoltine hybrids were utilized in the present study. Rearing of both silkworm breeds along with hybrids was conducted with three replications and 300 larvae were retained in each replication after III moult. Data were collected for eleven economic characters namely, fecundity, hatching %, pupation rate, yield/10,000 larvae by weight, cocoon weight, cocoon shell weight, cocoon shell percentage, filament length, reelability, raw silk percentage and neatness and analyzed through different statistical methods like multiple traits evaluation indices method of Mano et al. (1993), analysis of combining ability method of Kempthorne (1957) and hybrid vigour.

RESULTS AND DISCUSSION

Maximum rearing performance, evaluation index, GCA of parents, SCA of polyvoltine × bivoltine hybrids and hybrid vigour values pertaining to 11 economic characters have been given in Table 1. Among the parental silkworm breeds, DNP_1 was adjudicated as the best parent showing maximum values for seven economic characters namely, pupation rate, cocoon yield/10,000 larvae by weight, cocoon shell weight, cocoon shell percentage, filament length, raw silk and neatness followed by DNP_3 which revealed maximum values for three characters namely; fecundity, cocoon weight and reelability based on average performance and evaluation index values. Maximum general combining ability (GCA) effects were found in DNP_1 for five characters *viz.*, pupation rate, cocoon shell weight, cocoon shell %, raw silk and neatness.

Among sixteen polyvoltine × bivoltine hybrids, $DNP_1 \times CSR_2$ was found promising by exhibiting maximum values and evaluation indices for four characters namely, cocoon shell weight (0.402g and 63.30), cocoon shell percentage (20.62 and 65.52), raw silk (15.99 % and 72.43) and neatness (91 p and 65.18) followed by $DNP_3 \times CSR_{17}$ which exhibited maximum values and evaluation indices for three characters *viz.*, cocoon yield/10,000 larvae by weight (19.920 kg and 69.50), cocoon weight (2.135 g and 71.40) and reelability (85.5 % and 63.04). Maximum specific combining ability (SCA) effects were expressed in $DNP_4 \times CSR_4$ for three characters *viz.*, cocoon yield/10,000 larvae by weight, reelability and raw silk followed by $DNP_2 \times NB_4D_2$ and $DNP_3 \times CSR_{17}$ exhibiting SCA effects for two characters each. $DNP_2 \times CSR_4$ manifested maximum hybrid vigour for three characters *viz.*, pupation rate (14.16), reelability (9.64) and neatness (2.46) followed by $DNP_4 \times CSR_4$ for two characters cocoon yield/10,000 larvae by weight (51.78) and cocoon shell percentage (17.39).

Efforts have been made to select silkworm breeds and hybrids through multiple traits evaluation index method (Ramesh Babu et al., 2002; Gangopadhyay et al., 2006; Choudhary & Singh, 2006a; Rao et al., 2006; Lakshmi & Chandrashekharaiah, 2007; Nirupama et al., 2008a,b) and through analysis of combining ability and hybrid vigour (Datta et al., 2001; Choudhary & Singh, 2006b; Singh et al., 2000, 2001, 2010). Singh & Nirupama (2012) have selected promising polyvoltine breeds and polyvoltine × bivoltine hybrids on the basis of rearing performance, combining ability and hybrid vigour. Further, Singh & Gangopadhyay (2013) have identified bivoltine breeds and bivoltine hybrids based on rearing performance, combining ability and hybrid vigour. Results of the present study revealed that the identified polyvoltine breed DNP_1 may be further utilized in future breeding programmes for the development of outstanding polyvoltine silkworm breeds. The identified polyvoltine × bivoltine hybrid $DNP_1 \times CSR_2$ may be exploited on large scale for commercial exploitation.

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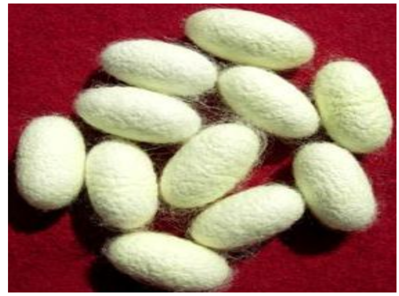

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Plate I. 1- Larvae of DNP_1, 2- Cocoons of DNP_1, 3- Larvae of $DNP_1 \times CSR_2$ and 4- Cocoons of $DNP_1 \times CSR_2$.

Table 1. Short-listing of polyvoltine breeds and polyvoltine × bivoltine hybrids based on various statistical measures.

