Potato agriculture research Station Batakundi, naran, a hot spot for cyst nematode (*Globodera spp.*) of potato in Pakistan

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Abstract. In Pakistan, potato summer crop in being cultivated in different agro-ecologies of Khyberpukhtun Khwa and in valleys of Gilgit Baltistan provinces. To understand the current biotic stresses scenario in the potato germplasm developed by National Institute of Genomics and Advanced Biotechnology (NIGAB) was cultivated in 2022-23. The valleys comprised on Sharan Forest Kaghan, Potato Agriculture Research Station, Batakundi Naran of KPK and Babusar valley as well as Mountain Agriculture Research Station, Chillas of Gilgit Baltistan were systematically surveyed. The soil samples were analyzed in for the cyst nematode (*Globodera spp*.) in potato fields as an invasive and quarantine regulated pest. Severe infestation of PCN was observed in PARS, Batakundi Naran. However, there were no any cyst was found in the rest of ecologies surveyed. The population dynamics of PCN was estimated ranges from 113-150 cysts in 100grams of soil samples. The center is being used as potato monoculture and crop breeding. The egg count estimates ranges from 270-320 eggs/cyst. There are some cysts showed the suppressive soil state as the eggs were infested with endophytes or rhizospheric microorganisms (bacteria or fungi). The cysts were morphologically characterized and identified in Crop Diseases Research Institute (CDRI) and National Nematological Research Center Pakistan.

1 Introduction

The agriculture exportable commodity Potato (*Solanum tuberosum*) is an important crop of Pakistan. It has been cultivated more than an area of about 170,300 ha with an annual yield of 4.0 million tons [1]. In Pakistan, this crop is being cultivated in the different agro-ecological zones and in three cropping seasons annually viz. spring, summer and autumn. More than 86% of total potato production is being cultivated in plains areas comprising Okara, Sahiwal, Kasur, Sialkot, Sheikhupura, Jhang, Narowal, Pak pattan, Gujranwala, T.T Singh, Khanewal Depal Pur and Lahore. of Punjab Province where spring and autumn crops are cultivated. The summer plantings in the uplands at elevation ranging from 1500 to 3,000

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m in Khyber PukhtoonKhaw and Gilgit Baltistan agro-ecolopgies. The potato crop in Pakistan is grown on more than area of 2.33 million hectare with a production of 3.8 million tones. Among the biotic stresses the potato is affected by many pests and diseases, and cyst nematode (*Globodera rostochinensis)* , late blight of potato (*Phytopathora infestance*), viruses (PVX, PVYetc) powdery scab (*Spongospora subterranean*), aphids and white grub (*Phyllophaga sp*.) are the most damaging [18].

The soil borne root pathogen cyst nematodes (*Globodera spp. Heterodera spp*.) are together with root-knot nematode (*Meloidogyne spp*.) and root lesion nematode (*Pratylenchus spp*.) are the phytopathogenic nematodes based on scientific research and economic importance [10]. Among the quarantine pathogens the nematodes (PCN) two well known species comprised on *G. rostochiensis and G. pallida* are quarantine pests usually found associated with some other Solanaceous vegetable species and potatoes. Some new descriptions of PCN elaborated as *G. ellingtonae* (Handoo et al. 2012 (the Ellington potato cyst nematode). Its incidence and distribution seems to be restricted to the USA and in Argentina [19,21].

These two PCN species *G. rostochiensis* and *G. pallida* are generally known to cause potato yield losses approximately at about 9% of total potato production around the globe [19]. In severe infestations the nematodes can reduce tuber size and quality while infected roots are extensively branched [14]. To understand the economic damage as well as threshold level (ETL), potatoes tuber yield loss was assumed to be more than 50% if 32–64 eggs g−1 soil of an Iranian population *G. rostochiensis* were inoculated without nematicide application under controlled environmental conditions [3]. In Indonesia it was studied that after inoculation with 2–256 cysts per pot of the population of *G. rostochiensis* the estimated yield of potato decreased about 17 to 45% [11].

