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CURRENT STATUS OF VEGETABLE DISEASES IN DISTRICT SARGODHA

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A B S T R A C T

The current research was planned to report the percent disease incidence (DI) of vegetable diseases in different areas of district Sargodha of province Punjab. To fulfil this objective, surveys were conducted in different areas of district Sargodha. The surveys were conducted at different growth stages of vegetables from October 2021 to April 2022. DI of anthracnose of tomato was significantly ($P<0.05$) high 59% in Chak-3 and 49% in Lillyani, respectively. The second highest DI was of black rot of cauliflower 82% in Jalalpur Jagir and 80% in Nathuwala, respectively. The DI of early blight of tomato in Nathuwala was 15% and in Chak-3 was 21%, respectively. The DI of powdery mildew of apple gourd in Chak-134 was 22%, and also 22% in Chak-34. Downy mildew of apple gourd was highest at 65% in Nathuwala, whereas in Chak-136 it was 15%. Mosaic virus of apple gourd in Chak-34 was 22% and 49% in Lillyani; Alternaria leaf spot of cabbage in Jalalpur jagir 32% and in Lillyani 49%; Black rot of cabbage in Nathuwala 80% and in Jalalpur jagir 82%; Bacterial leaf spot of pumpkin 65% in Nathuwala and 55% in Chak-164; black wet rot of pumpkin in Chak-164 was 52%, and was minimum in Nathuwala 15%; botrytis leaf spot of onion in Chak-136 was 15% and Lillyani it was 20%; and Alternaria leaf spot of turnip in Chak-164 was 52% and in Lillyani 32%, respectively. The present study indicated that vegetable crops cultivated in the district Sargodha are prone to various diseases, which significantly limits the production of high yields. Moreover, present investigation will help the research institutions investigate vegetable diseases to manage and reduce the agricultural losses.

Keywords: Early blight of tomato, Anthracnose of tomato, Black rot of cauliflower, Downy mildew of apple gourd.

INTRODUCTION

Pakistan has a wide range of climatic conditions, which provide a year of cultivation of a large range of vegetable crops (Nabi *et al*., 2022). As a result, the country's vegetable production is diverse in terms of the species grown (Aguiar *et al*., 2020). In Pakistan, more than 35 different types of vegetables are grown in a variety of ecosystems. During the summer and spring, chillies, tomatoes, potato, eggplant (brinjal), gourds, okra and cucumber are abundant; however, during the rainy season, cucumber, gourds, okra, eggplant and beans are readily available. Vegetables are second only to cereals in respect of carbohydrate content. Roots, stems, leaves, and fruits of vegetable plants are used to store reserve food and are eaten fresh, cooked, pickled, and combined with staple foods such as wheat and rice.

Vegetables have a high nutritional value due to the presence of nutrient-dense food containing mineral salts and vitamins. These nutritional requirements are necessary for maintaining good health and resistance to certain degenerative disorders (Włodarek, 2019).

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Pakistan grows a wide range of tropical, subtropical, and temperate vegetables. A healthy diet, according to human nutrition experts, includes 100 gram of vegetables per person each day. As a result, the vegetable harvests may be used to back up the cereal crops. According to estimates, the country's horticulture export revenues in 2015 and 2016 were $641 million. Furthermore, fruit and vegetables are grown in addition to agronomic crops on a commercial scale, and it aids in the fulfilment of dietary requirements to meet the needs of the country's growing population. Vegetables are considered a protective food since they are high in antioxidants, vitamins, minerals, and dietary fiber source (Sachdeva *et al*., 2013), and also rich in proteins and carbohydrates (Hameed *et al*., 2016).

Integrated Disease Management (IDM) programmes include a range of activities such as prevention, monitoring, accurate disease diagnosis, establishing thresholds, and selecting the most effective management tools (Shin *et al.,* 2023). Genetic, cultural, biological, and chemical management are all effective options that have been widely adopted (Ahmad *et al.,* 2021a; Naseer *et al.,* 2022). Vegetables diseases can be prevented through the use of host-plant resistance, cultural practises, and chemicals (Asif *et al.,* 2018; Khan et al., 2018). To effectively manage diseases, it is important to have an understanding of how pathogens can cause instability in crops. Disease progression is determined by the initial inoculum, disease rate, and crop growth time. These characteristics often lead to an exponential increase in pathogen population in production systems (Shin *et al.,* 2023).

Crop loss is primarily caused by diseases and pests (Kazige *et al*., 2022). Diseases and pests are causing loss of one-fifth of total vegetable production in the world, while diseases alone are causing 10% loss of global vegetable production. The main reason for losses is the mono-culturing of crops. While the evolution of new resistant strains (Jones and Naidu, 2019) could be reduced by growing new resistant varieties. Through proper disease diagnosis yield losses could be protected in vegetables. Pakistan is the world's seventh most populous country with the population increase rate of > 3% per year. Hence, a trend of production must be aligned with rapid growth of the population. The average yield of one acre of vegetables in developing countries is well below that of agriculturally advanced countries (Richard *et al*., 2022). Currently, there is no information about different vegetable diseases in Pakistan and particularly in the district Sargodha of Punjab. Therefore, the current study was conceptualized with two objectives, 1) identification of various diseases of vegetables prevalent in Sargodha district and 2) to calculate the disease incidence (DI) of different vegetable diseases in Sargodha district.

MATERIALS AND METHODS

Extensive surveys were carried out to report different diseases prevailing in various vegetable fields of three tehsils of district Sargodha (Figure 1). The purpose of selecting three tehsils of district Sargodha, i.e., Shahpur, Kotmommin and Sargodha, was because in these tehsils vegetables are mostly grown. For data collection, seven villages from each tehsil were selected. For data collection, four corners of each field and one from the center of the field were selected. Randomly 6 plants were selected from each corner and center of the field, respectively, and then the disease was identified and incidence was noted. The surveys were repeated every ten days intervals and continued for three months. The formula to calculate the disease incidence (DI) of each disease (Fateh *et al*., 2017) is as under:

$$\text{DI (\%)} = \frac{\text{Number of infected plants having disease symptoms}}{\text{Total plants observed}} \times 100$$

The diseases were identified on the leaves and fruits of vegetables. Various diseases were observed at different stages of vegetables in different villages of district Sargodha. These villages include Jalalpur Jagir, Nathuwala, Chak-164, Chak-134, Lillyani, Chak-34, and Chak-3. The current survey has identified various diseases, which are listed in Table 1 along with their corresponding symptoms in Table 2.

STATISTICAL ANALYSIS

The percent DI of each disease was subjected to analysis of variance (ANOVA) and means were compared using the least significant difference test (LSD) at 0.05 (Steel and Torrie, 1980).

