

EFFECT OF LARVAL COLLECTING SYSTEM ON THE SPAWNING EFFICIENCY AND QUALITY OF SEX REVERSED FRY IN TILAPIA FISH HATCHERIES

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SUMMARY

The present study was conducted to evaluate the effects of larval production system on the spawning efficiency and quality of Nile tilapia seeds produced in commercial hatcheries. This study was performed through two stages (spawning and larval rearing). Three treatments were performed during the spawning stage as follows: (1) larvae collected from hatching Laboratory lab. after egg hatching every 10-12 days; (2) larvae collected from hapa every 10-12 days and (3) larvae collected from brood's mouth every 4-5 days. Each treatment was performed in 5 hapas. One thousand and eight hundred brood fish were divided equally on fifteen hapas located in broodstock earthen pond. Each hapa was stocked with 120 broodstocks (90 Female +30 male) at a rate of 5 fish/m³. The average weight of each broodstock was 125 ± 7.8 g. Broodstocks were fed on a commercial diet contained 29.89% protein (produced by Hendrix Company, Egypt) at a rate of 2% of body weight, two meals daily except the days of eggs and/or larvae collection. The collected larvae from the previous treatment were treated with a high dose of hormone (17 α -methyltestosterone (MT) at 100 mg/kg diet for 21 days (larval rearing stage). The results revealed that the spawning performance was improved significantly with larvae collected from brood's mouth system every 4-5 days than those collected directly from hapa or incubated eggs in the laboratory every 10-12 days by about 196 and 148%, respectively. Larvae number/female/year was 2222, 1680 and 3298 larvae for collected system from laboratory, hapa and brood's mouth, respectively. The highest percentage of male was obtained for larvae collected from brood's mouth (96.61%) followed by larvae hatched in laboratory. (96.15%) and larvae collected from hapa (90.33%). The total production cost of fish fry collected from hatchery laboratory was higher than other systems. Percentages of net profit to total cost were 36.54; 24.88 and 94.67% for hatchery collected larvae from laboratory, hapa and brood's mouth, respectively. Sensitivity analysis showed that the three larvae collecting systems would still generate positive net returns even if sales prices decreased by 10% and variable costs increased by 10%. However when sales prices decreased 30% and total costs were increased by 30%, only the larvae collected from brood's mouth system could still be positive, while the larvae collecting system from laboratory and hapa showed losses.

Based on the obtained results, the collected larvae from brood's mouth in hapas every 4-5 days intervals could be recommended for Nile tilapia commercial hatcheries.

Keywords: Nile tilapia, spawning efficiency, sex reversal, economic efficiency

INTRODUCTION

Egypt was ranked in the ninth status in the global production of fish from aquaculture and the twelfth in the production of natural resources FAO (2014). Fish production from aquaculture activities contributed 74% of the total fish production which amounts to 1.305 million metric tons, constituting 63.48 % of them. The fisheries sector contributed 8.5% in national agriculture income. The exploited area in Fish farms in Fayoum Governorate was 2750 feddans besides 12 fish hatcheries (GAFRA, 2012).

Globally, Tilapias are currently the second most important farmed fish species (behind carps). As a result, the global production of farmed tilapia has increased from 383,654 metric tons (mt) in 1990 representing 4.5% of the total farmed fish production to 3,497,391 mt in 2010, representing 8.9% of the total farmed fish production, with an average annual growth of 13.5% (FAO, 2012). This trend has created a gap between seed supply and farmer's demand. Therefore, the major challenge facing tilapia culture industry is the production of sufficient amounts of high quality seeds. Tilapias are a hardy species produced by several culture methods under a wide

range of environmental conditions in tropical and subtropical regions in the developing countries and can be cultured in mesh cages that maintains good circulation of water. It ensures the flexibility in management practices with easy and low cost of harvesting.

