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Research Article

Impact of release of *Neochetina* spp. on growth and density of water hyacinth *Eichhornia crassipes*

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ABSTRACT: Water hyacinth (*Eichhornia crassipes*) is an invasive aquatic macrophyte which creates several problems in irrigation system of rivers. To control their rapid distribution in water bodies the biological control method was carried by employing weevils *Neochetina bruchi* and *Neochetina eichhorniae* on river based field trial. The study demonstrates effectiveness of biocontrol weevil open field release on experimental site (Chittar river). When compared to first release in field, the weevil intensity was increased in numbers. Active scraping was observed in the leaves and decay spots were seen in the stems of weed. Both *N. bruchi* and *N. eichhorniae* (250 No) were introduced biyearly at experimental site for one year. During these two years of observation period, stunted growth and reduced population were observed in the study site. The study highlights importance of *Neochetina* spp. on the management of *E. crassipes.*

KEY WORDS: Biological control, Chittar river*, Eichhornia crassipes, Neochetina bruchi, Neochetina eichhorniae,* water hyacinth

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INTRODUCTION

The Tamirabarani river is one of the important fresh water resource for Southern part of India and it originates from the peak of Pothigai hills of the Western Ghats. The Chittar river is being is severely infested with aquatic floating weeds and among them *Eichhornia crassipes* (commonly water hyacinth) is serious one. The *E. crassipes* is an important biological invaders, which is originated from South America and widespread around the world (Perrings *et al.,* 2002). The *E. crassipes* has large, purble colour flowers, with purple and yellow spots on the petals with shiny round green leaves. It can grow on various wetlands such as rivers, lakes, ponds, streams, ditches and backwater areas (Grodowitz, 1998). The hydrophytes– *E. crassipes* is a rapidly growing plant preferentially it can be reproduced by asexual reproduction (Philbrick and Les, 1996). Through vegetative reproduction, the daughter plants are developed from the stolons which grow on lateral sides and produce enormous offsprings. Interestingly, this fast active dividing weed can produce 3000 daughter plants within 50 days and it can duplicate its biomass in 10-12 days (Naseema *et al.,* 2004).

The active growth of *E. crassipes* has been spectacular and disastrous in water body. Specifically huge infestations originated in the Southern USA, Mexico, Panama, much of Africa, the Indian sub-continent, Southeast Asia, Australia and Pacific. The wide distribution of this plant caused severe deleterious effects in environment and also socio economic status to the Gulf of Guinea (West Africa coast). Water hyacinth infestation has been a menace choking river systems to a greater extent in Africa and Asia (Mshigeni *et al.,* 2002). The higher growth rate of this floating weed increased eutrophication in water bodies. In addition the enrichment of *E. crassipes* causes various deleterious effects in physical and chemical parameters of waters. It has been reported that enrichment of *E. crassipes* increases the pH, nitrogen, phosphorus and potassium level of water (Reddy and De Busk, 1985). On the other hand *E. crassipes* may cause other problems such as obstruction to waterways (Joffe and Cooke, 1997), blockage of water uptake (Masifwa *et al.,* 2001), it harbors vectors (Charudattan, 1996; Honmura and Miyauchi, 1998; Ogutu-Ohwayo *et al.,* 1997) and also affects fishery (De Groote *et al.,* 2003).

Controlling of plant growth is an important remedy to resolve this problem. Several controlling methods have been widely used to destroy the water hyacinth plants, such as mechanical control, chemical control, and biological control. The mechanical control is achieved by the constant removal of plants from the water body. The higher work load and cost effects are the major demerits of mechanical control method. The herbicides are used for the chemical control method but the chemical substance causes severe deleterious effects in river ecosystem. Hence, alternative methods are important to control this weed. Biological control of water hyacinth is the conventional effective method to manage *E. crassipes* in the aquatic system. Two species of weevils such as *Neochetina bruchi* Hustache and *N. eichhorniae* Warner and a mite**,** *Orthogalumna terebrantis* Wallwork are important bio-control agents of *E. crassipes* (Murugesan and Paulraj, 2004; Julien *et al.,* 2011).

