EVALUATION OF FUNGICIDES AND FREQUENCY OF APPLICATION FOR BIPOLARIS LEAF BLIGHT MANAGEMENT OF WHEAT

A THESIS

BY

Fariha Islam
Student No.: 1701134
Session: 2022-2023
Thesis Semester: July-December 2023

MASTER OF SCIENCE (M.S.)
IN
PLANT PATHOLOGY

DEPARTMENT OF PLANT PATHOLOGY

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR- 5200

DECEMBER, 2023

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DECEMBER, 2023

Dedicated to

My

Beloved Parents

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December, 2023 ***The Author***

ABSTRACT

A field experiment was conducted at the research field of Hajee Mohammad Danesh Science and Technology University, Dinajpur, during cropping season 2022-2023 to evaluate the effect of selected fungicides and number of sprays for management of Bipolaris leaf blight of wheat caused by *Bipolaris sorokiniana*. Randomized complete block design with three replications was followed for the experiment. The variety BARI Gom 30 was used in the experiment. Seeds were sown 21 November, 2022. Three fungicides were sprayed as treatment named Tilt 250EC, Amister Top 325SC and Caprio Top at a prescribe dose in each plot for 1, 2 and 3 times to control the disease. Plant height & spike length was recorded as vegetative parameters. Data on percent disease leaf area and disease severity for flag leaves and penultimate leaves were also recorded at several DAS. After harvesting, the number of healthy grains per spike, the number of black pointed grains per spike, the number of undersized grains per spike, total number of grains per spike, thousand grain weight etc. was calculated. After analyzing the data, it was concluded that the three applications of Amister Top showed better result than other fungicides to control the leaf blight disease. It also gave better yield compared to those fields which were unsprayed. Again, the highest number of healthy grains and lower number of black pointed seeds were also found with this fungicidal application.

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Chapter 1

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most significant cereal crops in Bangladesh (Hossain and Teixeira 2023). It is a part of Poaceae family and is the second most essential primary food after rice. In Bangladesh a majority of individuals fulfill their need for carbohydrates by consuming wheat (Majumdar 1991). It is more nutritious than rice due to the fact that the protein level of wheat is 12.3%, while rice has a protein level of 8.5% (Meisner *et al*. 2003).

Although the cultivation of crop has begun in 1961 within the country, its popularity among the people has significantly increased since 1975. At present the amount of wheat produced in South Asia is approximately 95 million tons, whereas the estimated demand for 2020 is approximately 137 million tons. The consumption of wheat is increasing approximately @3% per year (Saifuzzaman *et al*. 2008).

Although the size, output and efficiency of wheat cultivation have significantly have risen in recent year, the wheat production of Bangladesh remains comparatively low compared to other wheat growing countries such as Japan, India, China, South Korea, Mexico, USA and Australia (USDA 2007). Approximately 399 thousand hectares of land in Bangladesh were used for growing wheat, resulting in an annual production of 737 million tons (BBS 2008). In the period of 2018-2019, the amount of wheat has produced 1.02 million metric tons from a cultivated area of 0.3 million hectare, as reported by BBS 2019. The country requires 6.88 million metric tons of wheat, with the majority (around 80-85%) which are imported every year.

There are many reasons for lowering the yield of wheat in Bangladesh. Like other field crops wheat is also susceptible to a number of diseases. Wheat is attacked by about 20 different diseases including 12 fungi at vigorous stages of its growth in Bangladesh. Among them the most common and major diseases are Bipolaris leaf blight, leaf blotch, leaf rust, foot and root rot, seedling blight, black point etc. (Ahmed *et al*. 1994).

Leaf Blight caused by *Bipolaris sorokiniana* is regarded as destructive disease in the eastern region of South Asia (Siddique *et al*. 2006). In the past few years, it has become a serious threat for wheat cultivations in Bangladesh. It has been reported that leaf blight of wheat has caused a reduction in yield by 14.97% (Alam *et al*. 1995). In case of severe attack, it could lead to a complete loss of crop production (Hossain and Azad 1994). This disease is seed borne and frequently transmitted through seed (Bazlur Rashid *et al.* 1992, 1996, 1997). The disease become serious if there are regular rains or misty condition during the crop's maturity period. The disease incidence observed on stem and leaf increased across the growth stage. The disease worried all concerns particularly the wheat seed crop growers as regards to the impact of the disease on the crop.