The production of mono-sex (all-male) tilapia played a significant role in facing this challenge, due to their fast growth rates, tolerance of a wide range of environmental conditions, resistance to stress and diseases, higher energy conservation, reduced aggressiveness and greater uniformity of size at harvest (El-Sayed, 2006). Although mono-sex male population can be obtained by direct or indirect methods, oral administration of hormones for *Oreochromis niloticus* has been reported to be the most preferred method in the commercial uses (Green and Teichert-Coddington, 2000; Cagauan *et al.*, 2004, Wahby and Shalaby, 2010; and Celik *et al.*, 2011). Oral administration of 17 α -methyltestosterone (MT) hormone is the most common and successful method used for producing all-male tilapia (Penman and McAndrew, 2000; Beardmore *et al.*, 2001; and El-Sayed, 2006;). The hormone is generally

incorporated into starter larval feed at 30–60 mg MT/kg feed, during the critical period of sex differentiation.

The use of artificial incubation units involves the removal of eggs and sac fry from the mouth of females and incubating them artificially as an effective method of tilapia fry production. Net enclosures or hapas are also being used for the hatchery of tilapia (Guerrero, 1997). Hapas has many attributes that make them an excellent hatchery system for tilapia, especially in the developing countries (El-Sayed, 2006). These include easy construction, easy management, easy seed harvest and low cost. Hapas can also be suspended in fertilized earthen ponds, deep water bodies and concrete tanks supplied with clear water.

Currently in Egypt, the most hatcheries having incubation units started to reduce its using and began to depend upon the collected larvae from hapas or brood's mouth in hapas to decrease the hatchery costs. On the other hand, the used dose of hormone treatment increased from 60 mg/kg to 100-120 mg/kg in more than 75% of the Egyptian hatcheries. The intensive farming of tilapia is rapidly expanding and the need to produce sufficient quantities of high quality fry is becoming crucial to meet the increasing global demands for stocking tilapia farms.

The present study was conducted to evaluate the effects of larvae collecting system and treating with high dose of hormone on spawning efficiency and larvae quality as now applying in Egypt at a huge commercial scale.

MATERIALS AND METHODS

Zoo-technical Methods:

This study was conducted in a commercial hatchery at Shakshouk province, Fayoum Governorate, Egypt to evaluate the larval production systems for Nile tilapia applied in other commercial hatcheries on the spawning efficiency and quality of seed through two stages (spawning and larval rearing). The experiment extended during the period from 10 May, 2014 to 10 September, 2014.

Spawning stage:

One thousand and eight hundred broodstock were equally divided on fifteen hapa are placed in earthen pond (each measuring $5 \times 7 \times 0.7 \text{ m}^3$). The broodstock were stocked at a sex ratio of 3 female to 1 male (30 male + 90 Female) with an average weight of $125 \pm 7.8 \text{ g}$ / fish. Broodstocks in hapas were fed on a commercial diet contained 29.89% protein (Hendrix Company) at a rate of 2% of body weight (Bhujel *et al.*, 2007) two meals per day except the days of collecting of eggs or larvae .

Three treatments were tested. Each treatment represented by five hapas as follows :

- The first treatment: The eggs were collected from the mouth of female every 12 days and placed in the hatching laboratory and then fry estimated as weight, length and number in each hapa, then weighed 550 g of them and transported to the fry's

hapas in an area of $2 \times 4 \text{ m}$, then fed diet treated with hormone .

- The second treatment: The larvae were collected from hapa every 12 days quietly and without any disturbance for the broodstock in hapa, then weighed and measured for the length and weight of the larva and then placed in the fry's hapas at the same previous rate that was used in treatment 1 .
- The third treatment: The larvae were collected every 4-5 days from the mouth of each female by testing each female and leaving each female having eggs in mouth to the next collection and the collected larvae weighed and is estimated to the average weight and length and then placed in the fry's hapas at the same previous stocking rate.

Larval rearing stage:

Fish fry were fed on a diet containing 42.42% crude protein (CP) consisting of 30% Herring fish meal and 70% commercial diet (Hendrix company), plus 100 mg/kg diet from 17 α methyl testosterone and fed seven times/day with a feeding rate of 20% of its weight for 21 days.

