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ORIGINAL ARTICLE

Effect of different locally available botanical formulations on mounting of silkworm, *Bombyx mori* L.

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ABSTRACT
The effect of dust formulations of different botanicals viz., walnut hull (Juglans regia), pine needles (Pinus wallichiana) and tree of heaven leaves (Ailanthus altissima) on the natural/self-mounting of silkworm double hybrid ($CSR_6 \times CSR_{26}$) × ($CSR_2 \times CSR_{27}$) were investigated. The results of the study showed that mounting percentage and percentage of larvae spun the cocoons on the mountages were significantly improved in the treated batches compared to control. However, the worms treated with 100% Ailanthus altissima leaves powder recorded the highest mounting percentage of 97.00% and cocooning percentage of 96.00%. The results indicated that the application of 100% Ailanthus altissima leaves powder is the most effective for accelerating the natural/ self-mounting process of silkworm, Bombyx mori L.
Key words: *Silkworm, Bombyx mori, mounting, botanicals, acceleration*

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INTRODUCTION

The spinning of cocoons, which is also the nest for silkworms to metamorphosize into pupa, is a crucial part of silkworm rearing, that starts with identification and collection (picking) of mature larvae and transferring them on to the cocooning structures which are called as mountages. This process is called as 'mounting'. The quality and quantity of silk produced are highly related to the care taken during rearing, types of mountages used during spinning and mounting conditions [1]. Mounting of silkworm at right time of maturation and harvesting of cocoons at right time after the completion of pupation is very vital in terms of obtaining quality cocoons as well as subsequently in the production of quality silk. Even if the silkworm crop is healthy, improper mounting methods, spinning conditions, mounting of pre matured or over matured larvae and poor type of mountages can result in the formation of inferior quality cocoons. Silkworm mounting process is a laborious activity and is considered to be one of the major hurdles in expansion of the silkworm rearing. Thus, improvement in mounting process is indispensable for decreasing the labour requirement and reduction in input cost while improving the mounting efficiency. The two methods of silkworm mounting *viz*., hand picking and self or natural mounting are very much popular among sericulture farmers. For a long time, it has been practiced to pick up mature larvae one by one and transfer these to the cocooning frames. This method is more effective because it is possible to pick up only the mature larvae for mounting. However, it is a cumbersome process and needs a large labour force to carry out the work for a longer period. Sometimes it takes even 4-5 days depending on the scale of silkworm rearing. Natural or self-mounting is the most rational method, saving time and labour, but the mounting rate is generally low [2]. The few larvae make the cocoons in the rearing bed itself, if mounting of worms is delayed and it results in high humidity in the rearing bed which in turn affects the cocoon quality and its reelability. Thus, cocoons formed are of inferior quality and as such these cocoons fetch low price in the cocoon market which leads to considerable economic loss to the farmers. On the other hand, if there is delay in mounting, the silkworms after becoming mature waste their silk and thereby reduce the quality and quantity of cocoons. The poor spinning by ripened worms results in retention of some quantity of silk in the silk gland which adversely effects further growth and metamorphosis and can even result in death of silkworm. The efficiency of self-mounting has been improved by applying various plant-based materials like saw dust of Hinoki cypress, red pine [3, 4], Cresol with paddy husk [5] and saw dust [6]. Perusal of the literature revealed that various plants *viz*.,

Azadirachta indica (Neem), *Carica papaya* (Papaya), *Eucalyptus globulus* (Gum trees), *Manilkara zapota* (Sapota), *Taraxacum officinale* (Dandelion*), Juglans nigra* (American black walnut) etc., are also having positive effect on the mounting process due to the effect of their odour on the silkworm larvae particularly at the wandering stage which enhances self-mounting of the silkworms [7, 8]. The self or natural method of mounting is very popular in the Union Territory of Jammu and Kashmir, but due to the low mounting rate, it leads to considerable economic loss to the farmers. As there is enough literature that some of the plant-based dust formulations enhance this self-mounting of silkworms, as such the present investigation was undertaken to study the effects of various locally available plant-based dust formulations on the acceleration of mounting process of silkworm, *Bombyx mori* L.

MATERIAL AND METHODS

For the present study, effect of different botanicals on natural/self-mounting of silkworm, bivoltine double hybrid ($CSR_6 \times CSR_{26}$) × ($CSR_2 \times CSR_{27}$) were studied.

Table-1: Botanicals used for the preparation of powder for accelerating the natural/self-mounting process.