Cultivation of resistant variety is the most adoptable method for controlling this disease. But none of wheat varieties in our country resistant against this disease (Hossain and Azad 1992). Mishra *et al.* (2001) found that in wheat field where the crops was planted early, the prevailing maximum temperature of (22-25)^{0}C during December coincided with the extremely congenial weather conditions leading to the incidence of leaf blight disease.

The most effective method for controlling this disease is fungicide application. Fungicide has proven useful and economic in controlling Bipolaris leaf blight. But to the best of my knowledge, there is no available literature in our country to minimize the disease with fungicide application. Considering the above facts, the present study is undertaken with following objectives.

Objectives:

1. To evaluate the effect of selected fungicide for management of leaf blight of wheat.
2. To determine the number of fungicide sprays to minimize leaf blight disease of wheat.

Chapter 2

REVIEW OF LITERATURE

Bipolaris sorokiniana is a significant fungus that impacts both the upper and lower section of wheat. This section provides the relevant studies that are related to the current research:

Mustarin *et al.* (2021) reported that, recently a country wide survey on wheat diseases of Bangladesh on three major diseases–Bipolaris leaf blight, leaf rust and blast. Bipolaris leaf blight showed highest prevalence with 100% incidence and 28–56% diseased leaf area (DLA). None of the variety or field was free from leaf blight symptoms.

Magar *et al.* (2020) conducted an experiment with eight fungicides such as; Sectin, Curex, Bavistin, Vacomil plus, Saaf, Sajha, Criptan and Tilt at different application levels (25, 50 and 100 ppm). Tilt was the most efficient chemical that totally constrains the hyphal progression at all applications. As well, fungicides *viz.* Sajha (79.78%), Saaf (73.59%) and Sectin (70%), at 100 ppm were operative in controlling the pathogen than others. Hyphal growth reduction of the fungus was found to be amplified with the increase in ppm of chemicals.

Angdembe *et al.* (2020) evaluated four fungicides (mancozeb 75% wp, copper oxychloride 50% WP, carbendazim 50% WP and thiram 75% WS) with three concentrations (100, 200 and 400 ppm) against spot blotch pathogen *B. sorokiniana* of barley in Nepal. All concentrations of copper oxychloride and 400 ppm of mancozeb were capable to prevent more than 50% colony diameter of the fungus.

Momtaz *et al.* (2019) stated that, Bipolaris leaf disease affected the leaves of twenty-one different types of wheat in Bangladesh, and 35 types of fungi from 20 different genera were found to be responsible for it.

Momtaz *et al.* (2019). Reported that the most predominant fungi, in order of prevalence, were *Bipolaris sorokiniana*, *Alternaria alternata*, *Curvularia lunata*, *Cladosporium cladosporioides* and *Fusarium semitectum* association of five species of *Bipolaris* and two species of *Drechslera* were reported from BpLB infected wheat leaves.

Kavita *et al.* (2017) studied 15 fungicides on radial hyphal growth of *Bipolaris sorokiniana* on Barley. The radial mycelium growth was inhibited by propiconazole (0.1%) and (0.05%). Followed by hexaconazole (0.2%) and (0.1%).

Bacmaga *et al.* (2015) stated that strobilurin fungicides had unique mechanism to affect fungi by inhibiting mitochondrial respiration.

Yadav *et al.* (2015) explored the effects of fungicides (propiconazole, carbendazim and hexaconazole) on wheat seed production and spot blotch disease. The highest 38 decrease in disease was achieved with two sprays of carbendazim (0.1 percent) during the tillering and boot leaf stages, followed by two applications of propiconazole at the tillering and boot leaf stages. Propiconazole, carbendazim, and hexaconazole were also found to be helpful in lowering disease levels and increasing crop output.

Selvakumar *et al.* (2015) explained that artificial epiphytotic field conditions to test various fungicides (captan 50% WP, carboxin 37.5% WP + thiram 37.5% WP, propiconazole 25% EC, tubeconazole 25% EC and mancozeb 75% WP) as seed treatments or foliar sprays and in combination. The best control of leaf blight under severe circumstances was seed treatment with carboxin 37.5% WP + thiram 37.5% WP @ 1.5 g/kg seed, followed by spraying with propiconazole 25% EC @ 0.1 percent at boot leaf stage.