At the end of the experiment, the identification of the phenotypic sex for 200 juvenile fish from each treatment was determined by microscopic examination of the gonads when the fish reached 4-5 g. The thin gonad (thread-like structure lies along the dorsal side of the abdominal cavity) was extracted very carefully, placed on a glass slide and stained with a drop of aceto-carmin stain then it was lightly squashed with a glass cover slip and examined at 10X magnification for the identification of the juvenile gonads. The fish was a presumptive male and female if densely packed oocytes were found as reported by Guerrero and Shelton (1974).

Diets used during the broodstock and fry treatments were analyzed for their proximate composition in triplicates following the methods described by AOAC (1999). Water temperature, pH, dissolved oxygen (DO), total ammonia ($\text{NH}_3\text{-N}$), and salinity throughout the experimental period were measured periodically in the morning and at noon by centigrade thermometer, Orion digital pH meter model 201, oxygen meter, Cole Parmer model 5946, HACH test kit ammonia mid-range 0-3 mg/L model NI-8 , respectively.

Statistical Analysis:

Data were statistically analyzed using a one-way analysis of variance using SPSS (2007) version 16. Mean of treatments were compared by Duncan multiple range test when the differences were significant.

RESULTS AND DISCUSSIONS

Water quality:

Results in Table (1) show the water quality parameters measured during the study in fish hapas. Mean values (\pm SE) of water quality parameters were recorded as follows: dissolved oxygen DO 5.6 ± 0.10

mg/L, pH 8.0±0.18, water temperature 29±0.96 °C, NH₃-N 0.2±0.10 mg/L and salinity 1.4±0.10ppt respectively. These values were within the safe ranges and acceptable for the spawning and growth

of tilapia as reported by El-Sayed (2006), Magid and Babiker (1975), Ross (2000) and El-Sherif and El-Feky (2008).

Table 1. Water quality parameters (Mean±S.E.) measured during the experiment

Item	DO, mg/L	pH	Temp., °C	NH ₃ -N, mg/L	Salinity, ‰
First month	5.7±0.29	8.0±0.21	28±0.81	0.2	1.3±0.11
Second month	5.6±0.28	8.00.21	29±0.80	0.2	1.5±0.10
Third month	5.5±0.27	8.00.20	30±0.82	0.2	1.4±0.11
Forth month	5.5±0.27	8.00.21	28±0.81	0.2	1.5±0.13
Mean + S.E	5.6± 0.10	8.0±0.18	29±0.96	0.2±0.10	1.4±0.10

Spawning efficiency:

Results of spawning efficiency of Nile tilapia *O. niloticus* broodstocks under different larval collecting system are presented in Table 2. The results indicate that there were significant ($P \leq 0.05$) differences between treatments and larval collecting system from brood's mouth exhibited a significantly higher spawning performance than those collected from hapas or hatching laboratory, on larval weight (g/hapa), larval number (pcs/hapa), number of spawned females and the frequency of spawning per female. The spawning intervals (days) increased by approximately 196 and 148 % for brood's mouth compared with hapas and hatching laboratory, respectively. On the other hand, absolute fecundity improved significantly with larvae collected from hatching laboratory. compared with those collected from hapas and brood's mouth. Therefore, the total fry production of a hatchery collecting larvae from brood's mouth and contains 40 hapas was higher than other hatcheries depended on collecting larvae from hapas or hatching Lab. by 197.5 and 148%, respectively. FCR values during larval rearing period improved significantly for larvae collected from brood's mouth compared with hapas and hatching laboratory larvae. The results show significant improvement of spawning performance with larvae collected from brood' mouth system every 4-5 days than that collected directly from hapas or incubated egg in hatching laboratory every 10-12 days. This may be due to short time intervals between collection

