Entomology

A study on the pests and weeds and pests in the pokkali wetlands and adjoining areas of Ernakulam district, Kerala

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Abstract

Pokkali is a peculiar saline tolerant rice variety with Geographical Indication (GI). It is cultivating organically in the coastal regions of Ernakulam, Alappuzha and Thrissur districts of Kerala, India. This rice variety worth 3000 years is famous for its taste, protein content and medicinal properties. The Pokkali fields are unique, tidal wetlands which are highly nutritive and biodegradable, providing umpteen services. Ernakulam District has the largest area of Pokkali cultivation which are part of Vembanad Ramsar site. The rotational cultivation of paddy-prawn is a sustainable agriculture approach practiced in these fields. An intense study was carried out in the five selected Pokkali wetlands and adjoining areas of Ernakulam District, Kerala from 01st January 2016 to 31st December 2021 to identify the pests and weeds. Direct observation, point count and Quadrats methods were utilized for the study. Reference books and help of experts were utilized for specimen identification. The occurrence, abundance and diversity of the pests and weeds were recorded. Data analysis was done using statistical softwares (PAST, SPSS and R). During the study, a total of nine pests and 56 weeds were identified from the study area. Weeds serve as host for harmful pests and diseases. It affects the health of the ecosystem. The study of weeds and pests are important to analyze the successes and failures of crops cultivating in the study area. It is beneficial for the producers. Such studies are essential for implementing appropriate control measures.

Keywords: pokkali wetlands, vembanad ramsar site, pests, weeds

Introduction

Wetlands are special ecosystems between terrestrial and aquatic environments. They are commonly known as 'Kidney's of landscape' or 'Nature's Supermarket' [14]. In India, 15.26 meter hectares of area comprises of wetlands [17]. Kerala state has the largest area under wetlands [15].

The Pokkali rice is a unique, tall, saline resistant, traditional variety with Geographical Indication (GI) [4]. The paddy cultivation is carried out during the low saline phase (June-October/mid November) followed by shrimp cultivation in the high saline phase (October/mid November-April). It is a sustainable, organic method carried out in the water-logged coastal regions of Ernakulam, Alappuzha and Thrissur Districts of Kerala, India. These tidal wetlands are under the influence of salinity and regular flooding [19, 20] which are part of the Central Asian Flyway (CAF) and Vembanad Ramsar site. This ecosystem serves as Important Bird Areas (IBA) providing habitat for many avifauna and stopover sites for migratory birds [25].

Vegetation is an important feature of the wetland ecosystem. They are the key components of the ecosystem productivity and biogeochemical cycles, bioindicators and are used as tools in the conservation and management of wetlands [26].

Weeds compete with cultivated crops and other plants for water, nutrients and light. They serve as host for harmful pests and diseases. Weeds affect the crop yield and quality [16]. Their occurrence can be related to the status of the ecosystem. The study of weeds and pests are important to estimate the success or failures of cropping systems. It also helps the producers [7]. Such studies are essential for the implementation of appropriate control measures.

Materials and Methods

An intense study was carried out from 01st January 2016 to 31st December 2021 in the Pokkali wetlands and adjoining areas of Ernakulam District, Kerala to identify the pests and weeds. Five study stations were selected: Valiya Kadamakkudy (10°3'48.24"N, 76°14'57.696"E), Ezhikkara (11°6'11.8584"N, 76°6'37.548"E), Thathappilly (10°7'37.8768"N, 76°15'55.9728"E), Elamkunnapuzha (10°1'36.4872"N, 76°13'23.8368"E) and Kandakkadavu (9°51'34.182"N, 76°16'0.2604"E). The sample areas included cultivated as well as abandoned fields. Fortnightly visits were carried out. The field surveys during 2021 and 2022 were affected by the pandemic Corona outbreak and lock down. Average data analysis was done to get results. Spotting scope (10 – 45 X) and 8 x 40 (Bushnell) binocular were used. Direct observation [2], Point count and Quadrat (5×5 m) methods were utilised for the study. The occurrence, abundance and diversity of the pests and weeds were recorded. The diseases caused by the pests were also identified. Photographs of the specimens were taken using 36 X optical zoom camera (Nikon). Various reference books [6, 26, 16, 7] were utilised for the identification of specimens and the help of experts were also seeked. Yearly, monthly and seasonal data analysis were recorded. Parameters such as Frequency (F), Density (D), Relative Abundance (RA), Relative Density (RD) and Alpha Diversity indices were calculated to analyse the distribution and dynamics of the

weeds and pests in the study area [24]. Data analysis was done with the help of statistical softwares (PAST, SPSS and R).