Plant	Botanical name	Local name	Part used
Walnut	*Juglans regia*	Doon	Hull
Pine	*Pinus wallichiana*	Yaarii kull	Leaves
Varnish tree/Tree of Heaven	*Ailanthus altissima*	Handoon/Alamthar	Leaves

Walnut hull

Walnut hull powder

Pine needles

Pine needles powder

***Ailanthus* leaves**

***Ailanthus* leaves powder**

Collection and preparation of test botanicals

The test botanicals were obtained in fresh form. The samples were washed with running water and dried under shade. The drying was continued till samples became brittle. The sample materials were crushed to form powder and were stored in closed containers for further use. The test botanicals were prepared as per their required percentage *i.e.,* T_1 (50% walnut hull powder+50% paddy husk), T_2 (75% walnut hull powder+25% paddy husk), T_3 (100% walnut hull powder), T_4 (50% pine leaves powder+50% paddy husk), T_5 (75% pine leaves powder + 25% paddy husk), T_6 (100% pine leaves powder), T_7 (50% *Ailanthus* leaves powder+50% paddy husk), T_8 (75% *Ailanthus* leaves powder+25% paddy husk), T_9 (100% *Ailanthus* leaves powder), T_{10} (100% paddy husk) and T_0 (control). Mass rearing of the silkworms were conducted as per the standard package of practices issued by College of Temperate Sericulture, Mirgund.

On the 5th day of 5th instar, the larvae were distributed into eleven treatments with three replications @500 worms per treatment per replication in a Completely Randomized Design (CRD). The powder of test botanicals was applied @ 40 grams / 100 larvae by dusting over the ripe worms just when 40 per cent larvae were ready for spinning.

RESULTS

Accelerative effect of botanical formulations on natural mounting

The data pertaining to the acceleration of mounting percentage with regard to application of dust formulation of four botanicals are presented in Table-2 and depicted in Figure-1.

Treatment		Self-mounting (%) after maturation Time (hours)					
		Up to 06 hours	Up to 12 hours	Up to 18 hours	Up to 24 hours	Up to 30 hours	Up to 36 hours
T_1:	Walnut hull powder (50%) + Paddy husk (50%)	37.00	48.00	80.00	83.00	92.00	92.00
T_2:	Walnut hull powder (75%) + Paddy husk (25%)	42.00	55.00	82.00	86.00	93.00	93.00
T_3:	Walnut hull powder (100%)	57.00	70.00	91.00	96.00	96.00	96.00
T_4:	Pine leaves powder (50%) + Paddy husk (50%)	35.00	45.00	77.00	80.00	90.00	90.00
T_5:	Pine leaves powder (75%) + Paddy husk (25%)	41.00	52.00	78.00	84.00	91.00	91.00
T_6:	Pine leaves powder (100%)	53.00	65.00	89.00	92.00	93.00	93.00
T_7:	*Ailanthus* leaves powder (50%) + Paddy husk (50%)	37.0	50.00	80.00	83.00	94.00	94.00
T_8:	*Ailanthus* leaves powder (75%) + Paddy husk (25%)	45.00	59.00	82.00	88.00	95.00	95.00
T_9:	*Ailanthus* leaves powder (100%)	69.00	74.00	93.00	97.00	97.00	97.00
T_{10}:	Paddy husk (100%)	32.00	36.00	62.00	68.00	72.00	84.00
T_0:	Control (Standard Check)	30.00	33.00	60.00	65.00	71.00	81.00
	C.D (p≤0.05)	**3.40**	**3.25**	**3.16**	**2.98**	**2.35**	**2.17**

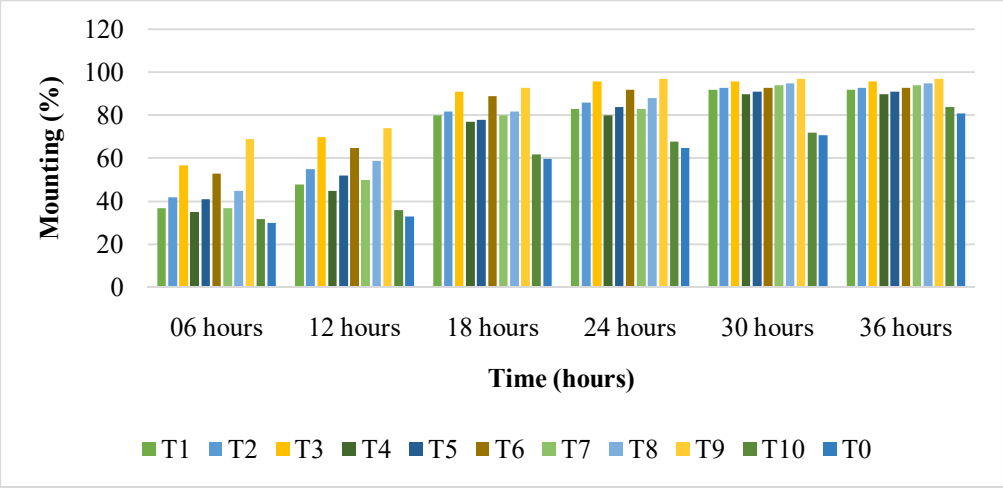

Figure-1: Effect of application of different botanical dust formulations on self-mounting of Bivoltine Silkworm, *Bombyx mori* L.