from brood' mouth which encourage the broodstock to inter to next spawning stage than hapas or hatching laboratory leading to an increase in the number of larvae collected from mouth by about 196 and 148% than other systems from hapa or lab., respectively. Larvae number/female/year was 2222, 1680 and 3298 larvae for collecting systems from hatching laboratory, hapas and brood's mouth, respectively. The spawning performance of female Nile tilapia observed in the present study is generally within the range of values or higher than that reported by other hatching laboratories based on the breeding experiments (Santiago and Reyes, 1993; Gunasekera *et al.*, 1996; Campos-Mendoza *et al.*, 2004; El-Sayed *et al.*, 2005; SBRT 2007; El-Sayed and Kawanna, 2008; Lupatsch *et al.*, 2010, Naiel *et al.*, 2011 and Nasr-Allah *et al.*, 2014) and less than that obtained by Ng and Wang (2011). However, any direct comparison with results from other studies should consider the differences in tilapia strains and experimental conditions used. Over the period of 4 months, larval collecting system using brood's mouth was the best in larvae number per hapa and per fish compared with the other larval collecting systems. However, the observed absolute fecundity did not significantly differ among the tested systems. The higher larvae production from brood's mouth was therefore due to increased spawning frequency, shorter inter spawning intervals and greater number of spawned females.

Table 2. Spawning efficiency of Nile tilapia (*O. niloticus*) brood-stocks under different larval collecting systems

Item	Larval collecting system		
	Laboratory	Hapa	Mouth
Larvae weight, g/hapa	2222 ^b ±89.6	1680 ^c ±126.5	3298 ^a ±119.3
Larvae number, fry/hapa	202474 ^b ±8136	152595 ^c ±1152	299981 ^a ±1084
No of spawned Female	292 ^b ±11.79	227 ^c ±17.09	446 ^a ±16.12
Spawning frequency, number/female	3.25 ^b ±0.13	2.52 ^c ±0.19	4.95 ^a ±0.18
Feed consumed, g/hapa	25000	25000	25000
FCR *	11.25 ^b ±0.45	14.88 ^a ±1.11	7.58 ^c ±0.26
Spawning intervals, days	37 ^b ±1.48	49 ^a ±3.57	24 ^c ±0.51
Absolute fecundity	693 ^a ±7.68	672 ^b ±10.68	673 ^b ±18.95
Total hatchery production per thousand	8099	6104	11999

Results are the mean ±S.E. Values in the same row with different superscripts are significantly different ($P \leq 0.05$)

*Feed conversion ratio = feed consumed/total larvae weight (As feed turns into fry)

Sex reversal efficiency:

Results of sex reversal efficiency as affected by larval collecting systems are illustrated in Table 3.

The results show that the highest percentage of male was obtained for larvae collected from brood's mouth (96.61%) followed by larvae collected from hatching

laboratory (96.15%) and larvae collected from hapa (90.33%). However, analysis of variance on the percentage of male indicated that there was no significant difference ($P \leq 0.05$) among larvae collected from brood's mouth and hatching laboratory but significantly higher than that collected from hapas. Percentage of males among the tested treatments were similar to the findings of Vera Cruz and Mair (1994). The androgen had no significant effect on growth and survival of fry during the treatment period and produced sex conversal rate of 94.36% male in hapas. Macintosh *et al.* (1988) reported a sex conversion of 95.7% and 92.8% in

their experimental units stocked with methyl-testosterone-treated fry.

Decreased male % of larvae collected from hapa (90.33%) may be due to presence of natural food in the water of hapa especially in Egypt where all fish farms based on agricultural drainage water rich in natural foods. Also, larvae collected from hapas system every 10-12 day have high probability to contain multi ages of larvae more than other systems with a high probability to begin feeding on natural foods in hapa before collecting. Thus, the larvae treated with hormone under hapas treatment was less effective than the other treatments.

