Current Journal of Applied Science and Technology

39(48): 439-444, 2020; Article no.CJAST.65020
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Performance of Double Hybrid of Silkworm (*Bombyx mori* L.) Fed on Leaf Raised under Different Fertilizer Schedules

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Authors' contributions

This work was carried out in collaboration among all authors. Author NN designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author MRM and MFB managed the analyses of the study. Author NUD managed the literature searches. All authors read and approved the final manuscript

Article Information

DOI: 10.9734/CJAST/2020/v39i4831256
Editor(s):
(1) Dr. Frédéric Ngezahayo, Ecole Normale Supérieure, Burundi.
Reviewers:
(1) Angélica Maria Penteado-Dias, Federal University Of São Carlos, Brazil.
(2) Glaucia Maria Machdo-Santelli, University Of Sao Paulo, Brazil.
Complete Peer review History: http://www.sdiarticle4.com/review-history/65020

Original Research Article

Received 24 October 2020
Accepted 28 December 2020
Published 31 December 2020

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

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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: T_{11} recorded the shortest values for total larval and fifth instar larval duration being statistically at par with treatments/ fertilizer schedules T_{12}, T_9, T_{10}, T_3, T_4, T_1, T_2 and T_7. Weight of ten mature larvae was recorded higher in treatment T_{14} being statistically at par with treatments T_{13}, T_{16} and T_{15} respectively. Cocoon yield per 10,000 larvae by number was recorded highest In T_{14} treatment, which was recorded statistically at par with treatments T_{13} and T_{16} respectively. Cocoon yield by weight was more in treatment T_{14} being at par with treatments T_{13} and T_{16}. Pupation rate was found higher in treatment T_{14} being at par treatment T_{13}.

Conclusion: Double hybrid performed better under parameters like- total as well as fifth instar larval duration in case of fertilizer schedule - T_{11} (N3P2K1), while as in case of larval weight, cocoon yield by number and by weight and pupation rate, the hybrid performed better under T_{14} (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, T_{11} (N3P2K1) recorded the shortest values for total larval and fifth instar larval duration being statistically at par with treatments T_{12} (N3P2K2), T_9 (N3P1K1), T_{10} (N3P1K2), T_3 (N1P2K1), T_4 (N1P2K2), T1 (N1P1K1), T2 (N1P1K2) and T_7 (N2P2K1). However, longer total larval and fifth instar larval duration were recorded in treatment T_{14} (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 T_{14} (N4P1K2) being statistically at par with 55.38, 55.31 and 54.90 grams found in treatments T_{13} (N4P1K1), T_{16} (N4P2K2) and T_{15} (N4P2K1) respectively. Whileas, lower weight of 51.33 grams was found in treatment T_{11} (N3P2K1) found at par (51.47 g) with treatment T_{12} (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

Table 1. Treatment details

Treatment Code	Treatment Symbol	Fertilizer combination (NPK)		
		1st Doze	2nd Doze	3rd Doze
T_1 (RFD)	N1P1K1	150+120+120	150+0+0	-
T_2	N1P1K2	150+120+60	150+0+60	-
T_3	N1P2K1	150+60+120	150+60+0	-
T_4	N1P2K2	150+60+60	150+60+60	-
T_5	N2P1K1	180+120+120	120+0+0	-
T_6	N2P1K2	180+120+60	120+0+60	-
T_7	N2P2K1	180+60+120	120+60+0	-
T_8	N2P2K2	180+60+60	120+60+60	-
T_9	N3P1K1	120+120+120	180+0+0	-
T_{10}	N3P1K2	120+120+60	180+0+60	-
T_{11}	N3P2K1	120+60+120	180+60+0	-
T_{12}	N3P2K2	120+60+60	180+60+60	-
T_{13}	N4P1K1	120+120+120	90+0+0	90+0+0
T_{14}	N4P1K2	120+120+60	90+0+60	90+0+0
T_{15}	N4P2K1	120+60+120	90+60+0	90+0+0
T_{16}	N4P2K2	120+60+60	90+60+60	90+0+0

