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STUDY ON USING DIFFERENT TECHNIQUES FOR WEEDS CONTROL IN FISH POND

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Abstract

This study was conducted during a culture season, 1995 in thirty fresh water earthen ponds having different areas; seven and half, one and half feddan in fish ponds of Central Laboratory for Aquaculture Research, Abbassa, Abou-Hammad, Sharkia, Agricultural Research Centre.

Natural feeding was established by applying chicken manure and superphosphate and urea. Commercial pelleted fish feed 25% crude protein was also applied as supplemental feed. Fish species under experimentation were tilapia, *Oreochromis niloticus,* common carp, *Cyprinus carpio,* silver carp, *Hypophthalmichthys molitrix,* and grass carp, *Cetenopfaryngodon idella.* All species were stocked under a good care in a polyculture system with number of 1500, 72 and 150 for tilapia, common carp and silver carp, respectively. Twelve fingerlings from grass carp were added for the three treatments (biological only, biological + mechanical and manual). Water quality was examined every two weeks. Three plants were tested (Cattail - Paragrass and Coontail) for control. Mechanical control was carried out by using American grass cutting machine (Hockney model Hc-10H). Manual control was done by using hand stickle. Biological control was applied,by using grass carp fish. At the end of the growing season in December 1995, ponds were drained and fish were collected by seining. Total fish production was determined.

Results indicated that increase pond area improved the machine performance. Increasing the moisture percentages led to high machine performance. It can be concluded that water depth of 100 cm improves the machine performance in controlling the three kinds of weeds.

Results obtained showed that pond conditions were 2% lifted weeds, free and 4% lifted weeds communities in the ponds at the end of the experiment for biological + mechanical, manual + biological and biological control, respectively.

Total fish production was highest for manual + biological control. Net return was highest under mechanical + biological method.

INTRODUCTION

Ponds and lakes can develop dense of aquatic vegetation that interfere with intended users and destroy the aesthetic value of the body of water. Most weed problems result from poor planning and poor management of a water body. It is often possible to manipulate factors affecting plant growth (i.e. water, light, nutrients, etc.). In such a way that noxious plant concentrations do not occur. The larger aquatic plants may be divided into several ecological groups of macrophytic algae and submersed, floating, floating-leafed, or emergent vascular plants. Macrophytic algae include these species which are attached to the bottom and extended upward through the water. Macrophytes may be responsible for a variety of ecological problems in ponds. They comet with phytoplankton for nutrients and light, provide cover so that too many forage fish escape perdition causing an imbalance of fish populations, interfere with fishing and with seining of fish, prevent fish from finding feed when it is applied, and cause deficiencies by covering the entire pond surface and limiting light penetration (Boyd, 1979).

Dobbins and Boyd (1976) reported that macrophyte growth was an important source of variation in plankton and fish production in pond fertilization experiments. Gross primary productivity values for ponds receiving the same treatment were usually highest in ponds with the least cover by macrophytes and vice versa. The authors also observed sudden die of macrophytic algae mats that cause D.O. depletion.

Michell and Thomas (1972) reported that there were four main life forms, which are related to the plant position with respect to the water surface:

- Free floating plants.
- Submerged plants generally attached to the bottom by roots.
- Attached plants with floating leaves.
- Surface plants with vegetative parts normally emerging above the surface of water.

Weed infestation of aquaculture farms is a problem in almost all systems of aquaculture all over the world. He added that it assumes very severe proportions in tropical and sub-tropical pond farms (Pillay, 1990). Besides restricting the movement of fish and other aquaculture organisms, dense growth of vegetation, particularly floating plants, prevent adequate light penetration in the water, and thus, may affect their productivity. Photothynthesis and oxygen production will be reduced when pond surface is covered by vegetation, and this may cause oxygen depletion and anoxia of the cultured fish species. Mass mortality of fish can occur under these conditions (Pillay, 1990).