Table 3. Sex reversal efficiency as affected by larval collecting system

Item	No examined	Male%	Female %	Intersex%
Larvae collected from laboratory	184	96.15 ^a ±0.16	2.72 ^b ±0.23	1.09
Larvae collected from hapa	172	90.33 ^b ±4.06	7.56 ^a ±0.82	2.33
Larvae collected from brood's mouth	204	96.61 ^a ±0.06	2.45 ^b ±0.16	0.98

Results are the mean ±S.E.

Values in the same column with different superscripts are significantly different ($P \leq 0.05$)

Growth performance and survival rate (%) of larvae:

Larval growth performance parameters are illustrated in Table 4 which show significant differences ($P \leq 0.05$) between treatments on average weight at stocking, weight at the end of the experiment (21 days), weight gain, SGR and FCR. The growth performance for larvae collected from hapas was higher than other larval collecting systems. Number of larvae at harvesting/ hapa and at starting was significant different ($P \leq 0.05$) but survival rate was insignificant.

The condition factor for *O. niloticus* larvae was 1.28, 1.24 and 1.26 after larval collection and 1.81, 1.65 and 1.62 after sex reversal period for larvae collected from hatching laboratory, hapas and brood's mouth, respectively. Results in Table 4 shows

that both larval length and weight after sex reversal were significantly ($P \leq 0.05$) lower with larvae collected from hatching Lab. than for larvae obtained from hapa and brood's mouth. There were no significant ($P > \leq 0.05$) differences in length at the start. The values of growth performance were obtained through the experiment from hapas treatment showed higher values compared to the larvae from laboratory or brood's mouth. These results may be due to the fact that larvae from hapa don't hatched in the same day but in different days and age was different and became high in weight than larvae from lab which hatched in the same day. However, larvae obtained from brood's mouth was in between because the larvae was taken from mouth or hatched in a previous day.

Table 4. Growth performance and survival rate (Mean±S.E.) of larvae produced under different larval collecting systems

Item	Larval collecting system		
	Laboratory	Hapa	Broods's mouth
Number of larvae at stocking/hapa	202474 ^b ±8136	152595 ^c ±1152	299981 ^a ±1084
Number of larvae at harvesting/hapa	182228 ^b ±7444	137340 ^c ±10166	269978 ^a ±11271
Survival rate, %	90.00±0.161	90.00±0.592	90.00±0.853
Larvae weight at start, mg	10.97 ^c ±0.008	11.01 ^a ±0.007	10.99 ^b ±0.007
Larvae weight at end, mg	97.90 ^c ±0.05	110.46 ^a ±0.27	103.61 ^b ±0.13
Weight gain, mg	86.93 ^b ±0.04	99.45 ^a ±0.27	92.62 ^b ±0.13
SGR*	10.42 ^c ±0.002	10.98 ^a ±0.011	10.68 ^b ±0.005
Larvae length at start, mm**	9.5±0.04	9.62±0.03	9.56±0.04
Larvae length at end, mm	17.54 ^c ±0.02	18.84 ^a ±0.05	18.58 ^b ±0.03
Condition factor at start	1.28±0.02	1.24±0.01	1.26±0.01
Condition factor at end	1.81 ^a ±0.01	1.65 ^b ±0.01	1.62 ^c ±0.01
Feed consumed, mg/larvae	72.92	72.92	72.92
FCR (for growth)***	0.84 ^a ±0.001	0.73 ^c ±0.002	0.79 ^b ±0.001

Values in the same row with different superscripts are significantly different ($P \leq 0.05$)

*Specific growth rate = $[(\ln \text{ final fish weight} - \ln \text{ initial fish weight}) / \text{time}] \times 100$.