Results and Discussion

During the study, a total of nine pests were observed from the study area. They include Stem borers, Thrip species, Root-knot nematodes, green leafhopper, Hispa, Leaf folder and Whorl maggot. These pests were mainly observed on the weedy flora found in the fields, bunds and adjoining areas.

The pests such as Stem borer and Leaf folder represents the order Lepidoptera and family Crambidae. During the vegetative stage, the stem borer larvaes bore at the base of the plants. They penetrate through the upper nodes of older plants and feed towards the base. They cause discolouration and Sheath rot disease. Three types of stem borers were observed during the study: striped stem borer (*Chilo suppressalis*), Yellow stem borer (*Scirpophaga incertulas*) and White stem borer (*Scirpophaga innotata*). Striped stem borer was dominant in the areas filled with weeds. It was observed that their final instars remained dormant during winter. The occurrence of White stem borer was found higher during the rainy season. The Thrip species from the order Thysanoptera and family Thripidae were found on the leaves and stems, puncturing and sucking up the contents. Sometimes they were found in the curls, rolls or folds of leaves causing distortion to the leaf blades. Root-knot nematodes (*Meloidogyne* species) belonging to the order Tylenchida and family Heteroderidae were found on monocots, dicots, herbs and woody plants. Green leafhopper (*Nephotettix virescens)* was found on weeds. They represent the order Hemiptera and family Cicadellidae. It causes yellowing of leaves, leading to drying. It also causes retarded growth of the plants. The Hispa or Leaf beetle (*Dicladispa armigera*) belongs to the order Coleoptera and family Chrysomelidae. Their eggs were found beneath and well as on the top of the leaves. The larvae leave an irregular discoloured pattern on the leaves. The Leaf folder or Leaf roller (*Cnaphalocrocis medinalis)* infects the leaves and stem. The larvae were more harmful than the adults. The Whorl maggot (*Hydrellia sasakii*) belongs to the order Diptera and family Ephydridae, feeds on the leaves resulting in discolouration and dwarfing.

Rice fields are favourable habitats of odoantes. Fraser [9, 10] identified three odonate species from the paddy fields of Bangalore. A total of 10 species were identified from the paddy fields of Dehradun valley [13]. From the paddy fields of Assam, eight species of odonates were recorded [12]. *Thoiymis tillarga* was observed from the paddy fields near Annamalai University, Tamil Nadu [3].

During the study, a total of 56 weeds were identified from the study area which were categorised into Grasses, Sedges, Broad leaf weeds and Ferns. The maximum abundance was observed for the family Poaceae (63.69% RA and 4.2% RD) and the least for Meliaceae (0.019% RA and 0.0013% RD). The species diversity was maximum for the order Poales with 26 species (three families and 29.21% RA), followed by Fabales with 10 species (one family and 10.11% RA) and Commelinales with seven species (two families and 7.87% RA). The species diversity was minimum for Apiales, Scrophulariales and Vitales (one species, one family and 1.12% RA each).

The seasonal variation of aquatic macrophytes at Salim Ali Bird Sanctuary, Thattekad, Kerala was assessed and recorded 91 plants representing 35 families with Poaceae as the dominant family, followed by Cyperaceae [18]. A total of 29 exotic, 17 endemic and 24 rare species were recorded from Kuttanad, Kerala [22]. A total of 32 plant species were recorded from Anachal, North Paravoor, Kerala [1]. The abundant family was Poaceae with the maximum number of species. A total of 100 plant species representing 52 families were identified from the pokkali wetlands and adjoining areas of Ernakulam. The dominant order was Poales, followed by Fabales. It was reported that a large number of exotic weed species affected the native plants [8]. Tomy recorded 196 plants representing 64 families from the kole wetlands, Thrissur. The dominant family was Poaceae, followed by Convolvulaceae, Salviniacea, Cabombaceae, Pontederiaceae, Asteraceae, Cyperaceae, Fabaceae and Onagraceae. The remaining 54 families were reported as rare, with one species each [23].