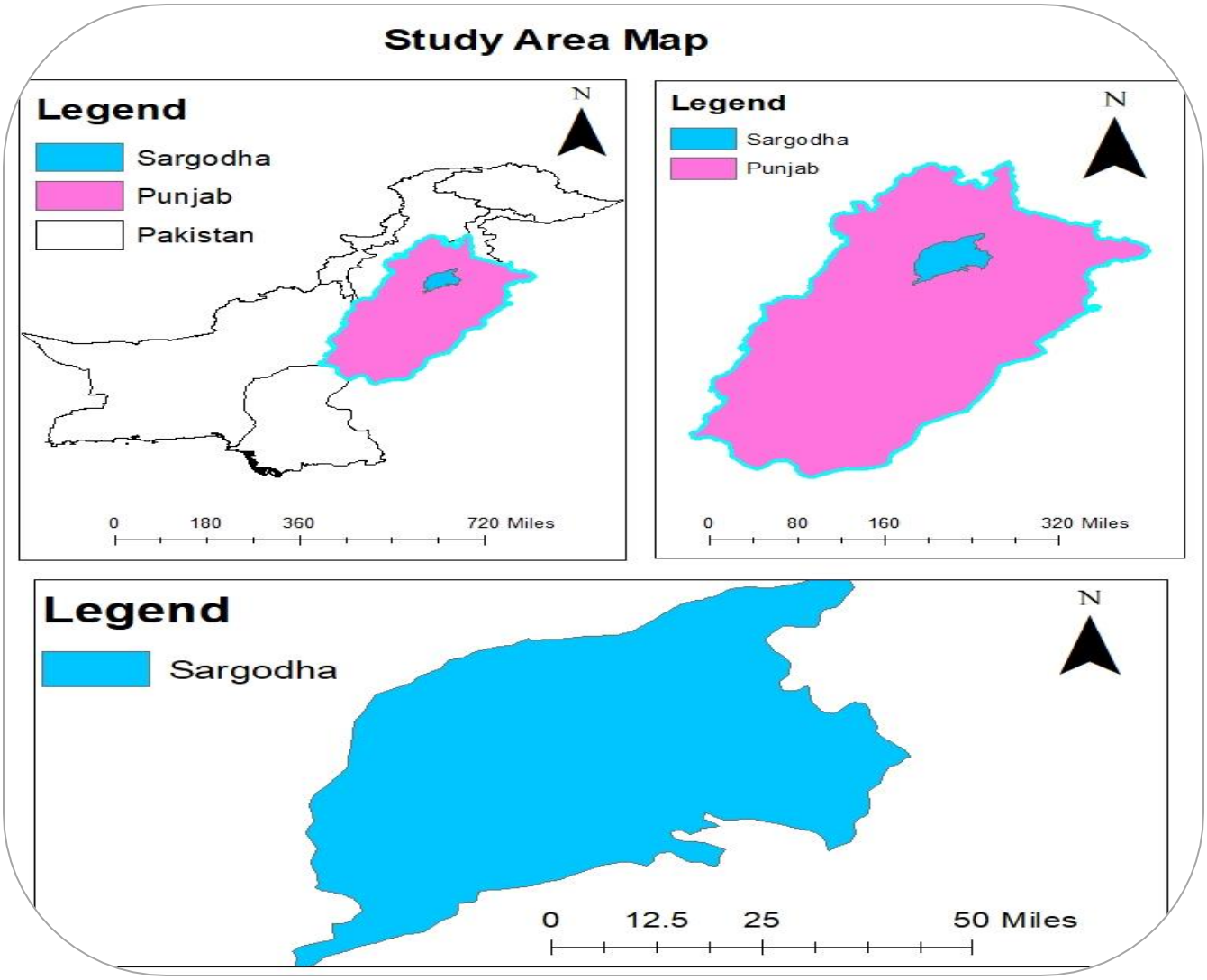
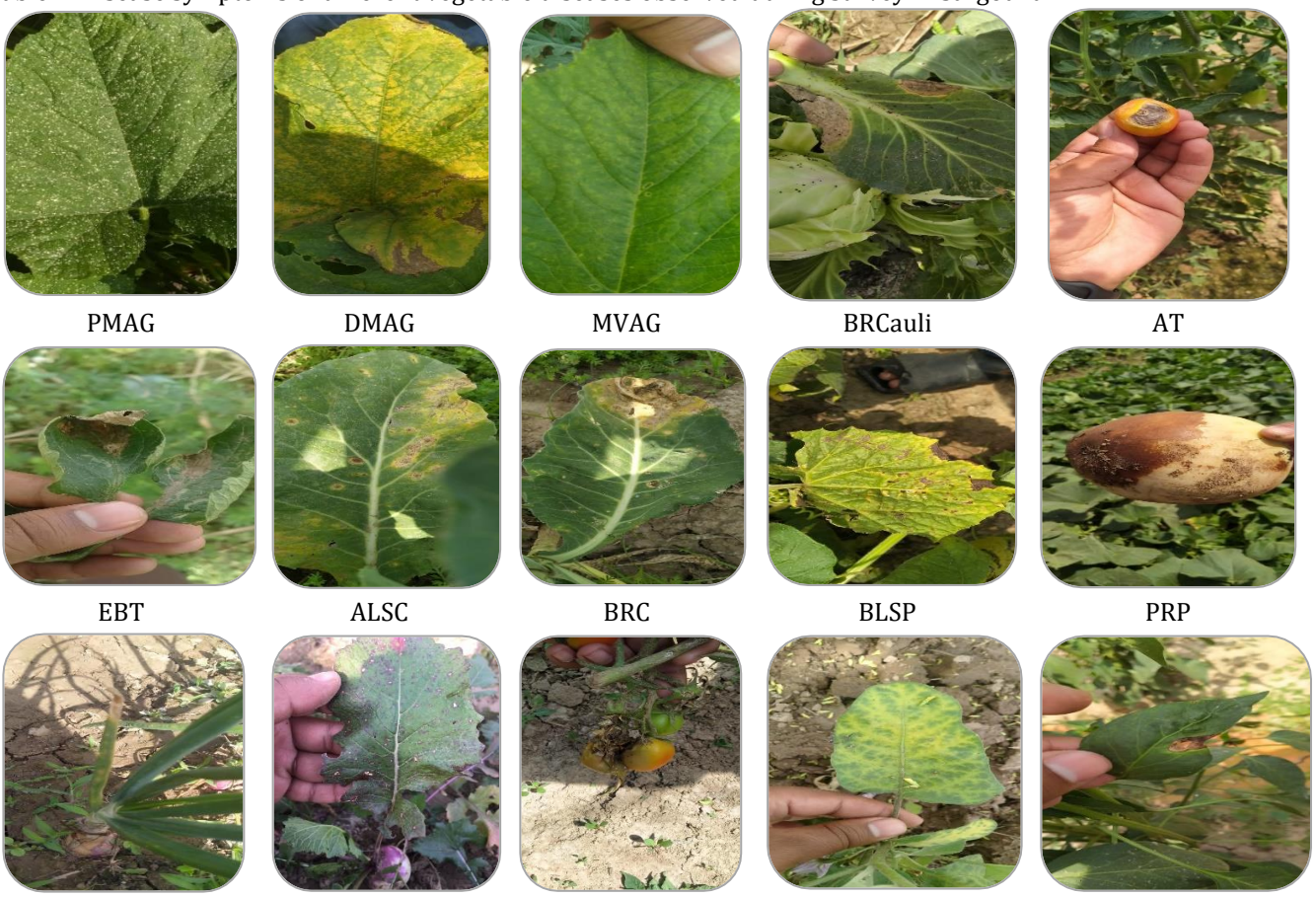