Weeds are normally removed thrc ugh two ways: cutting or dredging. Scarcity of labor and increasing of weed control costs are forcing the adoption of hand mooring among methods.

Mechanization is partly an answer, but does not overcome the need for continuous operation, and measures that give long-term growth control.

Biological control is relatively new. Grass carp. White amur (*Cetenopharyngodon idella*), native to a wide range of south China, had exhibited tolerance, to a wide range of temperatures, to low oxygen levels, as well as, to brackish water. These are considered to be one of the most promising agents for biological control of rooted aquatic plants (weeds).

This study is an attempt to solve weed problems by investigating such methods to select the proper method in respect to least requirement of energy, cost and time.

MATERIALS AND METHODS

This study was conducted through 1995 in thirty fresh water earthen ponds. The water area was divided into water plots having the area of seven and half, one and half fed (Fed) in Abbassa fish farm, belonging to Central Laboratory for Aquaculture Research, Abbassa, Abou-Hammad, Sharkia, Agricultural Research Centre.

Ponds

- First group: 9 earthen ponds 7.5 Fed having dimensions of 350 X 75 m. 6.2 fed net water area.
- Second group: 9 earthen ponds 1.25 fed having dimensions 107 X 50-m one fed net water area.
- Third group: earthen ponds 0.75 fed having dimensions of 106 X 28-m 0.50 fed net water area.

Normal water depth was adjusted to 100, 80, 60,50 and 40 cm in each pond during the period of the experiment.

Fertilization and feed

The natural food in the ponds was established by applying chicken manure, superphosphate and urea. Commercial pelleted fish 25% protein was also used as supplementary feed at a rate of 3% of fish biomass.

Fish

Tilapia species, *Oreochromis niloticus*, carp species, common carp, *Cyprinus carpio*, silver carp, *Hypophthalmichthys molitrix*, and grass carp, *Cetenophthalmichthys miltrix*. The average masses were 15, 130, 450 and 120 g for tilapia, common carp, silver carp and grass carp, respectively. The fish species cited above are stocked at a rate of 1500, 72, and 150 fish per fed in a polyculture system. Twelve grass carp fish were added extra to the ponds with biological control only, biological with mechanical control and biological with manual weeds removal.

Tools

- Secchi disk. It consists of a weight circular plate, 20 cm in diameter, with the surface painted with opposing black and white quarters. It is attached to a calibrated line a ring at the centre so that when held by the line it sinks readily. It is used to measure the visibility that reflects the density of natural food in ponds.
- pH meter used to measure hydrogen ion activity, which is logarithm of the reciprocal of the hydrogen concentration.
- Dissolved oxygen meter, used to measure the dissolved oxygen in water. Water depth was also determined every month. Table 1 shows the average water quality parameters of ponds in the growing season.

Aquatic weeds

Aquatic plants may be free floating, emerged, submerged or shoreline.

- Cattail (*Typha species*) emerged plants are flat and smooth flowers look like a "cat tail" and can be found in a tightly packed spike usually 6-8 inches long.
- Paragrass (*Brachiaria purpurascens*) Paragrass often forms stems several meters in length often on the ground. It can easily be identified by the dense hairs covered leaves located at the stem joints forming roots.
- Coontail (*Ceratophullum demersum*) submersed. Its leaves grow in a whorl and are finely dissected and have teeth on one side of the leaf margin. Leaves are 0.5-1 inch in length and crowded towards the stem tip giving the appearance of a raccoon. Coontail is rootless and floats near the surface in the warmer months. Its reproduction is by seed and fragmentation.

Machine for mechanical control

Mechanical control was conducted by using an American grass cutting machine (Hockney model) with the following specifications: model Hc-10H, engine: Wisconsin diesel wd2-1000, capacity power 21 Hp-2 cylinder, air cool, diesel fuel capacity 2.24 gallon, consumption 0.8 gallon/hour, oil capacity 2.1 quarts.

Sickles

Sickles were used in manual control for cutting grasses and weeds on drying land and also in water.