Character	Polyvoltine breeds			Polyvoltine × bivoltine hybrids			
	Based on average performance	Based on Evaluation Index values	Based on General Combining Ability (GCA)	Based on average performance	Based on Evaluation Index values	Based on Specific Combining Ability (SCA)	Based on Hybrid Vigour
Fecundity (no)	DNP_3 (484)	DNP_3 (62.39)	DNP_2 (53.13)	$DNP_2 \times CSR_2$ (566) $DNP_2 \times CSR_{17}$ (551)	$DNP_2 \times CSR_2$ (67.65) $DNP_2 \times CSR_{17}$ (64.59)	$DNP_3 \times CSR_{17}$ (50.29) $DNP_4 \times CSR_2$ (39.71)	$DNP_2 \times CSR_2$ (15.16)
Hatching (%)	DNP_4 (91.85)	DNP_4 (55.88)	DNP_2 (1.77)	$DNP_4 \times CSR_2$ (97.42)	$DNP_4 \times CSR_2$ (70.33)	-	$DNP_4 \times CSR_2$ (4.26)
Pupation rate	DNP_1 (92.56)	DNP_1 (59.15)	DNP_1 (1.89)	$DNP_4 \times NB_4D_2$ (98.20) $DNP_1 \times NB_4D_2$ (97.80)	$DNP_4 \times NB_4D_2$ (62.10) $DNP_1 \times NB_4D_2$ (60.95)	$DNP_4 \times NB_4D_2$ (3.64) $DNP_2 \times CSR_4$ (2.91)	$DNP_2 \times CSR_4$ (14.16) $DNP_4 \times NB_4D_2$ (14.05)
Cocoon yield/10,000 larvae by wt (kg)	DNP_1 (12.52)	DNP_1 (58.07)	DNP_3 (1.13)	$DNP_3 \times CSR_{17}$ (19.920) $DNP_1 \times CSR_{17}$ (19.360)	$DNP_3 \times CSR_{17}$ (69.50) $DNP_1 \times CSR_{17}$ (64.78)	$DNP_4 \times CSR_4$ (0.73) $DNP_2 \times NB_4D_2$ (0.55)	$DNP_4 \times CSR_4$ (51.78) $DNP_2 \times CSR_4$ (46.18)
Cocoon weight (g)	DNP_3 (1.368)	DNP_3 (58.51)	DNP_3 (0.09)	$DNP_3 \times CSR_{17}$ (2.135) $DNP_2 \times CSR_2$ (2.059)	$DNP_3 \times CSR_{17}$ (71.40) $DNP_2 \times CSR_2$ (64.08)	$DNP_3 \times CSR_{17}$ (0.09) -	$DNP_3 \times CSR_{17}$ (42.01) $DNP_2 \times NB_4D_2$ (38.61)
Cocoon shell weight (g)	DNP_1 (0.225)	DNP_1 (59.67)	DNP_1 (0.010)	$DNP_1 \times CSR_2$ (0.402) $DNP_1 \times CSR_{17}$ (0.396)	$DNP_1 \times CSR_2$ (63.30) $DNP_1 \times CSR_{17}$ (60.44)	$DNP_2 \times NB_4D_2$ (0.024) $DNP_4 \times CSR_4$ (0.022)	$DNP_2 \times NB_4D_2$ (51.16) $DNP_4 \times CSR_4$ (48.75)
Cocoon shell %	DNP_1 (16.71)	DNP_1 (64.67)	DNP_1 (0.67)	$DNP_1 \times CSR_2$ (20.62) $DNP_1 \times CSR_{17}$ (20.45)	$DNP_1 \times CSR_2$ (65.52) $DNP_1 \times CSR_{17}$ (63.39)	$DNP_2 \times NB_4D_2$ (0.68) $DNP_1 \times CSR_{17}$ (0.62)	$DNP_4 \times CSR_4$ (17.39) $DNP_4 \times CSR_2$ (14.92)
Filament length (m)	DNP_1 (573)	DNP_1 (64.67)	DNP_2 (53.65)	$DNP_2 \times CSR_{17}$ (998) $DNP_2 \times NB_4D_2$ (933)	$DNP_2 \times CSR_{17}$ (73.24) $DNP_2 \times NB_4D_2$ (60.99)	$DNP_3 \times CSR_2$ (43.69) $DNP_2 \times CSR_{17}$ (34.44)	$DNP_2 \times CSR_{17}$ (47.28) $DNP_2 \times NB_4D_2$ (46.66)
Reelability (%)	DNP_3 (83.2)	DNP_3 (62.67)	DNP_2 (1.57)	$DNP_3 \times CSR_{17}$ (85.5) $DNP_2 \times CSR_4$ (84.2)	$DNP_3 \times CSR_{17}$ (63.04) $DNP_2 \times CSR_4$ (58.86)	$DNP_4 \times CSR_4$ (3.62) $DNP_1 \times CSR_{17}$ (3.16)	$DNP_2 \times CSR_4$ (9.64) $DNP_2 \times NB_4D_2$ (8.52)
Raw silk %	DNP_1 (12.38)	DNP_1 (58.79)	DNP_1 (0.58)	$DNP_1 \times CSR_2$ (15.99) $DNP_2 \times NB_4D_2$ (15.48)	$DNP_1 \times CSR_2$ (72.43) $DNP_2 \times NB_4D_2$ (65.15)	$DNP_4 \times CSR_4$ (0.71) $DNP_1 \times CSR_2$ (0.59)	$DNP_1 \times CSR_2$ (14.81) $DNP_2 \times NB_4D_2$ (14.32)
Neatness	DNP_1 (89)	DNP_1 (55.00)	DNP_1 (0.46)	$DNP_1 \times CSR_2$ (91) $DNP_1 \times NB_4D_2$ (91)	$DNP_1 \times CSR_2$ (65.18) $DNP_1 \times NB_4D_2$ (65.18)	$DNP_1 \times NB_4D_2$ (0.96) -	$DNP_2 \times CSR_4$ (2.46) $DNP_2 \times CSR_2$ (2.45)