Neochetina bruchi and *N. eichhorniae* can usually be identified by the colour and pattern of the scales covering the elytra (fore wings). *N. bruchi* shows uniform tan or brown with no distinct markings to brown with broad, crescent-shaped or chevron – like tan band across the elytra. In contrast, the *N. eichhorniae* lack the tan band and is usually gray mottled with brown (Jayanth, 1987). Both species have two short, shiny, dark lines on the elytra on either side of the mid-line. The life cycle of *N. bruchi* and *N. eichhorniae* takes place in the plant *E. crassipes*, the adult *N. bruchi* lives for about 180 days and *N. eichhorniae* for about 200 days.

The adult weevils feed on the leaves of *E. crassipes* and cause damage at the leaf epidermal tissues. By the result of this effect it drastically increases the water loss exposing the plant to pathogens finally reducing the plant growth (Julien, 2000). They are the most effective biological controller of water hyacinth when compared with other arthropods (Center *et al.*, 1999b; Center and Van, 1989; DeLoach and Cordo, 1976). Among around 30 countries these weevils have been successfully utilized to control water hyacinth due to their host specific nature and effectiveness (Center *et al.,* 2002; Firehun *et al.,* 2015). Their significant results were reported in Egypt, Benin, Mexico, Edko lakes, Uganda, Kenyan and Tanzanian shores of Lake Victoria (Aguilar *et al.*, 2003; Ajuonu *et al.*, 2003; Cilliers *et al.*, 2003; Mallya *et al.*, 2000; Ochiel *et al.*, 2001; Ogwang and Molo, 2004). In order to control the *E. crassipes* biomass accumulation in Chittar river the present study was conducted using bio control weevils *N. bruchi,* and *N. eichhorniae.* They were introduced in selected sites of Chittar river such as Kadapokathi village (experimental site) and Valukkamparai (control site) near Azath nagar, where the damage was documented periodically.

MATERIALS AND METHODS

Experimental site

Kadapokathi village (8°57'00.3"N 77°20'12.5"E) in Chittar river basin was selected for studying the impact of *Neochetina* spp. on *E. crassipes*. The Valukkamparai (8°56'49.1"N 77°19'06.6"E) near Azath nagar, Tenkasi was selected for control site. The experimental sites were fully covered with high dense and proliferated *E. crassipes* weed and without natural presence of *Neochetina* spp.

Release of *Neochetina* spp.

The two biocontrol weevils [*Neochetina bruchi* (250 Nos.) and *Neochetina eichhorniae* (250 Nos.)] were introduced biyearly (January and July) at experimental site (Wright and Center, 1982). Weevils were released at four corners and at the middle of selected river site for dispersion.

Assessment of the weed growth parameters

After the release of biocontrol agents the growth parameters of water hyacinth were monitored seasonally and the following growth parameters were recorded periodically, 1. Average biomass of plants per quadrate (gm) 2. Total Number of leaves per plant (Nos.) 3. Average petiole length (cm) 4. Average root length (cm) 5. Leaf lamina width (cm) 6. Leaf lamina length (cm) 7. Number of weevils found per quadrate (Nos.) 8. Plant height per quadrate (cm). A quadrate of 0.25 m^2 size (0.5 m x 0.5 m) was marked and the above observations were made in both the control and experimental sites.

RESULTS AND DISCUSSION

The biocontrol of water hyacinth in pond, river and dams has been a successful method employing weevils in various counties (Abjar and Bashir, 1984; Aguilar *et al.,* 2003; Center *et al.*, 1999a; Center and Dray Jr, 1992; Ochiel *et al.* 2001; Wilson *et al.,* 2007). The impact of *Neochetina bruchi* and *Neochetina eichhorniae* were monitored every month in the experimental site (Kadapokathi village) and control site (Vallukam parai) (Fig. 1). Post release observations revealed that adult weevils which made scars in plant leaves. The average initial biomass weight of water hyacinth was 2.58 kg (Table 1) during winter season 2011 and it drastically reduced in monsoon and post monsoon of 2011. Simultaneously, the weevil population also increased in the experimental site. On November, heavy flood washed off majority of the plants in the experimental site. Then monitoring was continued in January (winter) 2012, during this period the initial biomass was 2.43 kg and it gradually decreased to 1.9 kg in post monsoon of 2012. When commencing with field trial the plant height (Table 1) (69.68 cm) and reduced up to (36.61 cm). These results expressed that weed growth was arrested after releasing the weevils.