Figure 1. Map of Pakistan indicating the study area of present investigation

Table 1. List of diseases observed during the present surveys

Sr. No.	Name of diseases
1	Powdery mildew of Apple gourd (Teenda) (PMAG)
2	Downy mildew of apple gourd (DMAG)
3	Mosaic virus of apple gourd (MVAG)
4	Black rot of cauliflower (BRCauli)
5	Antracnose of tomato (AT)
6	Early blight of tomato (EBT)
7	Alternaria leaf spot of cabbage (ALSC)
8	Black rot of cabbage (BRC)
9	Bacterial leaf spot of pumkin (BLSP)
10	Phythopthora rot of pumkin (PRP)
11	Botrytis leaf blight of onion (BLBO)
12	Alternaria leaf spot of turnip (ALST)
13	Late bligt of tomato (LBT)
14	Mosaic virus of brinjal (MVB)
15	Cercospora leaf spot of chilli (CLSC)

Table 2. Disease symptoms of different vegetable diseases observed during survey in Sargodha.



PMAG = Powdery mildew of Apple gourd (Teenda) (PMAG); DMAG = Downy mildew of apple gourd; MVAG = Mosaic virus of apple gourd; BRCauli = Black rot of cauliflower; AT = Antracnose of tomato; EBT = Early blight of tomato; ALSC = Alternaria leaf spot of cabbage; BRC = Black rot of cabbage; BLSP = Bacterial leaf spot of pumkin; PRP = Phythopthora rot of pumkin; BLBO = Botrytis leaf blight of onion; ALST = Alternaria leaf spot of turnip; LBT = Late bligt of tomato; MVB = Mosaic virus of brinjal; CLSC = Cercospora leaf spot of chilli

RESULTS

Incidence of PMAG disease in district Sargodha: In district Sargodha, the maximum incidence rate of PMAG (in %) was observed in Chak-3 as compared to the other villages, while the minimum incidence rate (in %) of PMAG was observed in Nathowala. The incidence of PMAG was significantly higher ($P<0.05$) in Chak-136 and Lillyani. (Figure 2).

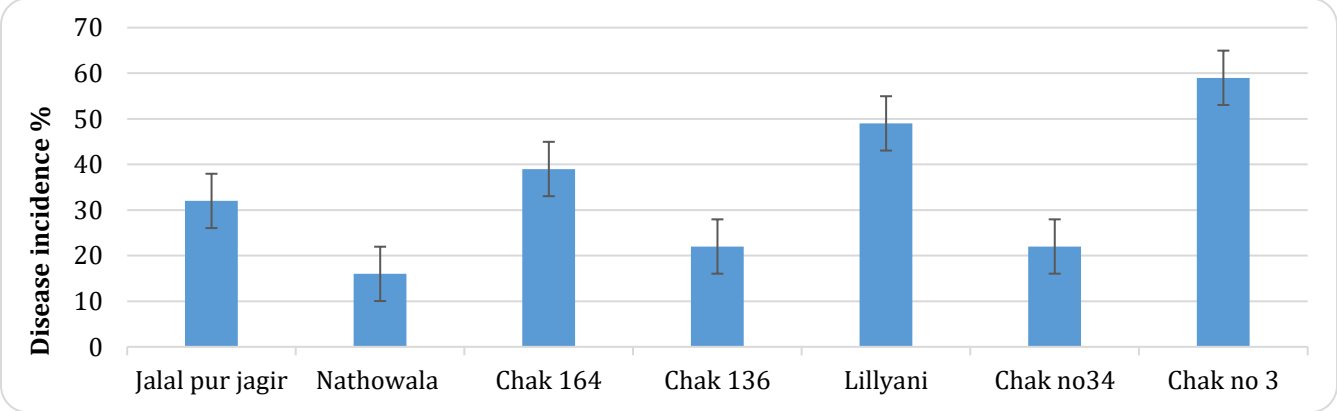


Figure 2. Percent incidence of PMAG in different villages of district Sargodha.

Incidence of DMAG disease in district Sargodha: The highest incidence of DMAG disease was observed in Jalalpur and Chak-34, whereas the lowest incidence was documented in Chak-136. (Figure 3).

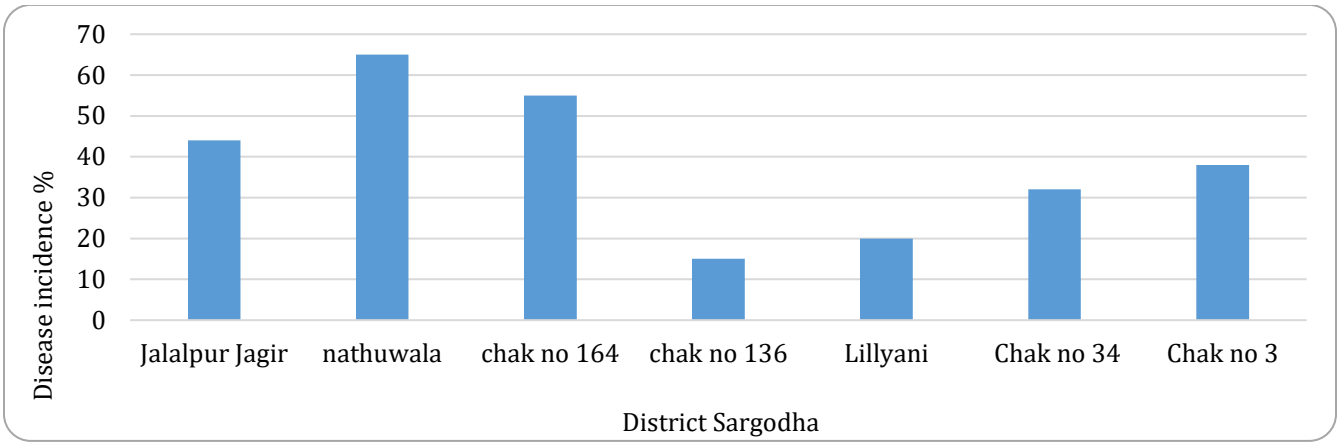


Figure 3. Percent incidence of DMAG in different villages of district Sargodha.

Incidence of MVAG disease in district Sargodha: Maximum incidence rate (in %) of MVAG was recorded in Chak-3 followed by Lillyani, while minimum disease incidence rate (in %) was recorded in Nathowala (Figure 4).

