ABSTRACT

Aim: The present study was aimed to see the performance of silk worm (Bombyx mori L.) double hybrid fed on leaf raised through splitting the recommended dose of chemical fertilizers.

Study Design: Completely Randomized Design (CRD).

Place and Duration of Study: College of Temperate Sericulture (CoTS) Mirgund, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-K), during 2017 and 2018.

Methodology: The present investigation was carried out at the experimental farm of College of Temperate Sericulture-Mirgund. Goshoerami a popular variety of mulberry in the region was used for the study. Disease free layings (dfl’s) of the popular double hybrid were obtained from the Germplasm Bank maintained at College of Temperate Sericulture (CoTS) Mirgund. These dfl’s were
incubated, brushed and reared up to 3rd instar en masse following the standard rearing procedure. After 3rd moult, 3 replications of 100 larvae in each treatment were maintained. Different larval and Cocoon parameters were recorded during the course of experimentation. Standard procedure was followed to record observations. The data was compiled and analyzed.

**Results:** T₁₁ recorded the shortest values for total larval and fifth instar larval duration being statistically at par with treatments/ fertilizer schedules T₁₂, T₉, T₁₀, T₃, T₄, T₁, T₂ and T₇. Weight of ten mature larvae was recorded higher in treatment T₁₄ being statistically at par with treatments T₁₃, T₁₆ and T₁₅ respectively. Cocoon yield per 10,000 larvae by number was recorded highest in T₁₄ treatment, which was recorded statistically at par with treatments T₁₃ and T₁₆ respectively. Cocoon yield by weight was more in treatment T₁₄ being at par with treatments T₁₃ and T₁₆. Pupation rate was found higher in treatment T₁₄ being at par treatment T₁₃.

**Conclusion:** Double hybrid performed better under parameters like- total as well as fifth instar larval duration in case of fertilizer schedule - T₁₁ (N₃P₂K₁), while as in case of larval weight, cocoon yield by number and by weight and pupation rate, the hybrid performed better under T₁₄ (N₄P₁K₂) fertilizer Schedule.

**Keywords:** Fertilizers; silkworm; mulberry; nutrients.

1. **INTRODUCTION**

The Silkworm (Bombyx mori L.) is very important economic insect which contribute substantially to the national economy and Gross Domestic Production (GDP) of many countries like China, India, Thailand etc [1,2]. Legay [3] stated that silk production is dependent on the larval nutrition and nutritive value of mulberry leaf which is the only food to silkworm. The silkworm growth and development is dependent on the nutritive composition of mulberry leaf, which alone contributes about 38.2 percent towards the success of silkworm rearing [4]. Silk worm consumes all the food during its larval stage to accumulate sufficient food energy to tide over non-feeding stages [5]. Quality of leaf influences the healthy growth of silkworm larvae and thereby the quality of cocoons [6]. Mulberry under Kashmir is applied the chemical fertilizer (NPK) @ 100:50:50 kg ha/yr and 300:120:120 kg ha/yr respectively for rain fed and irrigated plantation in two splits where the first dose comprising of half of N and full P and K is applied in spring season immediately after sprouting of winter buds (April) and the 2nd doze comprising of the remaining half of N is applied in First week of July.

Application of nitrogen to mulberry significantly increases the cocoon production, since it greatly influences cocoon weight, shell weight, shell percentage and finally the cocoon yield. Like nitrogen, phosphorus also affects not only the yield and quality of mulberry leaf but also the commercial characteristics of cocoons. Reduced intake of phosphorus results in decrease in body weight of silkworms. Phosphorus deficiency in leaves has a negative impact on the economic characters of cocoons (Radha et al., 1980). Potassium is the third major nutrient and has been reported as the key nutrient in maintaining mulberry leaf quality. Moisture content of the leaf also changes proportionately with potash content of the leaf (Radha et al., 1988).

The present study was, therefore, an attempt to test the performance of a double hybrid of silkworm on leaf raised under different splits of N, P and K.