It is probably spread to Europe with the breeding material brought for blight resistance in 1850's The nematode was first reported from Kuhn, Germany in 1881 and since then it has spread all over Europe. It is well known that PCN originates from the Andean region of South America and have accidentally been introduced into Europe and subsequently to the Americas, Asia, Africa, New Zealand and Australia, with infested potato tubers [2-5,8-10,18].

In Pakistan, this invasive PCN species is supposed to came from pattern of trade and introduced from western Europe. The potato growing areas of northern cooler areas of Pakistan including Kalam and Kaghan valley has cultivated improved potato varieties and assumed that the PCN has introduced through seed sources in early 1980 [18]. It was first reported and documented PCN (*Globodera rostochinensis*) in Pakistan and its incidence and severity from Utror Gabral areas of Kalam valley areas where PCN populations were as high as 894 cysts/100g of soil. Its distribution was further spread to the adjoining valleys of Kalam [12].

In Pakistan the PCN has given the economic importance of among the quarantine regulated pests in agriculture business and trade related agreements of potato vegetable crop. To ascertain the PCN cyst nematodes current distribution, diversity and population density are very crucial to define possible control strategies and would help to restrict the spread of the pest. The aims of this research were to provide the current trend of PCN of the distribution in northern areas and specifically the Gilgit Baltistan in Pakistan and their morphological and molecular identification PCN populations.

2 Materials and Methods

2.1 Potato soil samples and PCN nematode extraction

The soil bulk samples were systematically collected from 32 fields of potato crops of different remote valleys of Gilgit Baltisatan and Khyber Pukhtoonkhaw Provinces of Pakistan (Table 1). About ten plots of 5 × 5 m grid were selected surrounding infected potato plants root rhizosphere in each field. The 250 ml soil sample was taken of the rhizosphere zone in each grid with depth measuring 0–20-cm. A composite sample was made by missing of each individual samples of each plot. The composite sample homogenized and a 1000 ml subsample of soil was air-dried for 2 days for PCN cyst extraction. The cysts were extracted from a subsample of 100 ml of dried soil. The dried cysts that floating water were decanted and collected on 60mm (250µm) sieve and counted for incidence of cyst and their observation [20]. The bulk inoculum of soil samples with heavy infestation of cysts obtained from the potato research center Battakundi for extraction of PCN and used for further related research objectives of this study.

2.2 Morphological identification

Among the recovered population of cysts nematode, cysts were randomly selected and based on vulval plate and juvenile identifications. Following the method [22] Vulval plates were made of identified based on the vulval plate and one juvenile of each cyst. Vulval plates were prepared following the method of [20] and juveniles (J2) were described by anatomical characteristics using body, stylet, tail and hyaline region length [15,19,20,21].

Results

The invasive potato cyst (Globodera rostochinensis (Wollenweber 1923) was recovered and identified in total 466 cysts extracted from soil samples collected from the potato growing agro-ecologies comprised on Madyan, Behrain, Kalam, Utror, Ushu, Matiltan, Mahodand and Potato Research Center Battakundi of Khyber Pukhtoon Khwa (Table1). Our results reveal the presence of invasive pest G. rostochinensis in potato field of Khyber Pukhtoon Khwa. While the cysts obtained from agro-ecologies of Gilgit Baltistan were identified as either Heterodera avenae, Heterodera mani or Heterodera zeae (Table 1). The highest density of cyst (330 cycts per 10ml soil) was observed in Potato Research Center Battakundi. At this research station annual potato summer crop are being cultivated with national and international potato germplasm and varieties. The potato cyst infestation was were located in at relatively high elevation; all the potato fields were found positive in Khyber Pukhtoon Khwa . The age of potato did not affect PCN recovery, cysts were found in all surveyed sampling in Khyber Pukhtoon Khwa. Current status of PCN distributions were confirmed the previous distribution data in Pakistan [6,12]. The average eggs population of G. rostochinensis were in each cyst were 320 based on Dieng Kulon- Banjamegara populations and were retailed withing the cyst.

Table 1. Distribution of potato cyst nematode (Globodera spp.) in Khyberpukhtun Khwa (KPK) and Gilgit Baltistan (GB) provinces in Pakistan.