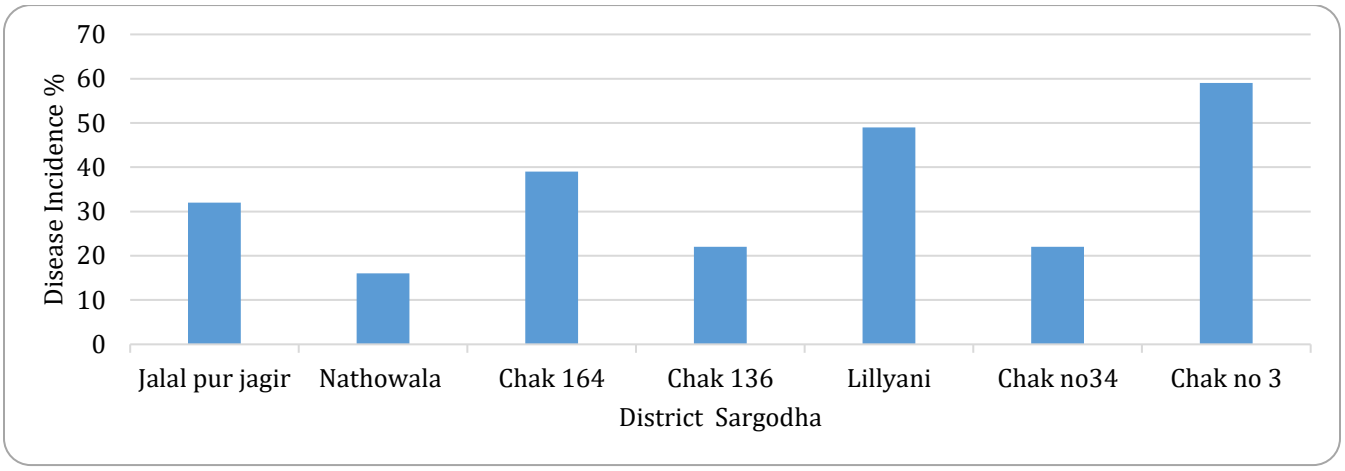


Figure 4. Percent incidence of MVAG in different villages of district Sargodha.

Incidence of BRC disease in district Sargodha: Maximum incidence rate (in %) of BRCG was recorded in Jalalpur and Nathowala, while minimum disease incidence rate (in %) was recorded in Chak- 3 (Figure 5).

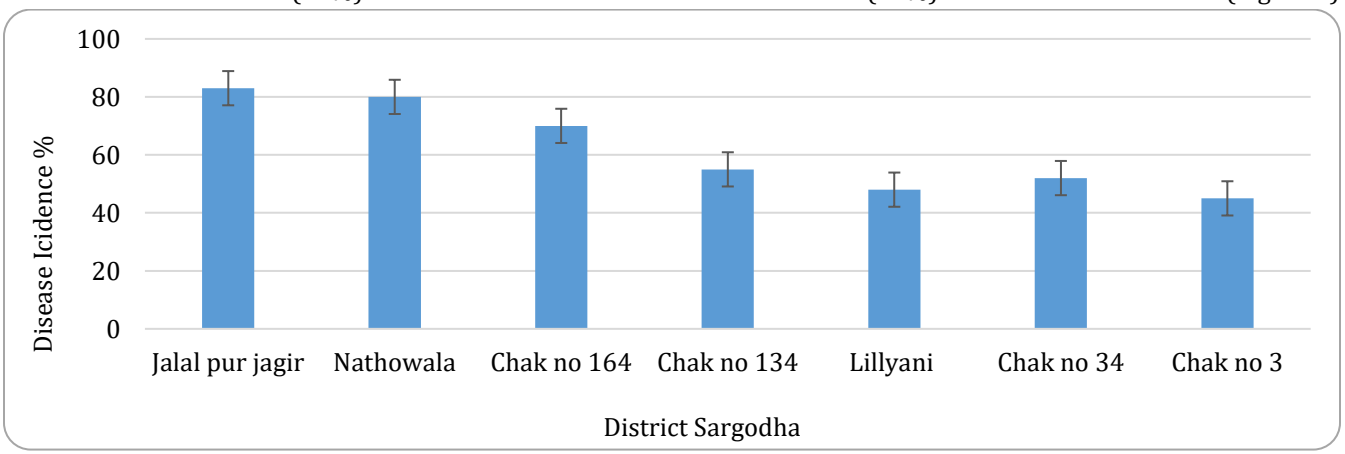


Figure 5. Percent incidence of BRC in different villages of district Sargodha.

Incidence of AT disease in district Sargodha: The highest incidence rate of AT disease was observed in Chak-3 and Lillyani, whereas the lowest incidence rate was documented in Nathowala. (Figure 6).

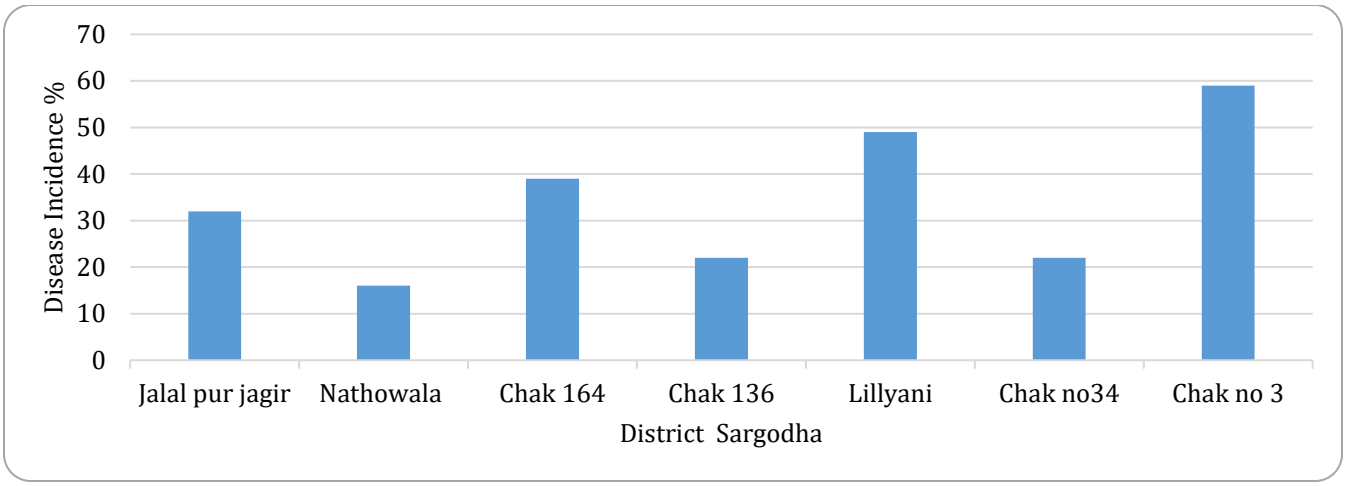


Figure 6. Percent incidence of AT in different villages of district Sargodha.

Incidence of EBT disease in district Sargodha: Maximum incidence rate (in %) of EBT was recorded in Chak-164, while minimum disease incidence rate (in %) was recorded in Nathowala and Chak 134 (Figure 7).