During the study, it was reported that the dominant grass weed was *Diplachne fusca* which occurred 86% in the study area. *Echinochloa crusgalli* was also abundant with a frequency of 80%. The dominant sedges were *Fimbrisrylis miliacea* (F: 58%) and *Eleocharis dulcis* (F: 47%). *Cyperus javanicus* was found least in the study area. The abundant broad leaf weeds were *Eichhomia crassipes*, *Monochoria vaginalis*, *Pistia stratiotes*, *Sphaeranthus africanus* and *Sphenoclea zeylanica*. The dominant fern was *Salvinia molesta*. The ferns such as *Acanthus ilicifolius* and *Acrostichum aureum* were found on the bunds of the cultivating fields as well as in abandoned regions. Some exotic pest and weed species affected the growth of native plants.

The ecology of the macrophytic vegetation in Pallom, Kuttanad was studied and recoded. *Cyperus compressus*, *Echinochloa stagnina*, *Eichhornia crassipes*, *Fimbristylis miliacea*, *Ludwigia hyssopifolia* and *Salvinia molesta* were the dominant weeds [5]. The abundant weeds from Kuttanad, Kerala were *Cyperus compressus*, *Eichhornia crassipes* and *Salvinia molesta* [22]. *Cyperus compressus*, *Diplachne fusca*, *Eichhornia crassipes Echinochloa stagnina* and *Salvinia molesta* and showed maximum abundance and density in the pokkali wetlands of Ernakulam [8]. The dominant weeds of kole wetlands were *Eichhornia crus-galli, E. stagnina, Ipomoea aquatica, Lindernia rotundifolia, Ludwigia adscendens* and *Sacciolepis interrupta* [23].

During the study, the species richness, abundance and density of weeds and pests were noticed as maximum from June to October (paddy cultivation months) when compared with the prawn cultivation and transient periods. These were considered as favourable months for the growth of weeds and pests. Decreased salinity and p^H, increased amount of rainfall, optimum temperature and humidity favoured their growth in the study area. The weeds in the pokkali fields were controlled by manual removal during the transplantation process. The species richness, abundance and relative density of weeds and pests were minimum during May due to hot climate, increased salinity and p^H; low rainfall and water availability.

The species richness, abundance and density of weeds in the pokkali fields was observed as maximum during the paddy cultivation season due to abundant rainfall, fresh water intrusion and favourable environmental parameters. The abundance, density and species richness were minimum during the prawn culture season due to the entry of saline water, high atmospheric and water temperature [8].

During the study, it was reported that the weed and pest community in the study area changes seasonally. The species richness was maximum during the South-West and North-East monsoons and minimum during the winter and summer seasons. The abundance and density were maximum during the South-West monsoon, followed by the North-East monsoon, winter and minimum during the summer.

The distribution of macrophytes in Chilika lake was studied and reported that the growth of aquatic macrophytes was lower in the monsoon season when compared with the summer. The macrophytes offer food and shelter for many organisms and enrich the habitat diversity [11].

During the study, *Aeschenomene aspera*, *Alternanthera sessilis*, *Azolla pinnata*, *Eichhornia crassipes*, *E. crus-galli*, *Hygrophila ringens*, *Ludwigia hyssopifolia*, *L. octovalvis*, *Monochoria vaginalis* and *Salvinia molesta* were identified from June to November. *Azolla pinnata*, *Eichhornia crassipes*, *E. crus-galli* and *Salvinia molesta* were found to occur from June to October. *Lemna minor* and *Pistia stratiotes* were observed throughout the months except May. The mangrove associates such as *Diplachne fusca*, *Phragmites karka* and *Zoysia matrella* were observed throughout the months. *Azolla pinnata*, *Eichhornia crassipes*, *E. crus-galli*, *Hygrophila ringens*, *Ludwigia hyssopifolia*, *L. octovalvis*, *Monochoria vaginalis* and *Salvinia molesta* were observed only during the paddy and prawn seasons and disappeared in the transient period. *Azolla pinnata*, *Eichhornia crassipes*, *E. crus-galli*, *Sacciolepis interrupta* and *Salvinia molesta* were present in large numbers during the paddy season. An increased abundance of *Cyperus cephalotes*, *C. compressus*, *C. difformis*, *C. iria*, *Eclipta prostrata* and *Fimbristylis miliacea* was noticed during the paddy and prawn seasons. The overgrowth of floating weeds hindered the oxygen exchange between the surface and the water affecting the growth of fishes. In the prawn season, the free-floating hydrophytes were removed from the fields during the exchange of water through the sluice gates.

The occurrence of *Cyperus compressus*, *Diplachne fusca* and *Echinochloa stagnina* was noticed mainly during May. *Eleocharis dulcis*, *Fimbristilis miliacea*, *Ludwigia hyssopifolia* and *Sphenoclea zeylanica* were recorded during July and were absent in November [8].