2. **MATERIALS AND METHODS**

The present investigation was carried out at the experimental farm of College of Temperate Sericulture-Mirgund, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-K) during 2017 and 2018. Goshoerami the popular variety of mulberry was used for the study and the chemical fertilizers (NPK) were applied as per treatments mentioned in Table 1.

For each treatment three replications and the number of plants per treatment in each replication was uniformly kept as five. The popular silkworm double hybrid was raised from parental stock drawn from Germplasm Bank of the Institute. The seed of the hybrid was incubated, brushed and reared up to 3rd instar en masse following the standard rearing procedure [7]. Just after 3rd moult, 100 larvae in each treatment were maintained and the number of replications was kept as three.
The ripe and translucent worms were mounted for spinning on plastic mountages and the time for each treatment was noted for calculating the total larval as well as 5th instar larval duration. Similarly, during 5th instar, mature larvae were randomly selected from each replicate on the 5th and 6th day and weighed on digital balance to get the maximum weight attained in their larval period. Data analysis was undertaken using O.P Stat software to assess the effect of feeding treatments on different economic parameters of silkworm hybrids. All the above mentioned parameters were calculated and recorded as per package of practices for silkworm rearing and mulberry cultivation in Kashmir [7].

3. RESULTS AND DISCUSSION

Larval duration is an indicative of leaf consumption and also speaks about the involvement of labour. In the current study, T11 (N3P2K1) recorded the shortest values for total larval and fifth instar larval duration being statistically at par with treatments T12 (N3P2K2), T9 (N3P1K1), T10 (N3P1K2), T3 (N1P2K1), T4 (N1P2K2), T1 (N1P1K1), T2 (N1P1K2) and T7 (N2P2K1). However, longer total larval and fifth instar larval duration were recorded in treatment T14 (N4P1K2) (Table 2), indicating the significance of leaf consumption. These results are in agreement with the findings of Shivakumar [8], who reported that silkworms exposed to stress i.e., poor feeding especially during later larval stages differ in growth and considerably exhibit reduced survival rate, cocoon quality and the fecundity.

Larval weight besides denoting the health and vigour of silkworms might also promulgate an idea about the silk and development of silk gland which is the ultimate concern of reeler and of course may also result in fetching more revenue for the rearer. In the present study, the data regarding weight of ten mature larvae exhibited treatmental effect, as the statistical analysis of the data revealed significant differences. The weight was recorded higher 55.40 grams in treatment T14 (N4P1K2) being statistically at par with 55.38, 55.31 and 54.90 grams found in treatments T12 (N4P1K1), T15 (N4P2K2) and T16 (N4P2K1) respectively. Whileas, lower weight of 51.33 grams was found in treatment T11 (N3P1K1) found at par (51.47 g) with treatment T12 (N3P2K2) (Table 1) which could be due to increased quantum of feed fed during active feeding stage. The results are in accordance with findings of Koul [9], Nagaraju [10], who reported that the growth and development of silkworm, Bombyx mori L. is known to vary depending on the quality and quantity of mulberry leaf.

Cocoon yield is one of the important factor for the success and survival of silk industry and is expressed in terms of quantum of viable cocoons as expressed number and kilograms procured from standard unit of 10,000 larvae. In the present study, cocoon yield per 10,000 larvae by number with respect to different treatments

| Treatment Code | Treatment Symbol | Fertilizer combination (NPK) |
|----------------|------------------|----------------------------|
| T1 (RFD)       | N1P1K1           | 150+120+120                |
| T2             | N1P1K2           | 150+120+60                 |
| T3             | N1P2K1           | 150+60+120                 |
| T4             | N1P2K2           | 150+60+60                  |
| T5             | N2P1K1           | 180+120+120                |
| T6             | N2P1K2           | 180+120+60                 |
| T7             | N2P2K1           | 180+60+120                 |
| T8             | N2P2K2           | 180+60+60                  |
| T9             | N3P1K1           | 120+120+120                |
| T10            | N3P1K2           | 120+120+60                 |
| T11            | N3P2K1           | 120+60+120                 |
| T12            | N3P2K2           | 120+60+60                  |
| T13            | N4P1K1           | 120+120+120                |
| T14            | N4P1K2           | 120+120+60                 |
| T15            | N4P2K1           | 120+60+120                 |
| T16            | N4P2K2           | 120+60+60                  |