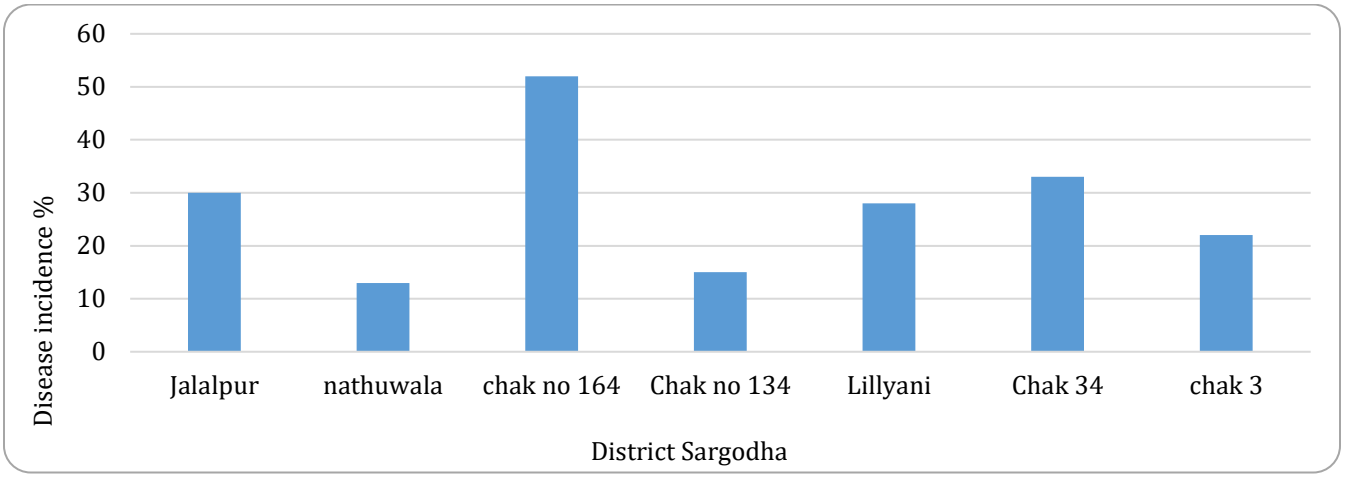


Figure 7. Percent incidence of EBT in different villages of district Sargodha.

Incidence of ALSC disease in district Sargodha: The highest incidence rate of ALSC was observed in Chak-3, whereas the lowest incidence rate of the disease was observed in Chak-34 and Nathowala. (Figure 8).

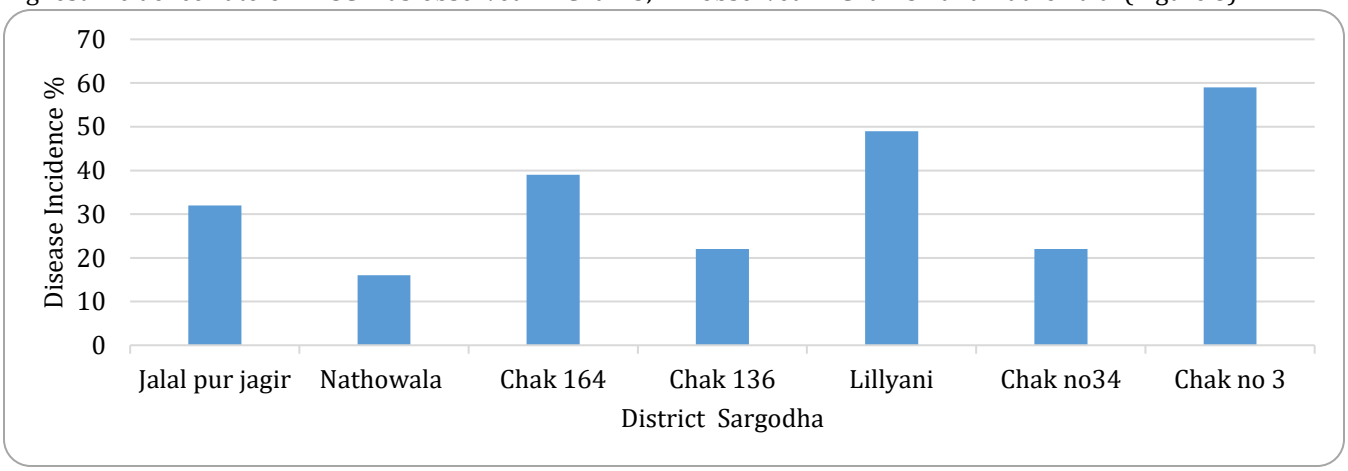


Figure 8. Percent incidence of ALSC in different villages of district Sargodha.

Incidence of BRC disease in district Sargodha: Maximum incidence rate (in %) of BRC was recorded in Jalalpur and Nathowala, while minimum disease incidence rate (in %) was recorded in Lillyani (Figure 9).

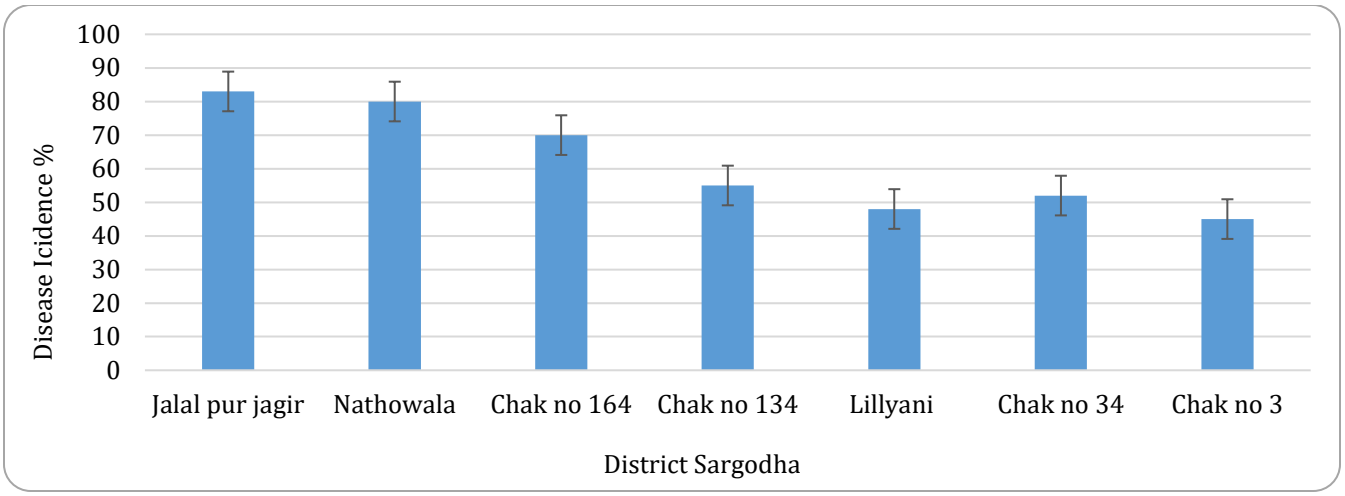


Figure 9. Percent incidence of BRC in different villages of district Sargodha.

Incidence of BLSP disease in district Sargodha: Maximum incidence rate (in %) of BLSP was recorded in Nathowala, while minimum disease incidence rate (in %) was recorded in Chak-136 (Figure 10).