As per research conducted by Chowdhary *et al.* (2013), Leaf blight is a significant disease of wheat in Nepal, caused by *Bipolaris sorokiniana* and

Pyrenophora tritici-repients either individually or together. The wheat plant in humid and warm regions, like India, Nepal and Bangladesh was greatly affected by leaf blight in a severe condition caused by *Bipolaris sorokiniana.* The disease was prevalent, especially in the North Eastern Plains Zone (NEPZ) of India (Bahadar *et al*. 2016). In warm and humid conditions, leaf blight is believed to cause a significantly reduced average wheat yield.

Hasan *et al.* (2013) discovered that difenoconazole+ propiconazole, propiconazole, hexaconazole, etc. completely inhibited the *Bipolaris sorokiniana* growth.

Singh *et al.* (2011) explored the efficacy of propiconazole and tebuconazole in controlling leaf blight in wheat variety HD 2329 under field conditions in India. Wheat grain yields increased considerably with both propiconazole (5.24 ton/ha) and tebuconazole (5.08 ton/ha) treatments.

Wegulo *et al.* (2009) explained Leaf blight has been described as a dangerous disease in several states in the United States as well as different parts of Europe and including west-north Russian Federation. The pathogen's capacity to acclimate to cold, which allows increased inoculum survival even in freezing winter temperatures, may explain its 9 presence in cooler parts of the world (east Europe, north-west China, north-west Africa and North America).

Duveiller and sharma (2009) reported that, *Bipolaris sorokiniana* is a noxious organism that grows well in places with a lot of moisture and heat, as well as poor soil quality, like region in South America, Africa, and Australia. It can also be seen in non- traditional subtropical lowland wheat areas in Brazil, North east Argentina and Paraguay as well as similar environments in Tanzania and rain-fed wheat cultivation regions of Zambia and Madagascar (Hetzler *et al.* 1991)

As stated by Malaker and Mian (2009), applying Tilt 250EC (at a concentration of 0.05 percent) to the leaves, except for the 70 and 90 DAS, had a significant impact in reducing disease severity when compared to the control.

Hasan *et al*. (2008) examined the impact of five fungicides namely hexaconazole, carbendazim, mancozeb, difenoconazole+ propiconazole and propiconazole at different concentrations (100, 200, 300, 400 and 500 ppm) on the colony growth of *B. sorokiniana*. 100% colony diameter reduction with the use of propiconazole, Hexaconazole and difenoconazole+ propiconazole at all application was succeeded.

Malaker *et al*. (2007) conducted an experiment where black pointed seeds were collected from major growing areas of Bangladesh. *Bipolaris sorokiniana* was the most prominant fungus there.

Siddique *et al*. (2006) carried out repeated trials in a warm region of Bangladesh during the 2003 and 2004 winter season at two places: grower’s farm and research center. Leaf blight impacted 60% of the crop, resulting in crop losses of 2–22%.

Singh *et al*. (2005) discovered that the efficacy of Vitavax 200 WS (Carboxin; 2.0, 2.5 or 3.0 g/kg of seeds), Vitavax 75 WP (2.5 g/kg) and Thiram 75 WS (3.0 g/kg), applied to seeds at 24 h before sowing, against *B. sorokiniana* and *A. triticina* in wheat (cultivars PBW 373 and HUW 234) was evaluated in Karnal and Cooch Behar, Haryana, India, during 2003-04. Vitavax 200 WS at all rates completely eradicated *B. sorokiniana* and *A. triticina* in Karnal and meaningfully reduced the frequency of both pathogens in Cooch Behar.

Singh *et al*. (2005) investigated the spot blotch disease in growing period, India's eastern state of Uttar Pradesh.

Shazia and Iftikhar (2005) conducted a research on foliar blight of wheat with an 85% frequency incidence, *B. sorokiniana* was the most common cause of wheat leaf blight in the major rice-wheat farming regions of Pakistan. They identified *Alternaria alternata*, *Pyrenophora tritici-repentis*, *B. sorokiniana*, *Stemphylium* spp. and *Cladosporium* spp.