*RFD = Recommended fertilizer doze
Table 2. Larval characteristics of silkworm (*Bombyx mori* L.) fed on leaf raised under different fertilizer splits

| Treatments | Total larval duration (days) | 5th instar larval duration (days) | Weight of 10 mature larvae (g) |
|------------|-------------------------------|----------------------------------|-------------------------------|
| T1 (N1P1K1) | 26.16<sup>a</sup> | 6.16<sup>a</sup> | 52.73<sup>e</sup> |
| T2 (N1P1K2) | 26.18<sup>a</sup> | 6.18<sup>a</sup> | 53.35<sup>f</sup> |
| T3 (N1P2K1) | 26.11<sup>a</sup> | 6.11<sup>a</sup> | 52.46<sup>ef</sup> |
| T4 (N1P2K2) | 26.15<sup>a</sup> | 6.15<sup>a</sup> | 52.64<sup>e</sup> |
| T5 (N2P1K1) | 27.05<sup>b</sup> | 7.05<sup>b</sup> | 54.70<sup>b</sup> |
| T6 (N2P1K2) | 27.09<sup>b</sup> | 7.09<sup>b</sup> | 54.86<sup>b</sup> |
| T7 (N2P2K1) | 26.20<sup>a</sup> | 6.20<sup>a</sup> | 53.53<sup>c</sup> |
| T8 (N2P2K2) | 27.02<sup>b</sup> | 7.02<sup>b</sup> | 53.65<sup>c</sup> |
| T9 (N3P1K1) | 26.08<sup>a</sup> | 6.08<sup>a</sup> | 51.63<sup>g</sup> |
| T10 (N3P1K2) | 26.10<sup>a</sup> | 6.10<sup>a</sup> | 52.35<sup>d</sup> |
| T11 (N3P2K1) | 26.03<sup>a</sup> | 6.03<sup>a</sup> | 51.33<sup>h</sup> |
| T12 (N3P2K2) | 26.06<sup>a</sup> | 6.06<sup>a</sup> | 51.47<sup>gh</sup> |
| T13 (N4P1K1) | 27.73<sup>b</sup> | 7.73<sup>b</sup> | 55.38<sup>a</sup> |
| T14 (N4P1K2) | 28.00<sup>b</sup> | 8.00<sup>b</sup> | 55.40<sup>a</sup> |
| T15 (N4P2K1) | 27.12<sup>b</sup> | 7.12<sup>b</sup> | 54.90<sup>a</sup> |
| T16 (N4P2K2) | 27.13<sup>b</sup> | 7.13<sup>b</sup> | 55.31<sup>a</sup> |
| C.D (p<0.05) | 0.194 | 0.194 | 0.270 |
| SE (d) | 0.095 | 0.095 | 0.132 |
| SE(m) | 0.067 | 0.067 | 0.093 |
| CV | 0.435 | 1.747 | 0.302 |

Table 3. Economic parameters of silkworm (*Bombyx mori* L.) fed on leaf raised under different fertilizer splits