**Condition factor = $100 \times W/L^3$, where W is the fish weight (g), and L is the total length of fish (cm).

***Feed conversion ratio = feed consumed/total larvae weight (As feed turns into fry)

Economic efficiency:

The economic efficiency of the tilapia hatcheries that are applying these systems and containing 40 hapas of broodstocks (3600 ♀ + 1200 ♂) is illustrated in Table 5. Total costs of each hatchery was different according to their equipment. Larvae hatched in laboratory was higher in costs and fry sales price than other systems. The net returns from each hatchery was higher with brood' mouth collecting system followed by hatching laboratory and hapas systems. This study shows that if larvae are collected from brood's mouth every 4-5 days in a hatchery contained 4800 broodstock (40 hapa) will produce about 10.799 million fry after sex reversal in a spawning season. Total costs were 215,000; 104,000 and 113,000 LE /hatchery for the larval

collecting systems from hatching laboratory, hapas and brood's mouth, respectively. These results reveal that the total cost of hatchery contains laboratory was the highest than other systems. On the other hand, the total cost of hatchery based on larvae collected from hapa (without lab) was the lowest due to the absence of lab and less labor costs. Net returns in LE per hatchery were 78,564; 25,872 and 106,982 for the larvae collected from laboratory, hapa and brood's mouth, respectively. Percentages of net return to total cost were 36.54; 24.88 and 94.67% for hatchery collected larvae from laboratory, hapas and brood's mouth, respectively. The results indicated that the highest net returns were obtained with the larval collecting system from brood's mouth.

Table 5. Economic efficiency of tilapia hatcheries applied different larval collecting systems

Item	Larval collecting system		
	Hatching laboratory	Hapa	Brood's mouth
Hatchery costs, LE*			
Brood	25,000	25,000	25,000
Feed	28,000	24,000	33,000
Equipment and apparatus	112,000	27,000	27,000
Other (land, labors)	50,000	28,000	28,000
Total costs	215,000	104,000	113,000
Selling fry, LE			
Mono sex fry	291564	109872	215982
Mixed fingerlings	2000	20000	4000
Total sales	293564	129872	219982
Net returns/hatchery, LE	78,564	25,872	106,982
Net returns/total costs %	36.54	24.88	94.67

* U.S.\$ = 7.4 LE

Price of 1000 fry was 40 LE for hatching Lab and 20 LE form hapa and brood's mouth

Sensitivity analysis:

Sensitivity analysis was performed to measure the financial performance of the three larval collecting systems in the case of increasing total costs and decreasing sales prices (Table 6). There are critical threats facing hatcheries during spawning season, particularly the increasing cost of feed, fuel and labor costs. Also, sales prices have decreased over the years, probably due to increasing competition between hatcheries. The system of larval collection from brood's mouth is more stable in positive case compared to other systems that were less stable. Sensitivity analysis showed that the three larval collecting systems would still generate positive net returns even if sales prices decreased by 10% and variable costs increased by 10%. However when

sales prices decreased 30% and total costs were increased by 30%, only the larvae collected from brood's mouth system could still be positive, while the larval collecting systems from lab and hapa showed losses. Hatcheries collected larvae from hapa appears more affected by increasing total costs or decreasing sales prices for more than 20% but hatcheries using larvae collected from lab are in between. These results are in agreement with the results obtained by Green *et al.* (2002) who found that a 20% reduction in fish selling prices for Egyptian fish farmers resulted in negative net returns indicating that hatcheries are more tolerant to financial shocks than grow-out fish farms.

Table 6. Sensitivity analysis of changes in sales prices and total costs on net returns per hatchery (LE/season)

Larvae collected system	Change in sales price	Changes in total costs			
		0	+10	+20	+30
Laboratory	0	78.564	57.064	35.564	14.064
Hapa	0	25.872	15.472	5.072	-5.328
Brood's mouth	0	106.982	95.682	84.382	73.082
Laboratory	-10	49.208	27.708	6.208	-15.292
Hapa	-10	12.885	2.485	-7.915	-18.315
Brood's mouth	-10	84.984	73.684	62.384	51.084
Laboratory	-20	19.851	-1.649	-23.149	-44.649
Hapa	-20	-0.102	-10.502	-20.902	-31.302
Brood's mouth	-20	62.986	51.686	40.386	29.086
Laboratory	-30	-9.505	-31.005	-52.505	-74.005
Hapa	-30	-13.09	-23.49	-33.89	-44.29
Brood's mouth	-30	40.987	29.687	18.387	7.087

CONCLUSIONS

In conclusion, larval collecting system from brood's mouth every 4-5 day was the best on basis of spawning efficiency, high sex reversal rate and economic efficiency than larvae collected from hapas and this system can be applied easy in any hatchery.