Chowdhury *et al.* (2005) observed that when examining the wheat fields in West Bengal, India, from January to February in 2003-2004, they observed common signs of zonate eyespot as well as spot blotch symptoms caused by *B. sorokiniana*. Numerous small, circular to oval, dark brown lesions emerged on healthy leaves as disease. The center of the spot lost its color rapidly, changing from dark brown to light brown with distinct dark brown borders. At the later phases of crop development, comparable indications were noticed on the spikelet.

In a study conducted by Bhandari *et al.* (2003), it was found that when 30 wheat genotypes were examined in the lab, they showed infection with B. sorokiniana. However, genotypes BL 1724. BL 1868, NL 781, and Chirta-3 had infection levels lower than 10%.

Bartett *et al*. (2001), Sauter *et al*. (1999) stated that the first patent for a Strobilurin fungicide (azoxystrobin) was publicized in the German market in 1996. And then a series of Strobilurin fungicides, including, azoxystrobin, pyraclostrobin, tryfloxystrobin, metominostrobin etc. were developed and marketed (Rodrigues *et al*. 2013, Khandelwal *et al*. 2014).

Singh *et al.* (2001) reported that wheat leaf blight pathogens in 16 Indian states: Bihar, Delhi, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamilnadu, Uttar Pradesh and West Bengal. He stated that *B. sorokiniana* was the most common cause of leaf blight in Bihar and West Bengal. He also reported about the disease in neighboring countries of Bangladesh and Nepal.

Pandey and Tewari (2001) analyzed Tilt 250 EC (propiconazole), Folicur 250 EC (tebuconazole), and Bayleton 25 WP (triadimefon) to suppress *B. sorokiniana*. Folicur was shown to be the most effective at controlling foliar blight, followed by Tilt and Bayleton. Folicur (16.26 %) had the best grain production increase over check, followed by Tilt (13.47 percent) when sprayed @ 750 ml ha^{-1}.

Mishra *et al.* (2001) discovered widespread incidence of head blight of wheat in Indore, Dhar, Dewas and Ujjain districts of western Madhya Pradesh during 1997-98 and reported that the early-sown crop of wheat cultivar “WH 147” was susceptible to head blight during January 1998 in some fields of Dhar district.

Giri *et al.* (2001) explained that diseased grains grown up on damp cotton in test tubes yielded brown necrotic spots on leaf blade and sheath of the emergent sprouts within 10 to 15 days. Diseased cells when isolated on PDA, produced culture of *B. sorokiniana*. Among the fungicides used (carbendazim at 1 g/kg and captan, thiram and mancozeb each at 3g/kg seed), mancozeb was the highest efficient (90.5%) to protect kernels from infection, followed by thiram (84.2%). Germination performance was also better in mancozeb (34.65%), followed by thiram (34.15%). carbendazim failed to seed borne infection.

Bazlur Rashid *et al.* (2001) previously found that using a 0.1% concentration of Tilt 250 EC through spraying on leaves successfully controlled *B. sorokiniana* infection on leaves and lowered the occurrence of black point in grains.

According to Pandey and Tiwari (2001) spot blotch caused the most output loss (15.5%) in UP 2338. In UP 2338 and UP 262, the decline in test weight was 5.76 and 7.2%, accordingly. In comparison to UP 115, HD 2329, HUW 895 and Kalyansona (yield loss 18.7–33.5%), the damage owing to spot blotch in five wheat varieties (HUW 206, UP 262, UP 2121, PBW 299, and UP 2338) was smaller since these experienced less loss in yield (8.5–15.8%) and test weight (7.3–15.1%) despite similar disease severity (58.5–67.6%). They summarized grain losses due to spot blotch of wheat (*B. sorokiniana*) from 24–27% in highly susceptible cultivars.

Rajender singh *et al.* (2000) observed the effect of sowing date and fungicidal sprays on the yield of 19 Wheat cultivars in Hryana, India. Wheat was sown on 15 and 30 November, and 15 and 30 December and inoculated with Blight pathogens (*Alternaria triticiana* and *Helminthosporium sativum syn. Cochliobolus sativus*) in equal portion at growth stage 3. Seven fungicides (Propiconazole, Hexaconazole, Tricyclazole, Flusilazole, Thiophanate methyl, Cymoxanil and Carbendazim) were applied at 0.05% and 0.1% at the start of the disease and leaf blight data were recorded at dough stage. They found the highest incidence of leaf blight for the 30 November sowing and incidence was lowest for the 15 November sowing.