After the application of dust formulation of botanicals over the rearing beds, the silkworms mounted much more rapidly on the cocooning frames than the control. There was a significant difference in the acceleration of mounting percentage of silkworm from the beginning *i.e.,* 06 hours to 36 hours of seriposition in all the treatment groups when compared to control. Significantly, the accelerative effect of botanical formulations on mounting percentage was highest in T_9 *i.e.,* 100% *Ailanthus* leaves powder at 6 hours (69.00%) after maturation and 12 hours (74.00%) after maturation followed by T_3 (100% Walnut hull powder) *i.e.,* 57.00 per cent and 70.00 per cent at 6 hours and 12 hours respectively when compared to control and all other treatment groups. However, there was no significant effect on the percentage of self-mounting after 06 hours and 12 hours of maturation between T_{10} (100% paddy husk) and T_0 (control). After 18 and 24 hours of mounting, significantly highest accelerative effects on mounting percentage were recorded *i.e.,* 93.00 per cent and 97.00 per cent were again observed in T_9 (100% *Ailanthus* leaves powder) when compared to T_0 (control) and all other treatment groups. However, T_9 (100% *Ailanthus* leaves powder) and T_3 (100% Walnut hull powder) were significantly at par with each other and no significant effect was observed between T_{10} (100% paddy husk) and T_0 (control). After 30 hours of mounting period, significant differences were observed in T_1 to T_9 when compared to T_{10} (100% paddy husk) and T_0 (control). This was followed by T_{10} and T_0, however, there was no significant difference among these two treatments. The same trend was observed on over all mounting percentages at 36 hours of mounting. Among all the treatment groups, 97.00 per cent of larvae finished mounting up to 24 hours in T_9 (100% *Ailanthus* leaves powder). This was followed by T_3 (100% Walnut hull powder) *i.e.,* 96.00 per cent when compared to all other treatment groups including control.

Cocooning percentage on mountages and rearing bed

The results of cocooning percentage on mountages and rearing bed have been summarized in Table-3 and depicted in Figure-2. The highest cocooning percentage of 96.00 per cent on mountages was observed in T_9 (100% *Ailanthus* leaves powder) when compared to T_{10} (100% paddy husk) and T_0 (control). However, T_9 (100% *Ailanthus* leaves powder) did not differ significantly with all other treatment combinations.

Cocooning percentage on rearing bed showed significant differences among the treatments and the lowest value 2.00 per cent of cocooning percentage on rearing bed was recorded in 100 per cent *Ailanthus* leaves powder when compared to the group of silkworms treated with 100 per cent paddy husk and control which was followed by T_1, T_2, T_6 and T_7 as all of these treatments recorded the cocooning percentage of 3 per cent on rearing bed.

Table-2: Effect of application of different botanical dust formulations on cocooning percentage on mountages and rearing bed of Bivoltine Silkworm, *Bombyx mori* L.

Treatment		Cocooning on mountages (%)	Cocooning on rearing bed (%)
T_1:	Walnut hull powder (50%) + Paddy husk (50%)	87.00	3.00
T_2:	Walnut hull powder (75%) + Paddy husk (25%)	90.00	3.00
T_3:	Walnut hull powder (100%)	91.00	5.00
T_4:	Pine leaves powder (50%) + Paddy husk (50%)	85.00	6.00
T_5:	Pine leaves powder (75%) + Paddy husk (25%)	87.00	5.00
T_6:	Pine leaves powder (100%)	89.00	3.00
T_7:	*Ailanthus* leaves powder (50%) + Paddy husk (50%)	90.00	3.00
T_8:	*Ailanthus* leaves powder (75%) + Paddy husk (25%)	92.00	4.00
T_9:	*Ailanthus* leaves powder (100%)	96.00	2.00
T_{10}:	Paddy husk (100%)	79.00	6.00
T_0:	Control (Standard Check)	75.00	5.00
C.D ($p \leq 0.05$)		**2.259**	**2.355**