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تأثير نظام جمع اليرقات على كفاءة التفريخ وجودة الزريعة المحولة جنسيا في مفرخات اسماك البلطي

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أجريت الدراسة لتقييم تأثير نظام إنتاج اليرقات على كفاءة تفريخ وجودة زريعة البلطي النيل المنتج في المفرخات التجارية. أجريت هذه الدراسة من خلال مرحلتين (تفريخ وتربية اليرقات) أجريت ثلاث معاملات خلال مرحلة التفريخ على النحو التالي: (1) اليرقات التي تم جمعها من الفقس في المعمل بعد جمع البيض كل 10-12 يوما (2) اليرقات التي تم جمعها من الهابا كل 10-12 يوما و (3) اليرقات التي تم جمعها من فم الامهات كل 4-5 أيام. مثلت كل معاملة في 5 هابات. وقد تم تقسيم ألف وثمانمائة ام على نحو متساو على خمسة عشر هابة تقع في الأحواض الترابية. وقد تم تخزين كل هابة ب 120 ام (90 أنثى + 30 ذكر) بمعدل 5 أسماك / م³. وكان متوسط وزن كل من الأمهات 125 ± 7.8 جرام. تم تغذية الامهات على علف تجاري يحتوي على 29.89% بروتين (تنتجها شركة هندريكس، مصر) بمعدل 2% من وزن الجسم، ووجبتين يوميا باستثناء أيام جمع البيض أو جمع اليرقات. تم معاملة اليرقات التي تم جمعها من المعاملات السابقة بجرعة عالية من الهرمون 17-α ميثيل تستوسترون (100 ملجم / كجم من العليقة) لمدة 21 يوم (مرحلة تربية اليرقات). وأظهرت النتائج أن أداء التفريخ تحسن بشكل ملحوظ مع اليرقات التي تم جمعها من فم الامهات كل 4-5 أيام من تلك التي تم جمعها مباشرة من الهابات أو البيض الذي تم فقسه في المعمل كل 10-12 يوما بحوالي 196 و 148% على التوالي، وبلغ عدد اليرقات / ام / السنة 2222 و 1680 و 3298 يرقة للنظام الذي تم جمعه من البيض الفاقس بالمعمل ثم المجموعة من الهابات و المجموعة من فم الامهات على التوالي.

أعلى نسبة من الذكور لليرقات التي تم جمعها من فم الامهات (96.61%) تليها اليرقات الفاقسة في المعمل (96.15%) واليرقات التي تم جمعها من الهابة (90.33%)، وكانت تكلفة إنتاج الزريعة التي تم جمعها من المعمل أعلى من نظيرتها الأخرى. وبلغت نسبة صافي الربح إلى إجمالي التكلفة 36.54، 24.88 و 94.67% لليرقات التي تم جمعها من المفرخات من المعمل، الهابات و فم الامهات على التوالي وقد أظهر تحليل الحساسية أن أنظمة جمع اليرقات الثلاثة ستظل تحقق عائدا صافيا إيجابيا حتى لو انخفضت أسعار المبيعات بنسبة 10% وزادت التكاليف المتغيرة بنسبة 10%. ومع ذلك، عندما انخفضت أسعار المبيعات بنسبة 30%، وزادت التكاليف الإجمالية بنسبة 30%، فإن اليرقات التي تم جمعها من نظام فم الامهات لا تزال إيجابية، في حين أظهر نظام جمع اليرقات من المعمل و الهابات خسائر.

استنادا إلى النتائج التي تم الحصول عليها، يمكن أن يوصى بنظام جمع اليرقات من فم الامهات كل 4-5 أيام لمفرخات البلطي التجارية