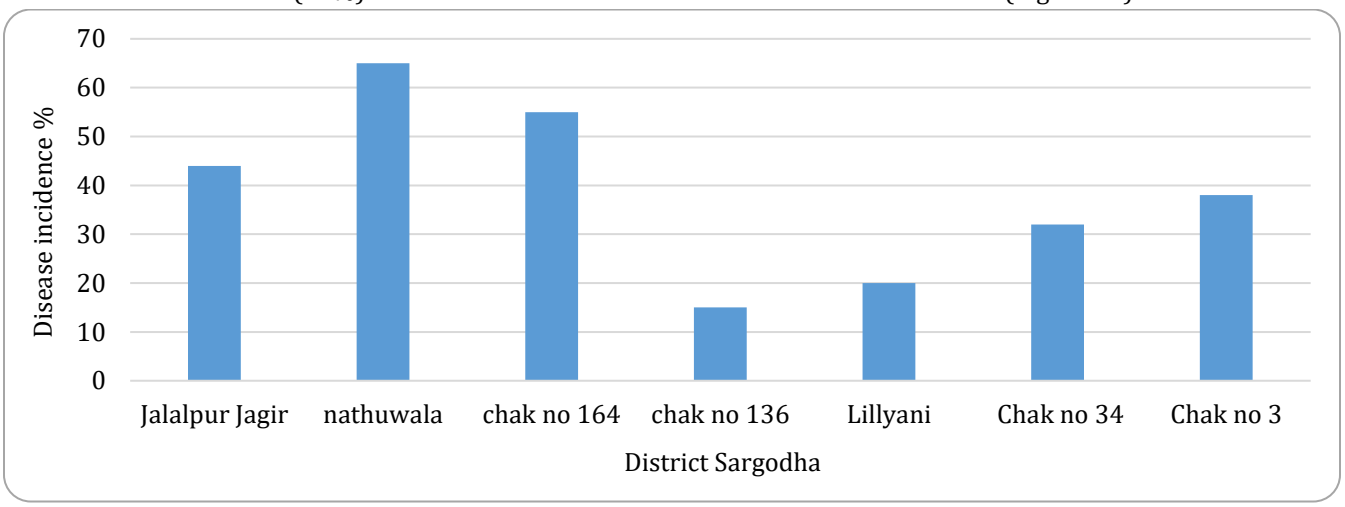


Figure 10. Percent incidence of BLSP in different villages of district Sargodha.

Incidence of PRP disease in district Sargodha: Maximum incidence rate (in %) of PRP was recorded in Chak-164, while minimum disease incidence rate (in %) was recorded in Chak-134 and Nathowala (Figure 11).

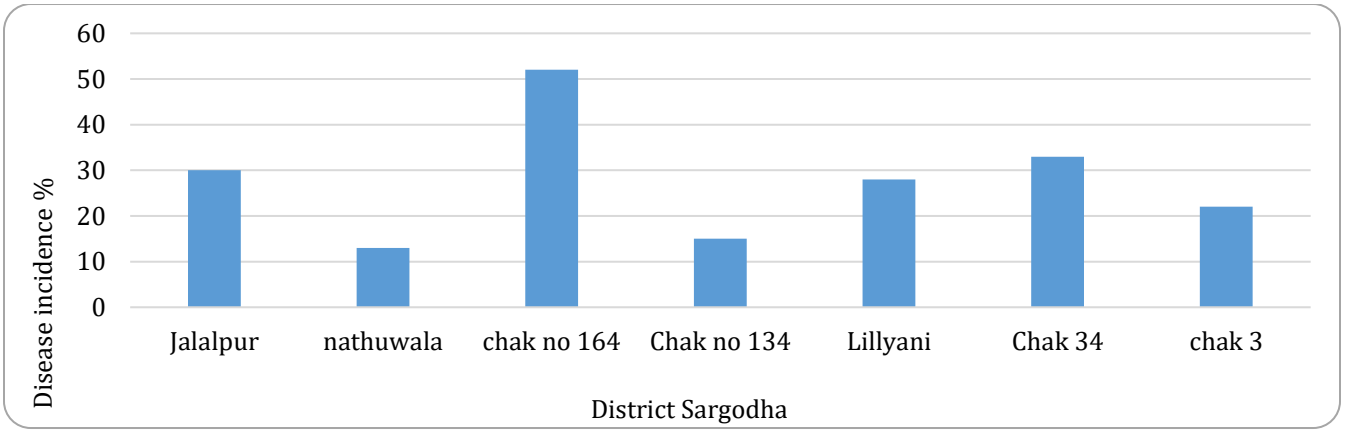


Figure 11. Percent incidence of PRP in different villages of district Sargodha.

Incidence of BLSO disease in district Sargodha: Maximum incidence rate (in %) of BLSO was recorded in Nathowala, while minimum disease incidence rate (in %) was recorded in Chak-136 (Figure 12).

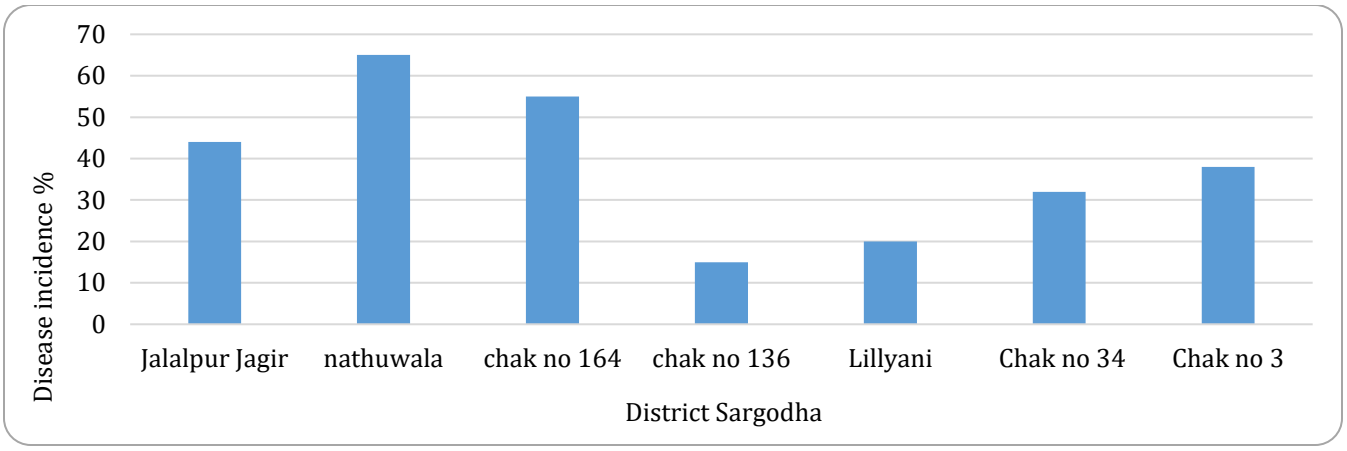


Figure 12. Percent incidence of BLSO in different villages of district Sargodha.

Incidence of ALST in district Sargodha: Maximum incidence rate (in %) of ALST was recorded in Chak-164, while minimum disease incidence rate (in %) was recorded in Nathowala (Figure 13).