**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)
T_1 (N1P1K1)	26.16^{a}	6.16^{a}	52.73^{e}
T_2 (N1P1K2)	26.18^{a}	6.18^{a}	53.35^{f}
T_3 (N1P2K1)	26.11^{a}	6.11^{a}	52.46^{ef}
T_4 (N1P2K2)	26.15^{a}	6.15^{a}	52.64^{e}
T_5 (N2P1K1)	27.05^{b}	7.05^{b}	54.70^{b}
T_6 (N2P1K2)	27.09^{b}	7.09^{b}	54.86^{b}
T_7 (N2P2K1)	26.20^{a}	6.20^{a}	53.53^{c}
T_8 (N2P2K2)	27.02^{b}	7.02^{b}	53.65^{c}
T_9 (N3P1K1)	26.08^{a}	6.08^{a}	51.63^{g}
T_{10} (N3P1K2)	26.10^{a}	6.10^{a}	52.35^{d}
T_{11} (N3P2K1)	26.03^{a}	6.03^{a}	51.33^{h}
T_{12} (N3P2K2)	26.06^{a}	6.06^{a}	51.47^{gh}
T_{13} (N4P1K1)	27.73^{b}	7.73^{b}	55.38^{a}
T_{14} (N4P1K2)	28.00^{b}	8.00^{b}	55.40^{a}
T_{15} (N4P2K1)	27.12^{b}	7.12^{b}	54.90^{a}
T_{16} (N4P2K2)	27.13^{b}	7.13^{b}	55.31^{a}
C.D ($p \leq 0.05$)	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 (%)
T_1 (N1P1K1)	8500.00^{e}	18.48^{g}	93.77^{d}
T_2 (N1P1K2)	8566.67^{de}	18.54^{f}	93.89^{cd}
T_3 (N1P2K1)	8366.67^{f}	18.31^{i}	93.56^{de}
T_4 (N1P2K2)	8433.33^{ef}	18.40^{h}	93.67^{d}
T_5 (N2P1K1)	8833.33^{c}	18.87^{de}	94.16^{c}
T_6 (N2P1K2)	8900.00^{b}	19.01^{c}	94.28^{bc}
T_7 (N2P2K1)	8633.33^{d}	18.79^{e}	93.89^{cd}
T_8 (N2P2K2)	8766.67^{c}	18.84^{e}	94.06^{cd}
T_9 (N3P1K1)	8233.33^{g}	18.25^{j}	92.58^{f}
T_{10} (N3P1K2)	8300.00^{f}	18.29^{ij}	93.35^{e}
T_{11} (N3P2K1)	8133.33^{g}	18.10^{l}	90.08^{h}
T_{12} (N3P2K2)	8200.00^{g}	18.17^{k}	90.60^{g}
T_{13} (N4P1K1)	9100.00^{a}	19.37^{a}	95.57^{a}
T_{14} (N4P1K2)	9133.33^{a}	19.38^{a}	95.59^{a}
T_{15} (N4P2K1)	8966.67^{b}	19.25^{b}	94.41^{bc}
T_{16} (N4P2K2)	9066.67^{a}	19.30^{a}	94.53^{b}
C.D ($p \leq 0.05$)	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 T_{14} (N4P1K2) treatment which was found statistically at par with 9100.00 and 9066.67 in treatments T_{13} (N4P1K1) and T_{16} (N4P2K2) respectively. Whileas, lowest number of 8133.33 was found in treatment T_{11} (N3P2K1) being statistically at par with 8200.00 and 8233.33 found in treatments T_{12} (N3P2K2) and T_9 (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 T_{14} (N4P1K2) being at par with 19.37 and 19.30 kilograms in treatments T_{13} (N4P1K1) and T_{16} (N4P2K2). While as minimum yield of 18.10 kilograms was found in treatment T_{11} (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 T_{14} (N4P1K2) being at par with 95.57 percent found in treatment T_{13} (N4P1K1). Whileas, lower rate of 90.08 percent was found in treatment T_{11} (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- T_{11} (N3P2K1), while as in case of larval weight, cocoon yield by number and weight and pupation rate, the hybrid performed better under T_{14} (N4P1K2) fertilizer Schedule.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/65020