Grass carp

Plant-eating organisms (herbivores) have been stocked in ponds to control vegetation. Fish such as the white amur or grass carp have been introduced to consume weeds and algae.

Each pond, before being used, was drained and left to be completely dry. Great care was undertaken to screen the water inlets and outlets. Fertilizations were carried out at intervals of one month at a rate of 50 kg chicken manure, 25 kg superphosphate and 12.5 kg urea per fed. Supplemental feed was applied in each pond every day at a rate of 3% of body weight of the fish. Water quality of ponds was checked monthly to determine its temperature, salinity, pH, dissolved oxygen, nitrate according to Boyd (1979).

All species were stocked in polyculture system with numbers of 1500 tilapia, 72 common carp, 150 silver carp and 12 grass carp per pond or per feddan for the three treatments (biological only, biological + mechanical and biological + manual).

Two experiments were done. The first one was carried out to measure the capacity of machine in weed control. The machine was used to control three species of weeds. The work was done at different depths 100, 80, 60, 50, and 40 cm in all experimental ponds (7.5, 1 and 0.5 fed). The second experiment was carried out to evaluate the effect of different methods of weed control on the total fish production.

The cost estimation for each method was calculated according to market prices. This evaluation was done according to Awady (1978) as follows:

$$C = P/h\ (1/a + i/2 + t + r) + (1.2\ W.S.F.) = m/144$$

Where:

C = hourly cost
P = capital investment = 2500 pound
h = yearly operation hours = 1000 h/y
a = life expectancy of the machine = 10 years
i = interest rate 13%
t = takes ratio 5%
r = repair and maintenance ratio 10%
1.2 a factor including reasonable estimation of the oil consumption in addition to fuel.
W = horse power of the engine
F = specific fuel consumption lit/kW = 1.9/15.7
S = price of fuel per liter = 0.40 pound
m = labor wage rate per month in pound = 150 pound
144 = reasonable estimation of monthly working hours.

RESULTS AND DISCUSSION

Factors affecting the mechanical control performance

Pond area

Table 2 shows the effect of different pond areas of 0.5, 1 and 7.5 fed on machine performance in controlling three weed species under 80 cm depth of water. It was noticed that values of performance rate of 2185, 289 and 255 m^2/h were remarked under pond area of 7.5 fed, for cattail, coontail and paragrass weeds, respectively. The machine productivity was of 1505, 167 and 117 m^2/h for catial, coontail and paragrass, respectively at the area of 0.5 fed. At water area one fed., machine performance was 1757, 279 and 245 m^2/h for cattail, coontail and paragrass, respectively.

It could be said that the increase of pond area improved the machine performance. This could be attributed to the less time losses compared with the small areas.

Weed species

The relation between weed species and performance of the machine is presented in Table 2 indicating that the machine performance is more affected by weed species, whereas, the highest productivity values of 1505, 1757 and 2185 m^2/h for cattail, 167, 279 and 289 m^2/h for coontail and 117, 245 and 255 m^2/h for paragrass under

0.5, 1 and 7.5 fed area were noticed, respectively. This may be due to that the cattail weeds have flat leaves and smooth flowers and can be found in tightly spike usually 6-8 inches long (15-20 cm). Moreover, coontail weeds are rootless and float near the surface in warmer months. Paragrass can easily be identified by the dense hairs being located at the stem joints forming roots. In addition, moisture percentage for cattail was slightly higher (89.80%) than coontail and paragrass (89.51 and 87 %, respectively). Increasing the moisture percentage leads to high machine performance.

Water depth

Table 2 shows the effect of water depth on machine performance at different pond areas of 0.5, 1 and 7.5 fed in controlling different weeds. It was noticed that the highest values of machine performance of 2188, 1760 and 1508 m^2/h for cattail, 292, 280 and 168 m^2/h for coontail and 258, 247 and 118 m^2/h for paragrass under pond area were 7.5, 1 and 0.5 fed, respectively at water depth 100 cm.