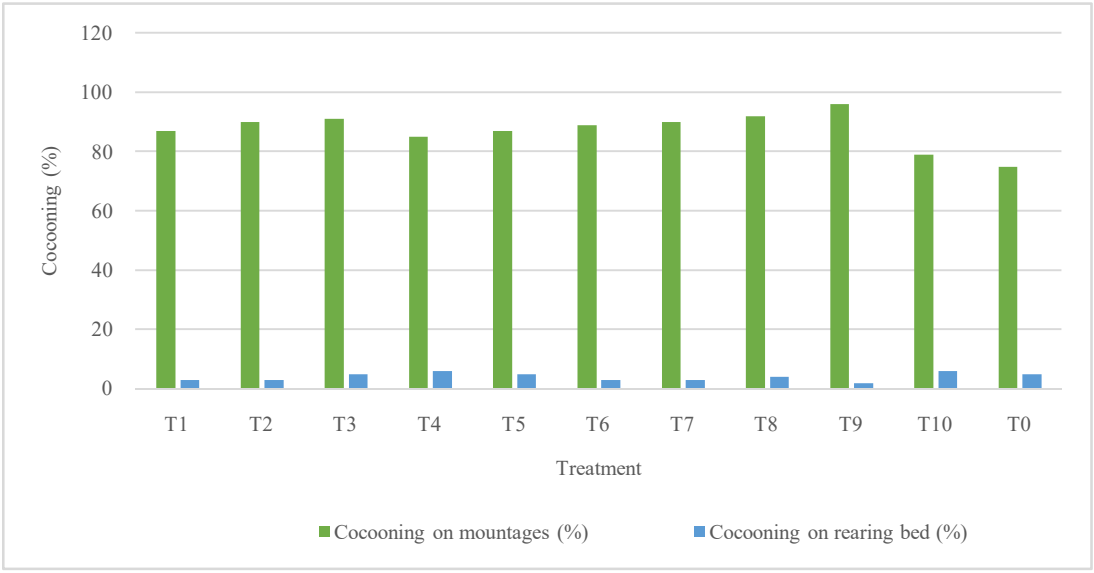

Figure-2: Effect of application of different botanical dust formulations on cocooning percentage on mountages and rearing bed of Bivoltine Silkworm, *Bombyx mori* L.

DISCUSSION

Mounting percentage

The results related to the acceleration of mounting percentage clearly indicate that in T_9 *i.e., Ailanthus* leaves powder (100%) treated batches, silkworms accelerated towards mounting frames and climbed on them in much shorter periods followed by T_3 *i.e.,* walnut hull powder (100%). This observation is in conformity with the studies of Ashida [2] and Kamimura *et al.* [5] who have reported that accelerative effect was observed on the mounting percentage of silkworm batches treated with Hinoki saw dust. He has further reported that the accelerative effect on mounting percentage is due to the repellent effect of hinoki saw dust on wandering larvae. Acceleration of mounting percentage by application of *Ailanthus* leaves powder are also in harmony with the results of Rajan *et al.* [7] who have reported that sprinkling of saw dust at wandering stage of silkworm accelerated the mounting process. Singh *et al*. [9] also has reported improvement in acceleration of mounting after application of dust formulations of various botanicals. The improvement in the mounting percentage of the treatment groups treated with *Ailanthus* leaves powder followed by walnut hull and pine might be due to the repellent compounds present in these botanical powders [1, 3]. Therefore, due to this smell, the ripe larvae accelerate their movement towards the mountages for seriposition rapidly.

Cocooning percentage on mountages and rearing bed

The results of formation of cocoons on mountages of different treatment groups showed significantly higher cocooning percentage *i.e.,* 96.00 per cent in the group of silkworms treated with *Ailanthus* leaves powder when compared to all other treatment groups and control. These results correlate well with the earlier reports of Singh *et al.* [10] who reported highest cocooning percentage in saw dust and eucalyptus leaves powder treated groups when compared to control. The results are also in harmony with the findings of Himantharaj *et al.* [4] who also reported significant improvement in percentage of cocoon formation on mountages in saw dust treated batch when compared to control. This can be attributed to the highest mounting percentage of the larvae towards the cocooning frames (mountages) due to the strong accelerative effect of *Ailanthus* leaves powder on the mounting of silkworm at wandering stage.

In the present investigation, cocooning percentage on rearing bed was found significantly lower *i.e.,* 2.00 per cent among the group of silkworms treated with *Ailanthus* leaves powder when compared to all other treatment groups and control. These results are in conformity with the results of Singh *et al.* [11] who reported significant reduction in cocooning percentage on rearing bed *i.e.,* 6.9 per cent in eucalyptus and neem treated batches when compared to the control (11.2%). The results of percentage of cocoon formation on rearing bed is attributed as the highest number of silkworms climbed and formed the cocoons on the mountages in 100 per cent *Ailanthus* leaves powder treated batches.

CONCLUSION

The investigation of the present study revealed that the silkworms treated with 100 percent Ailanthus leaves powder showed that application of this botanical formulation during wandering stage has

accelerated mounting process, reduced the seriposition time and labour. Thus, the application of this eco-friendly and locally available botanical formulation can help the farmers to reduce the considerable time, labour and economic loss of seriposition under self/natural mounting method.

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