Duveiller and Altamirano (2000) explained that although leaf blight, common root rot and black point are all caused by the same pathogen and can co-occur, depending on the environmental circumstances, one disease type typically dominates over the others.

Mahto (1999) discovered that the presentation of Tilt at 125 ml ai/ha with three sprays at two weeks interval gave excellent protection upon testing various fungicides *viz.*, Blitox, Captan, Dithane M-45, Thiram, Folicur, Tilt, Bayleton and Contaf against *B. sorokiniana*.

Goel *et al.* (1999) demonstrated wheat spot blotch research at the National Centre for Foliar Diseases in Faizabad, which indicated that *Helminthosporium sativum* was India's most common pathogen.

Rahman (1998) conducted an experiment with Tilt 250 EC 0.1% was shown to be highly efficacious as a foliar spray than the impact of seed treatment with Vitavax-20 in reducing Bipolaris leaf blight of wheat.

Bazlur Rashid (1998) researched that, the impact of *B. sorokiniana*, which is carried by seeds, on the growth and survival of wheat plants. The study revealed that the severity of infection significantly increased at the seedling stages.

Bazlur Rashid and Fakir (1998) studied the decrease in crop production in Kanchan and Sonalika varieties caused by *B. sorokiniana*, which was found to be 57.6% and 64.5% respectively.

Hossain *et al.* (1998) said that leaf blight disease caused by *Bipolaris sorokiniana* reduced yield up to 40% and 88% over the control under natural field condition and artificial inoculation, respectively.

Jahan *et al.* (1998) conducted a study with several wheat genotypes under natural epiphytotics. They stated all genotypes differed significantly from one to another in respect of leaf blotch (*Bipolaris sorokiniana*) severity at flowering (sown at 24th November) and milk ripening stage (sown at 24th November and 10th December). Comparatively less LAD (Leaf Area Disease) was recorded in genotypes sown in 10th December than in 24th November.

Jahan *et al.* (1998) noticed that the intensity of the infection grew as the plant grew older.

Maraite *et al.* (1998) stated that *D. sorokiniana* was present in 81% of the specimens and was related with foliar blight in warm and moist places.

Singh *et al.* (1997) reported that yield loss 21.72% and 1000 grain weight loss being 9.8% in wheat cultivars HP-1633 was caused by leaf blight pathogen, whereas cultivar UP-262 showed 18.34% yield loss and 9% loss in 1000 grain.

Zhimin *et al.* (1997) in a study stated that the *Bipolaris sorokiniana* is the most important, accounting for more than 80% of fungal strains collected. Annual yield losses due to *Bipolaris sorokiniana* are estimated at 10-15%. Grated damage occurs during the flowering to milking stage of wheat plants. Disease severity is closely related to temperature and humidity, especially temperature several days before flowering.

Ahmed and Meisner (1996) stated that, the optimal period for sowing wheat is the final two weeks of November. Planting earlier to November led to a decrease in crop production based on the planting date. They also mentioned that the reduction is approximately 1.3% or 44 kg/ha/day for late seedling after November 30.

Picinini *et al*. (1996) assessed for a long period the efficacy of Propiconazole applied @ 125 g ai/ha against foliar blight of wheat and the disease control was achieved with two sprays (at booting and flowering stages). Yield differences between treated and untreated plots varied from 18% in 1991 to 23% in 1982. The average yield of treated plots was 3734 kg/ha, which was 44.61 percent (1152 kg/ha) greater than the yield of untreated control plots.

Sharma and Chaudhury (1996) brought out field experiment with 15 wheat cultivars in 1992-94 at Rampur, Nepal which were sown on 20 or 30 November or10.20 or 30 December. They noticed that grain yield was significantly decreased by delaying sowing after 30 November high yielding cultivars we UP 262(1.97t/ha), RR 21(1.91 t/ha) and Annapurna (1.90 t/ha).

Alam *et al.* (1995) evaluated the decrease of wheat (Kanchan) yield caused by spot blotch at farmer’s field in four different places- Dinajpur, Jessore, Jamalpur and Ishwardi. Propiconazole was applied at a concentration of 0.04%, leading to a significant reduction in the severity.