It could be concluded that water depth of 100 cm improved machine performance in controlling the three kinds of weed (cattail, coontail and paragrass). This may be attributed to that, decreasing water volume, the machine was near to the bottom and consequently decreased the efficiency of machine performance. In this respect, Abdel-Maksoud and Salem (1976) reported that operation of the Machine depends on many factors, mainly soil moisture content, area and nature of canal and drain section; depth of operation, density of weed growth. Lewis and Miller (1980) reported that some machines have been developed to control aquatic Weeds. These machines, either cut or drag weeds from the ponds. The authors found that seining or raking weeds out of the water can be an effective control method in small ponds. Pillay (1990) mentioned that there are several types of mechanical equipment that have been devised for weed control. He added that, many of them consist of flat-bottom boats filled with cutting beams or other cutting devices which can be adjusted to cut at different depths.

Based on these results, it is to recommend the application of machine weed Control model Hockney Hc-10H for pond areas over one fed. at depths over 50 cm for better efficiency and performance.

Weed species

Table 2 shows the effect of the different weed species on the manual control at different water depths. It was noticed that the highest values of productivity rate were

15.2, 14.1 and 11.1 m^2/h for cattail, paragrass and coontail, respectively at water depth 40 cm.

From the obtained results, it could be concluded that weed species affected the manual productivity. Manual control increased with the softness of weeds and decreased with their hardness. This result agreed with the conclusion of Committee members of exotic pest plant Council (1990).

Biological control

The obtained values showed that grass carp in biological treatment had highest body weight and body length (2228g and 56 cm) (Table 3). Manual + biological control resulted in the lowest body weight and body length (1355g and 50 cm). Mechanical biological control registered intermediate values (1737g and 53 cm) (Table 3). In this respect, Scott *et al.* (1993) found that the total value of vegetation declined by 30%, whereas, the total vegetation biomass performance was related to grass carp size, which would be considered when target plant species will be evaluated. They added that grass carp provided economical and effective method of biological weed control. The results obtained showed that pond conditions were 2% lifted weeds, free and 4% and 0% lifted weed communities in the ponds at the end of the experiment for biological + Mechanical, manual + biological and biological control, respectively, while, control ponds showed 75% weeds lifted (Table 4).

Biological + manual control showed best method for weed control followed by Biological + mechanical in a decreasing order. Depending on biological method only, it seemed to have the lowest effect on weed control.

It could be concluded that biological control in addition of manual control was an effective method for controlling weeds in aquaculture ponds.

Economic evaluation of weed control methods

Table 4 showed pond condition under different weed control methods at the end of the experiment. Manual and manual + biological methods could be considered as a vital method to get rid of all weeds, but it requires more effort and more time, so, it will be uneconomic. Ponds were free from weeds in those two methods.

Mechanical and mechanical and mechanical + biological methods show 2% of lifted weed from the pond area. Weeds in biological methods 4% lifted weeds from the ponds at the end of the experiment.

Table 4 showed that fish production were 611.68, 583.85, 578.35, 566.42 and 554.37 kg/pond for manual + biological, manual, mechanical + biological, mechanical and biological control methods, respectively. High fish production was observed for manual + biological then, manual, mechanical + biological and Mechanical in a decreasing order. Biological method showed less fish production. Low fish production was observed when weeds were uncontrolled. This result can be attributed to low value of available nutrition, dissolved oxygen, disease infection and high mortality.

Economic evaluation of weed control methods was shown in Table 4. The costs of the different methods were 1146.75, 1042.95, 816.82, 813.95 and 802.95 L.E. for manual, manual + biological, mechanical + biological, mechanical and biological, respectively.