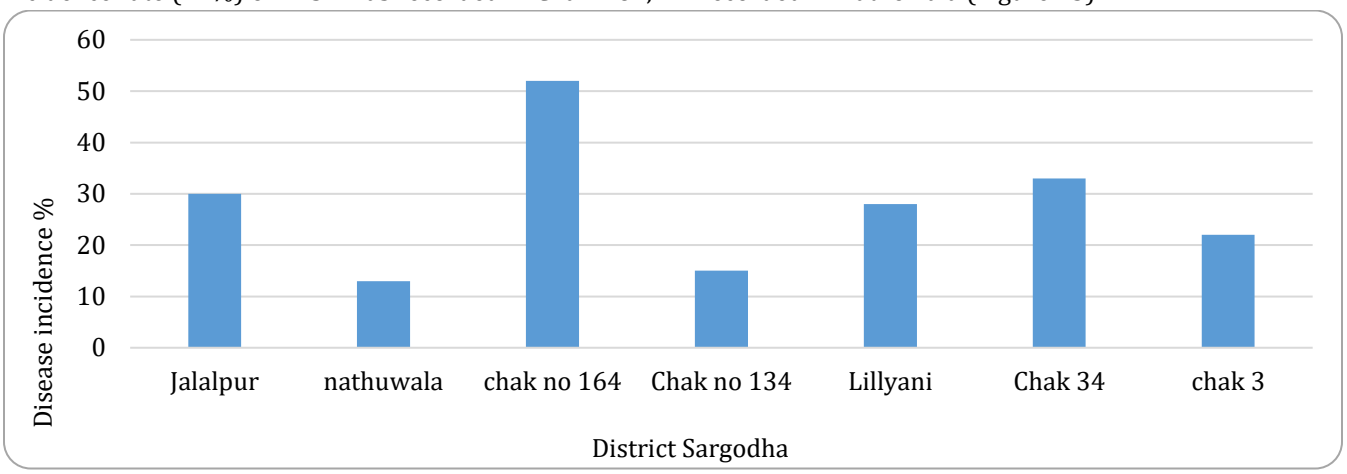


Figure 13. Percent incidence of ALST in different villages of district Sargodha.

Incidence of LBT disease in district Sargodha: Maximum incidence rate (in %) of LBT was recorded in Nathowala, while minimum disease incidence rate (in %) was recorded in Lillyani (Figure 14).

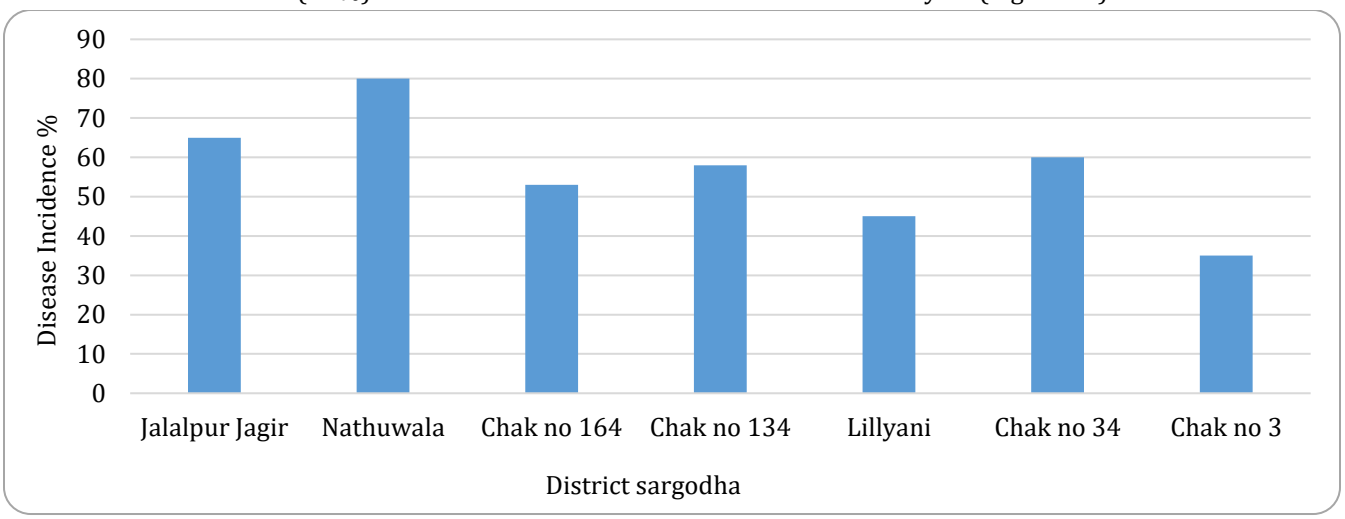


Figure 14. Percent incidence of LBT in different villages of district Sargodha.

Incidence MVB disease in district Sargodha: Maximum incidence rate (in %) of MVB was recorded in Chak-164, while minimum disease incidence rate (in %) was recorded in Chak-134 (Figure 15).

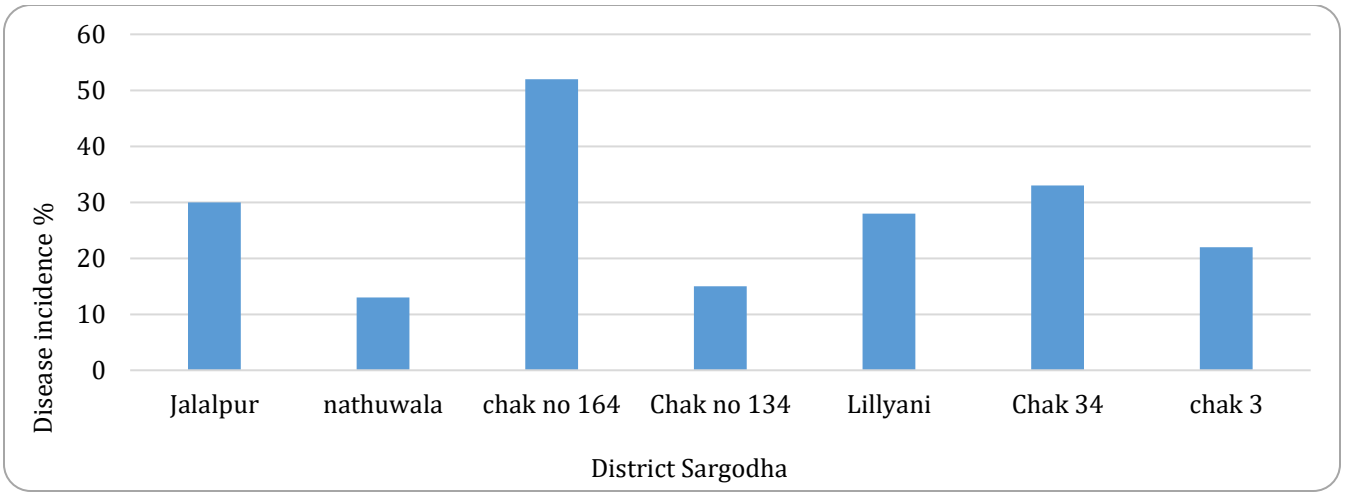


Figure 15. Percent incidence of MVB in different villages of district Sargodha.