It was very significant that the bio control weevils have accelerated the collapsing ratio of water hyacinth leaves by scabbing and wounding the surface. The average leaves (Table 1) of water hyacinth were 8.90 numbers per weed on winter 2011 and final (post monsoon - 2013) observation showed decrease in number of leaves 3.66 per plant. Apart from the complete collapse of the leaves, their laminal length (Table 1) and width (Table 1) were also been gradually reduced.

The initial study showed leaf lamina length and width as 11.84 and 14.67 cms while the final observations revealed significant decrease (6.79 cm and 7.71 cm respectively). During the start of the field trails petiole looked tall and robust, and length was found to be 43.04 cm (Table 1). The weevils infestation resulted gradual shrinking in petiole length was evidenced to 17.14 cm during end of experiment.

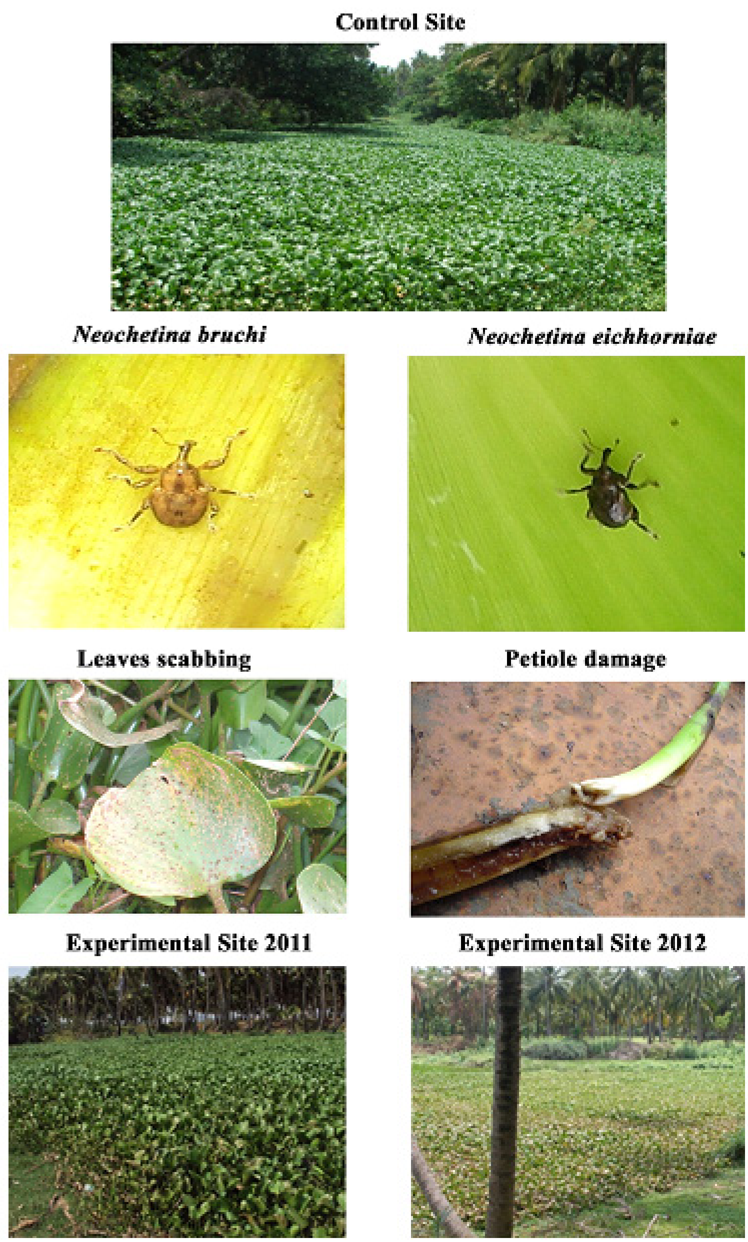

Fig. 1. Impact of release of *Neochetina* spp. on experimental site.