Net return was the highest for mechanical + biological method. It was 1496.58 L.E. The net return of mechanical, biological, manual + biological and manual were 1451.73, 1414.53, 1403.77 and 1188.65, respectively. The lowest net return for manual + biological and manual control may be due to the high cost of carrying out those two methods. However, early manual removal of invading plants is an effective means of preventing serious weed infestations. Water bodies should be examined frequently during the growing season and when possible stands of potentially noxious plants manually removed before seed formation. Van Zon (1977) stated that the mechanical means costs are too high, especially as results of the control frequently to keep the machinery effective. One of the reasons that prohibits the cost of mechanical control to be kept down in the fact that every aquatic situation needs its own adapted machinery. For some users of water, mechanical control may cause disagreeable side-effects, the aquatic life cycle are interrupted way vigorously, and life possibilities for escaping organisms can be decreased tremendously.

Table 1. Average water quality (analysis) of ponds in growing season respectively.

Measurments	Treatments					
	mechanical	manual	mechanical + biological	manual + biological	biological	control
Temperature	28.2	28.2	27.9	28.4	28.2	29.5
Dis. oxygen	2.6	2.6	1.7	2.0	2.4	3.1
Salinity	0.05	0.05	0.05	0.05	0.05	0.05
pH	8.8	8.8	8.8	8.8	8.8	8.8
Ammonia	0.7	0.7	0.7	0.7	0.7	0.7
NH_3	0.28	0.28	0.28	0.28	0.28	0.28

Table 2. Factor affecting the manual and machine productivity under different water depths.

water depth (cm)	weed species											
	Cattail				paragrass				coontail			
	machine productivity (m^2/h)			manual productivity (m^2/h)	machine productivity (m^2/h)			manual productivity (m^2/h)	machine productivity (m^2/h)			manual productivity (m^2/h)
	pond area (fed)			pond	pond area (fed)			pond	pond area (fed)			pond
	7.5	1.0	0.5	different areas	7.5	1.0	0.5	different areas	7.5	1.0	0.5	different areas
100	2188	1760	1508	12.5	258	247	118	12.3	292	280	168	9.5
80	2185	1757	1505	13.1	255	245	117	12.6	289	279	167	9.7
60	2064	1659	1352	13.4	240	228	97	12.9	275	261	150	9.8
50	2058	1652	1347	14.25	236	225	95	13.4	268	259	146	10.2
40	0000	0000	0000	15.2	000	000	000	14.1	000	000	000	11.1

Table 3. Effect of control method on growth performance of grass carp.

Treatment	Stocked				Harvest			Gain	
	No.	Avg. wt. (g)	Total length (cm)	Total wt. (kg)	Avg. wt. (g)	Total length (cm)	Total yield (kg)	Avg. wt. gain (kg)	Net yield (kg)
Biological	12	450	25	5.4	2228	56	26.736	1.77	21.34
Biological + Mechanical	12	450	25	5.4	1737	53	20.844	1.28	15.44
Biological + Manual	12	450	25	5.4	1355	50	16.260	0.91	10.86

Table 4. Effect of treatments on pond condition %, fish production kg, the total cost, total production and net return (LE).

	Treatments					
	mechanical	manual	mechanical + biological	manual + biological	biological	control
pond condition (%)	2	0.000	2	0.00	4	75.00
fish production (kg)	5.66	583.85	578.35	611.68	554.37	175.53
the cost (L.E.)	813.95	1146.75	816.82	1042.95	802.95	786.75
the production (L.E.)	2265.68	2335.4	2313.4	2446.72	2217.48	702.12
net return (L.E.)	1451.73	1188.65	1496.58	1403.77	1414.53	-83.63

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دراسة عن استخدام طرق مختلفة فى مقاومة الحشائش بأحواض الاستزراع السمكى

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يتوقف زيادة الإنتاج السمكى من المزارع السمكية على مدى العناية بإدارة الأحواض وبالأخص الحشائش الضارة التى تقيد حركة الأسماك وتنافسه فى الغذاء وتعمل على تجرح الأسماك وبالتالى إصابة الأسماك بالفطريات. كما أن كثافتها العالية تؤدى إلى تكوين طبقة عازلة تمنع الضوء وبالتالى انخفاض تركيز الاكسجين بالأحواض. ومن أهم أنواع الحشائش المنتشرة والتى تم التعرف عليها هى البوط والججنة ونخشوش الحوت.