| Treatments | Cocoon yield per 10,000 larvae by No. | Cocoon yield per 10,000 larvae by wt. (kg) | Pupation rate (%) |
|------------|---------------------------------------|--------------------------------------------|-------------------|
| T1 (N1P1K1) | 8500.00<sup>e</sup> | 18.48<sup>f</sup> | 93.77<sup>d</sup> |
| T2 (N1P1K2) | 8566.67<sup>de</sup> | 18.54<sup>e</sup> | 93.99<sup>cd</sup> |
| T3 (N1P2K1) | 8366.67<sup>ef</sup> | 18.31<sup>f</sup> | 93.56<sup>de</sup> |
| T4 (N1P2K2) | 8433.33<sup>ef</sup> | 18.40<sup>h</sup> | 93.87<sup>d</sup> |
| T5 (N2P1K1) | 8833.33<sup>c</sup> | 18.87<sup>de</sup> | 94.16<sup>c</sup> |
| T6 (N2P1K2) | 8900.00<sup>b</sup> | 19.01<sup>c</sup> | 94.28<sup>bc</sup> |
| T7 (N2P2K1) | 8633.33<sup>d</sup> | 18.79<sup>e</sup> | 93.89<sup>cd</sup> |
| T8 (N2P2K2) | 8766.67<sup>c</sup> | 18.84<sup>e</sup> | 94.06<sup>cd</sup> |
| T9 (N3P1K1) | 8233.33<sup>g</sup> | 18.25<sup>f</sup> | 92.58<sup>f</sup> |
| T10 (N3P1K2) | 8300.00<sup>f</sup> | 18.29<sup>i</sup> | 93.35<sup>e</sup> |
| T11 (N3P2K1) | 8133.33<sup>g</sup> | 18.10<sup>i</sup> | 90.08<sup>n</sup> |
| T12 (N3P2K2) | 8200.00<sup>g</sup> | 18.17<sup>g</sup> | 90.60<sup>g</sup> |
| T13 (N4P1K1) | 9100.00<sup>a</sup> | 19.37<sup>a</sup> | 95.57<sup>a</sup> |
| T14 (N4P1K2) | 9133.33<sup>a</sup> | 19.38<sup>a</sup> | 95.59<sup>a</sup> |
| T15 (N4P2K1) | 8966.67<sup>b</sup> | 19.25<sup>b</sup> | 94.41<sup>bc</sup> |
| T16 (N4P2K2) | 9066.67<sup>a</sup> | 19.30<sup>a</sup> | 94.53<sup>a</sup> |
| C.D (p<0.05) | 115.650 | 0.043 | 0.310 |
| SE (d) | 56.519 | 0.021 | 0.152 |
| SE(m) | 39.965 | 0.015 | 0.107 |
| CV | 0.802 | 0.137 | 0.198 |

showed significant differences being highest 9133.33 in T14 (N4P1K2) treatment which was found statistically at par with 9100.00 and 9066.67 in treatments T13 (N4P1K1) and T16 (N4P2K2) respectively. Whileas, lowest number of 8133.33 was found in treatment T11 (N3P2K1) being statistically at par with 8200.00 and 8233.33 found in treatments T12 (N3P2K2) and T9 (N3P1K1) respectively (Table 2), justifying the view that leaf quantum bears positive correlation...
with cocoon yield [11]. The present findings are supported by the findings of Legay [3] who reported that cocoon production is chiefly dependent on nutrition and nutritive value of mulberry leaf and conversion efficiency of silkworm larvae.

Cocoon yield by weight was more (19.38 kg) in treatment T14 (N4P1K2) being at par with 19.37 and 19.30 kilograms in treatments T13 (N4P1K1) and T16 (N4P2K2). While as minimum yield of 18.10 kilograms was found in treatment T11 (N3P2K1) (Table 3), indicating the significance of better quantum of leaf consumption. The present findings are also supported by the findings of Geetha [12] and Rath [13] who reported that the quality and quantity of mulberry leaf bears a positive correlation with the cocoon yield.

Pupation rate is considered to be a positive sign for survival of the breed/hybrid and also for seed production and is influenced by both biotic as well as abiotic factors like- rearing environment, nutrition etc. In the present study it was found higher (95.59%) in treatment T14 (N4P1K2) being at par with 95.57 percent found in treatment T13 (N4P1K1). Whileas, lower rate of 90.08 percent was found in treatment T11 (N3P2K1) (Table 02), indicating the significance of nutritionally enriched leaf. The results are in accordance with findings of Takano and Aral [14], Aftab Ahamed et al. [15] who reported that nutritional efficiency in the larval stages significantly influences the resulting pupa, adult and production of silk, particularly in an economically important insect like silk worm Bombyx mori.

4. CONCLUSION

Significant differences were observed among all the parameters, and it was found that the double hybrid thrived well under parameters like- total as well as fifth instar larval duration in case of fertilizer schedule- T11 (N3P2K1), while as in case of larval weight, cocoon yield by number and weight and pupation rate, the hybrid performed better under T14 (N4P1K2) fertilizer Schedule.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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