Table 1. Seasonal variation in growth parameters of water hyacinth plants in the experimental site and Control site of river Chittar during year of 2011 - 2012 (n=3) (Mean ± S.D)

No	Seasons	Petiole Length (cm)		Leaf Lamina (cm)				Root Length (cm)	
				Length		Width			
		Control	Experiment	Control	Experiment	Control	Experiment	Control	Experiment
1	Winter 2011	36.1±0.4	49.2±2.9	10.4±0.6	11.80±0.3	12.2±0.3	14.60±0.4	24.0±0.06	18.8±0.8
2	Summer 2011	33.8±0.6	34.0±9.3	09.9±0.1	10.90± 0.8	13.0±0.2	10.90±1.4	23.8±0.20	16.1±2.5
3	Monsoon 2011	35.9±0.1	26.0±3.5	11.8±1.7	09.80±0.2	12.9±0.8	09.40±0.7	24.9±0.40	12.8±1.6
4	Post Monsoon 2011	36.3±0.4	19.1±2.9	14.7±0.6	07.30±0.3	12.9±0.3	08.30±0.4	25.5±0.60	10.9±0.8
5	Winter 2012	27.1±0.3	31.5±0.4	07.3±0.5	10.00±0.4	08.8±0.1	09.90±0.4	18.2±0.30	15.2±0.3
6	Summer 2012	27.2±0.2	28.2±1.0	08.1±0.2	09.10±0.5	10.3±0.7	09.30±0.3	19.8±1.10	13.9±1.1
7	Monsoon 2012	28.9±0.5	23.1±2.1	09.2±0.2	08.05±0.6	10.9±0.1	08.01±0.7	23.2±0.60	11.7±0.6
8	Post Monsoon 2012	25.9±1.5	20.5±0.8	08.5±0.2	06.70±0.3	09.6±0.4	07.70±0.4	21.3±0.08	10.4±0.7
		Plant Height (cm)		No. of Leaves		No. of Insects (per quadrate)		Average Biomass (gm)	
		Control	Experiment	Control	Experiment	Control	Experiment	Control	Experiment
1	Winter 2011	66.9±0.10	69.6±00.3	08.70±0.3	8.9±0.07	0	01.5±2.1	0.6±0.3	2.50±0.9
2	Summer 2011	67.2±1.50	57.6±10.7	09.70±0.7	7.6±1.10	0	03.5±0.7	1.6±0.6	2.30±0.7
3	Monsoon 2011	72.0±1.70	44.2±09.0	11.00±0.2	5.2±0.20	0	05.9±0.9	1.6±0.6	1.30±0.7
4	Post Monsoon 2011	76.0±0.10	36.6±00.3	12.00±0.3	5.3±0.07	0	07.4±2.1	1.7±0.3	0.98±0.2
5	Winter 2012	52.1±0.20	56.9±01.0	05.80±0.2	7.6±2.80	0	02.7±1.0	1.3±0.8	2.4±0.3
6	Summer 2012	54.5±1.80	51.0±02.4	07.40±1.1	7.2±0.10	0	06.2±1.9	1.3±0.5	2.2±0.4
7	Monsoon 2012	60.5±1.01	43.6±04.0	10.50±0.6	5.6±0.80	0	08.2±1.5	1.4±0.6	2.2±0.3
8	Post Monsoon 2012	55.5±1.70	38.0±01.6	10.30±0.3	4.2±0.60	0	10.2±0.7	1.4±0.5	1.9±0.5

Root length of plants declined from 19.04 cm to 8.96 cm on final observation. Similarly, a number of *Neochetina* adult weevils present per 0.25 m^2 area were recorded periodically and it was found that their number has gradually shot up after their release in the experimental site. The role of *Neochetina* in the collapse of *E. crassipes* was documented in earlier studies (Center *et al.*, 1999a; Julien, 2008). After post monsoon of 2011, the heavy rain washed away the water hyacinth major portion. Due to heavy flow of river water in previous monsoon, winter 2012 showed low count of weevils in experimental site. But after winter 2012, the population of weevils greatly elevated. The extreme weather of 2011 raised an important question whether the heavy rainfall act as a major part to accelerate the water hyacinth decline of proliferation. But we clearly observed that the positive results occurred only due to biocontrol agents. The similar effects has been discussed in Lake Victoria and they concluded without biocontrol weevils water hyacinth would not have been controlled (Wilson *et al.*, 2007) . The studies indicated the potential role of *Neochetina* spp. in the total eradication of *E. crassipes*.

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