أجريت هذه الدراسة بالمعمل المركزى لبحوث الأسماك بالعباسة التابع لمركز البحوث الزراعية. مدة التجربة سنة كاملة من ١/١/١٩٩٥ إلى ٣١/١٢/١٩٩٥، وذلك بهدف الوصول إلى أنسب الطرق لمقاومة هذه الحشائش بالأحواض السمكية للحصول على إنتاج من الأسماك بأقل التكاليف الممكنة. وقد نفذت فى التجربة ثلاث طرق:

- المقاومة الآلية - المقاومة اليدوية -المقاومة البيولوجية

تم إجراء التجربة على أحواض مساحتها ٠,٥ ، ١ ، ٧,٥ فدان لمعرفة معدل أداء الآلة فى المساحات المختلفة من الأحواض وتحت أعماق مختلفة ١٠٠ ، ٨٠ ، ٦٠ ، ٥٠ ، ٤٠ سم.

استخدمت اسماك البلطى والمبروك العادى الفضى بمعدلات ١٥٠٠ و٧٢ و١٥٠ على التوالى. وضعت الأسماك بنظام الاستزراع المختلط. أضيفت أسماك مبروك الحشائش بمعدل ١٢ سمكة فى الفدان لكل من المقاومة البيولوجية والمعاملة البيولوجية + المقاومة الميكانيكية والمعاملة البيولوجية + المقاومة اليدوية. استعملت فى المقاومة الآلية آلة مقاومة أمريكية

American machine grass cutting (Hockney model Hc-10H)

أسفرت النتائج عن أنه كلما زادت مساحة الحوض زاد معدل أداء الآلة ووجد أن معدل أداء الآلة كان عالياً فى حشيشة البوط يليها النخشوش ثم حشيشة الججنة. وجد كذلك أن معدل أداء الآلة يقل كلما قل عمق الماء فى الأحواض ويزداد بزيادة عمق المياه بالأحواض.

استخدم فى المقاومة اليدوية المنجل اليدوى العادى ووجد أن زيادة عمق الماء أدى إلى انخفاض معدل أداء العامل فى المقاومة اليدوية فى الحشائش الثلاثة كما وجد أن نوع الحشائش يؤثر على معدل أداء العامل. فقد وجد أن معدل الأداء لمقاومة حشيشة البوط أعلى من حشيشة الججنة. وأقل

معدل أداء وجد لحشيشة النخشوش.

تم إجراء المقاومة البيولوجية باستخدام مبروك الحشائش مع استخدام أحواض نصف فدان. وتم إجراء المكافحة البيولوجية مع المقاومة الآلية ثم مع المقاومة اليدوية وذلك للوصول إلى أكفأ الطرق فى مقاومة الحشائش وكانت النتائج كالآتى:

النسبة المئوية للحشائش المتبقية بالأحواض بعد المقاومة صفر فى الأحواض التى تم فيها استخدام المكافحة البيولوجية مع المقاومة اليدوية، بينما كانت النسبة المئوية للحشائش المتبقية بالأحواض ٢٪ من مساحة الحوض وذلك بالأحواض التى تم فيها استخدام المكافحة البيولوجية مع المقاومة الآلية. وكانت نسبة الحشائش المتبقية بالأحواض ٤٪ من مساحة الحوض الذى تم فيه استخدام المكافحة البيولوجية فقط باستخدام عدد ١٢ سمكة مبروك حشائش فى كل من المعاملات الثلاثة.

أسفرت النتائج الخاصة بالتكلفة الاقتصادية لكل طريقة عن زيادة تكاليف المكافحة اليدوية عن باقى الطرق المستخدمة، بينما حققت المكافحة البيولوجية أعلى عائد اقتصادى.