The excess growth of *Azolla pinnata* and *Salvinia molesta* hindered the oxygen exchange, affecting the growth of fishes and other aquatic organisms [8, 23].

During the study, it was observed that the abundance and density of pests and weeds were maximum at Valiya Kadamakkudy pokkali field and minimum at Elamkunnapuzha. Striped stem borer was the abundant pest in the study area. The abundance of *Azolla pinnata*, *Cyperus cephalotes*, *C. compressus*, *Diplachne fusca*, *Eichhornia crassipes*, *E. crus-galli*, *Fimbristylis miliacea*, *Lemna minor*, *Monochoria vaginalis*, *Phragmites karka*, *Pistia stratiotes*, *Salvinia molesta* and *Zoysia matrella* at Valiya Kadamakkudy was high. At Ezhikkara field, *Azolla pinnata*, *Cyperus compressus*, *Eichhornia crassipes*, *E. crus-galli*, *Lemna minor*, *Monochoria vaginalis*, *Phragmites karka*, *Pistia stratiotes*, *Salvinia molesta* and *Zoysia matrella* were observed in large numbers. *Lemna minor* was the abundant species at Thathappilly. *Lemna minor* and *Pistia stratiotes* were abundant at Elamkunnapuzha pokkali field. *Azolla pinnata*, *Diplachne fusca*, *Eichhornia crassipes*, *E. crus-galli*, *Lemna minor*, *Monochoria vaginalis*, *Phragmites karka*, *Pistia stratiotes*, *Salvinia molesta* and *Zoysia matrella* were found as high at Kandakkadavu. It was observed that the occurrence, abundance and diversity of weeds and pests were influenced by climate change (especially variations in the duration, timing and amount of rainfall received).

The abundance and density of pests and weeds were recorded as maximum in 2021, followed by 2020. The area was much less affected by anthropogenic interactions during this period due to the pandemic Corona outbreak and lockdown. Least number of pests and weeds were recorded during 2018 August due to flooding. An equal number of species was observed throughout the course of the year.

The species dominance (Dominance_D) was maximum in 2021 (D for weeds 0.079, D for pests 0.085), followed by 2022 (D for weeds 0.078, D for pests 0.084) and least in 2018 (D for weeds 0.071, D for pests 0.081). During 2021, the Shannon Wiener value (H) was recorded as maximum reflecting high diversity (H for weeds 2.893, H for pests 3.55) and low in 2018 (H for weeds 2.871, H for pests 3.11). The species evenness (e^H/S) was high during 2021 (e^H/S for weeds 0.391, e^H/S for pests 0.29) and low in 2018 (for weeds 0.321, e^H/S for pests 0.22). The species richness (Margalef Index) was same throughout the years (Margalef Index for weeds 7.9, Margalef Index for pests 5.1).

The floral diversity of the kole wetlands was influenced by extreme climatic changes, natural disasters and anthropogenic activities [21].

During the study, the pest infestation was noticed only on weeds, native plants and crops in the study area except Pokkali. The rice variety has the capability to resist pests and hence their growth and yield were not affected by the occurrence of pests. The increased occurrence of weeds and pests affected the growth of crops such as peas and bananas cultivated in the adjoining areas of the fields. Their occurrence also affected the quality and healthy status of the ecosystem. Biological control methods are the most sustainable approach for their and management.

Weeds serve as host for harmful pests and diseases. It affects the crop yield and quality [16]. The study of weeds and pests are important to analyse the successes and failures of cropping systems. It can also help producers to predict their harvest and profit [7].

Conclusion

Weeds serve as host for harmful pests and diseases. Large number of pests and weeds were reported in the abandoned rice fields and adjoining areas. Some exotic pest and weed species affected the growth of native plants. Pest infestation was noticed on weeds, native plants and crops in the study area, with the exception of Pokkali, which has the ability to resist pests. As a result, the occurrence of pests has no effect on the growth and yield of pokkali. The increased presence of weeds and pests harmed the growth of crops such as peas and bananas grown in the surrounding areas. Their occurrence, abundance and diversity were influenced by climate change (especially variations in the duration, timing and amount of rainfall received). Their occurrence had an impact on the quality and health of the ecosystem.

The study of weeds and pests are important to determine the

successes and failures of the crops cultivating in the study area. It aids producers in forecasting yield, profit and failure. Such studies are necessary for putting in place effective control measures. Biological control is the greatest long-term solution for their management and control.

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