Incidence of CLSC disease in district Sargodha: The highest recorded incidence rate of CLSC was observed in Nathowala, whereas the lowest incidence rate of the disease (in %) was documented in Chak-3. (Figure 16).

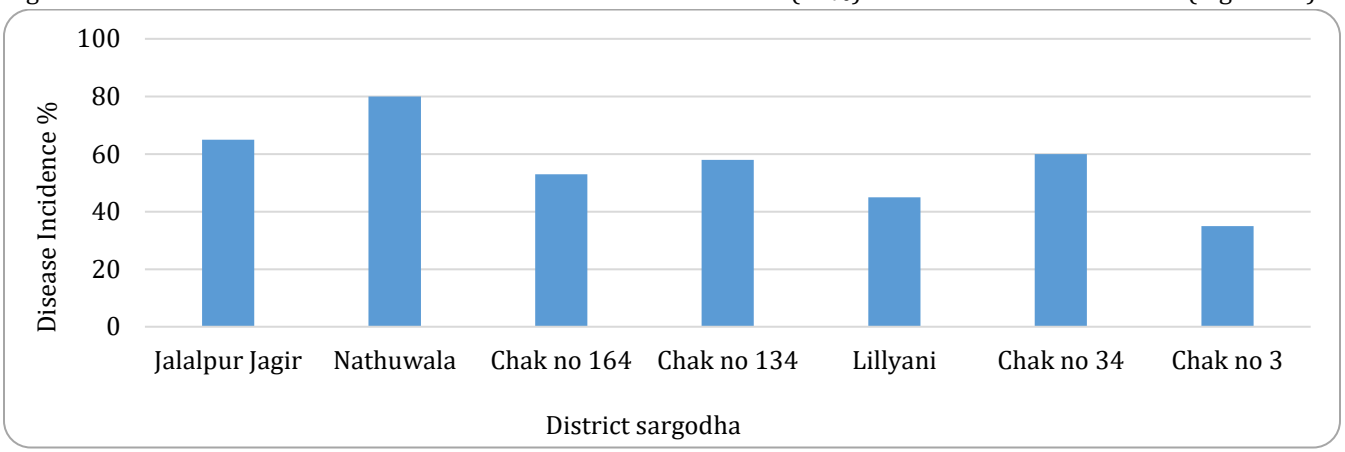


Figure 16. Percent incidence of CLSC in different villages of district Sargodha.

DISCUSSION

The survey revealed that certain diseases found on vegetables were a result of fungal infections, while others were caused by bacteria and viruses. The survey results indicated the presence of EBT in the Sargodha district. This disease was observed during all of the surveys. EBT is a highly prevalent and destructive disease in major tomato-growing regions worldwide, and it has also been reported in Algeria (Akhtar et al., 1994). Another significant disease that we observed in our survey was ALS. This disease is a major foliar disease that affects brassica crops, including cabbage fields worldwide. The pathogen only targets leaves, and if the infection is severe, it can lead to a decrease in yield as a result of foliage loss (Rimmer et al., 2007).

. Our survey results showed that PMAG was present in all villages of district Sargodha. The incidence value of PMAG in Jalalpur was 32% and in Chak-3 was 59%, and it was present at peak level during the season. BLSP is a bacterial disease and is caused by *Xanthomonas cucurbitae*. It is gram-ve bacteria and causes economic losses in pumpkin fields in Nepal (Bradbury, 1986; Maringoni *et al*., 1988). Our survey results also observed BLSP in district Sargodha. The severity of BLSP in chak-164 was 70%, whereas in Nathuwala village it was 80%, and was the second most prevailing disease in chak-134. The BLSP was at peak level in the Jalalpur district of Sargodha. Similar findings have been given by different researchers. Bradbury (1986) conducted surveys in Nepal and found this disease very prevalent in Nepal states. They also reported heavy yield losses due to this disease in Nepal. This disease is present in Nepal for last ten years (Adhikari *et al*., 2023). He reported BLSP as a chronic issue of Nepal. They conducted surveys from three to seven years and found a linear relationship between BLSP incidence. They concluded that BLSP

disease was very prevalent.

The susceptibility of tomato to *Alternaria solani* (AT) and Fusarium wilt is significant (Ahmad *et al.,* 2021b). According to Damm *et al*. (2009), *Colletotrichum* spp. is the causal organism of AT. Prior studies have confirmed our findings. The presence of AT disease was noted in all of the villages that were surveyed. The prevalence of AT in Nathuwala was found to be 18%, while in Chak-136, it was observed to be the same at 21%. The prevalence of AT disease was found to be at its highest level in the population residing in Chak-3. The results of our study are consistent with the research conducted by Glass and Donaldson in 1995. According to their report, a majority of tomato fruits exhibit susceptibility to AT (Paudel *et al.,* 2021; Olowe *et al.,* 2022). Additionally, he reported a high prevalence of this disease in the southern hemisphere. According to Chethana *et al.* (2015), this disease poses a significant threat in the western states of India and has resulted in substantial losses.

BRC is also known as black heart disease. It is a severe disease in cabbage fields in Africa, where crop losses are especially during the wet and warm seasons (Larsen and Larsen, 2006). However, recent reports are confirming that the yield losses due to BRC were greater in the rainy and warm seasons than the cold and dry seasons (Hsiao *et al*., 2023). Our results are in agreement with the results of Day *et al*. (1992). They reported 45% BRC incidence in different fields of Africa. Our survey results showed the incidence of BRC in the fields of all major vegetable-growing villages of district Sargodha. The prevalence of BRC was 82% in Jalal pur Jagir and in Nathowala it was 70%. BRC disease was observed in every field of cabbage in all villages. This corroborates the findings of Hsiao *et al*. (2023), in their surveys this disease was present in almost every visited field. They concluded BRC disease was a potential threat to the brassica crop. They further reported that this disease is spreading to new areas where previously was not present.

We also observed many other diseases of vegetables in different villages of this district. This is in line with the findings of Behrani *et al*. (2015). They conducted surveys and observed various diseases of vegetables. The diseases they reported were basal rot, Fusarium wilt, early blight, late blight, downy mildew and bottom rot. Alternaria has various species which also cause leaf spot or black spot disease in Solanaceae crops and Brassica vegetables (Mamgain *et al*., 2013).

The current research unravels the occurrence of fifteen diseases in villages of district Sargodha. These diseases have been reported to cause heavy yield losses worldwide. Hence, more studies are required to effectively manage these diseases. To safeguard the vegetable crops, certified disease-free vegetable nursery stocks should be promoted in Sargodha.

CONCLUSION

The research findings documented the presence of fifteen diseases across seven villages located in the Sargodha district. The diseases were PMAG, DMAG, MVAG, BRCauli, AT, EBT, ALSC, BRC, BLSP, PRP, BLBO, ALST, LBT, MVB and CLSC. The present research will help the research institutes to conduct further research on these vegetable diseases to control them effectively to avoid future yield losses.

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