Province	Location	Potato cyst nematode recovery (100 grams of soil samples)
Khyberpukhtun Khwa (KPK)	Madyan	08
	Behrain	07
	Kalam	43
	Utror	37

Continuation of Table 1

	Ushu Glashier	23
	Matilatan	06
	Mahodand	12
	Potato Research Center, Batakundi	**330**
Gilgit Baltistan (GB)	Jutial Hunza Road Gilgit	0
	Nilt Nagar Hunza	0
	Shish Khat Ghizer	0
	Shish Khat Ghizer	0
	Japookey, Ghizer	53
	Gula Pur Ghizer	01
	Atkash Yaseen	0
	Yaseen Khan	0
	Hanzal Gahkooch Road	30
	Chator Khand Ishkoman	0
	Chator Khand Ishkoman	0
	Bar Jungal Ishkoman	0
	Pakora Pine Ishkoman	0
	Ishkoman	0
	Emit Ishkoman	0

3 Results and Discussion

The cyst from potato field was reported and identified from high altitude potato including Abbotabad, Potato Research Center (PRC) Batakundi, Sawat and Kalam ([12].There are high risk of quarantine and biosecurity due to invasive pest problem that are being hindering the local, regional and international trade around the global perspective. Many countries have unable to mitigate the dispersion and introduction of cyst nematode of potato into their agro ecologies. The spread only be made by utilizing the infested potato seeds or infested soil movement from one region to another. In potato growing agro-ecologies of different countries, new status of incursions cyst nematode have also been reported from Egypt and Indonesia [7,10,16] at higher altitudes. Such reports of PCN status shows the establishment of pests in temperate areas of Africa and Asian regional agro system.

The potato cyst nematode are soil dwelling pest and when observed a field for nematode extraction and detection, a limited quantity of soil can be processed. It may be pointed out that in random sampling of larger areas and fields, it is significantly possible to ignore out the cyst nematode particularly if cyst populations dynamics are low as their build up is decline. New infestations status may therefore, take ranging between 25 and 35 years to develop to a cyst detectable level [5].

Thus it is likely that by the time a new infestation or occurrence is detected, it might have been dispersed to other fields through different sources and means. Once established, they are difficult to eradicate because PCNs have one of the highest survival values for any pathogen and they can survive in soil for over 30 years as eggs are protected by durable cyst wall [10]. The importance of PCN as pest on potato agro ecologies needs to be cautioned and continuous check, especially on the potential to be spread into un-infested new potato cultivated areas. Therefore, regular vigilant monitoring and surveillance to track movement and dispersal of PCN in potato growing fields in high altitude during summer and in planes in winter must be carried out in order to check this invasive pathogen away from potato core areas of Punjab. Province in Pakistan.

4 Conclusion

The potato export from Pakistan has increased from 272.8 thousand tonnes in 2011-12 showing an average growth rate of about 11%. However, the increase in the earning from potato export is at a much lower rate showing declining potato export prices for Pakistani potato suggesting increasing problems in the value chain of potato. Russia is another big market where demand of Pakistani potato is on rise. Export of potato from India has always been an active player in the potato export and expanding both production and export of potato internationally and regionally. Potato is one of the principal cash crops of Pakistani farmers and the primary exportable horticulture commodities from the country. It is the fourth most significant crop in term of bulk of production. Pakistan has become self-sufficient in potato production for its domestic use and seed development. More than 95% seed supply for potato cultivation is informal. Punjab produces almost 93% of the potato crop. The acreage of Potato is increasing every year with hope of better exports and profitable returns. Enhancement in the production of potato is just due to the application of modern technologies and utilization of quality seed and new potato varieties to meet the processing and export demand.

Authors' contribution

Conceptualized by Shahid Ahmed and Muhammad Faseeh, Methodology and data collection by Shahid Ahmed and Muhammad Faseeh, Financial resources was provided by Asad Farooq from the Project, "PSDP PESC-II, PARC/III-CDRI", Manuscript writing, editing-review and editing was performed by Muhammad Faseeh, Shahzad Asad provided project administration and funding acquisition from different resources.

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