Singh and Chauhan (1995) conducted *In vitro* and *in vivo* studies with Dithane M-45 (0.25 and 0.30%), Tilt 25 EC (0.025 and 0.05%), and Topsin M (0.05 and 0.10%) against *Helminthosporium* leaf blight of wheat. With a cost benefit ratio of 1:2:6:9, Tilt (500 ppm) gave considerable pathogen control after 24 and 28 hours of incubation, whereas Tilt (0.05%) provided substantial control as foliar treatment in the field after three sprays at a 10-day interval.

Singh *et al.* (1995) investigated four fungicides to treat wheat foliar blight: Mancozeb, Tilt 25 EC, Topsin M and Rhizolex. With three sprayings of Tilt (500 ml/ha) at disease appear, the greatest yield, grain weight, and least disease were identified among the four tested fungicides. In terms of productivity, grain weight, and disease severity, three Tilt sprays were as good as four. Mancozeb (2.5 kg/ha) was the second most effective fungicide, with four treatments at disease started.

Villareal *et al.* (1995) examined 25 spring bread wheat varieties for crop production and other characteristics for two years in Poza rica, Mexico, fungicide-protected or unprotected, under natural evidence of leaf blight. Fungicide-protected plot yields were 43.2% higher than unprotected.

According to Duveiller and Gilchrist (1994) the most economic varieties are either moderately resistant or susceptible to the pathogen, in 1991-92, yield reduction up to 29% was calculated. Worldwide spot blotch is considered a hazard to wheat farming.

Alam *et al.* (1994) observed that, spot blotch which is caused by *Bipolaris sorokiniana*, is presently the most prevalent disease affecting that affecting wheat in Bangladesh. The disease begins at the early growth phase and increases time progresses. Most commercial varieties are either moderately susceptible or prone to this disease. Between 1991-1992, the decrease in productivity was calculated to be 29% in the Kanchan variety. Although

Kanchan is a slightly more resistant to the disease compared to previously released variety.

Malaker *et al.* (1994) noticed that the severity of disease at four locations under conditions of natural infection by *H. sativum* in each location there were two treatments sprayed with Tilt 100 EC @ 0.125% and unsprayed (control). Tilt 100 EC was effective against leaf blight (HLB) and disease severity were significantly different 3.04 and 3.44 for unsprayed and sprayed plots respectively. In compared to unsprayed plots, the use of Tilt 25 EC as a foliar spray resulted in increased grain number per plot, 1000 grain weight, and big seeds, resulting in a better grain yield.

Duveiller and Gilchrist (1994) mentioned that spot blotch caused by *Bipolaris sorokiniana* is the major disease constraint limiting wheat production in the hotter region. They also reported that the main element to increase yield or make wheat a commercial crop in several areas, has been slow due to the high variability of the pathogen and inadequate understanding of how environmental aspects influence the occurrence of the disease and the way host plant reacts.

Hossain and Azad (1994) explained that the artificial inoculation of wheat plant with *B. sorokiniana* at flag leaf stage decreased the no. of grain/spike and thousand seed weight by 7–100 percent and 12–100 percent. They used nutrient element particularly micro elements Cu, B and Mo as a substitute technique of spot blotch management. On the other hand, use of B improved kernel maturation and productivity. Under natural field conditions and controlled inoculation.

Bazlur Rashid *et al.* (1994) demonstrated the impact of leaf blotch on various factors related to wheat production, including yield characteristics and grain qualities, spike size, quantity of seeds per spike, and thousand grain weight. The infection of *B. sorokiniana* on the flag leaf caused the most damage to the crops, while the disease on the third leaf resulted in the least amount of damage. When evaluated on the criteria of the highest production failure rate was observed in Kalyansona variety with regards to number of seeds per spike, weight of seed per spike and thousand grain weight (81.68%).

Anon (1994) observed that during Rabi season at three areas of grower's field, yield reduction was estimated due to spot blotch of wheat. It was observed that Tilt 100 EC sprayed from the arrival of infection four times at fifteen days' gap, reduced percent blighted leaf area and loss in grain yield. The average yield loss was 12.86%. The 1000 grain weight of non-sprayed and sprayed plots ranges from 37.4 to 41.3 g and 43.0 to 46.0 g, respectively.

Wolf and Hoffmann (1994) stated that the highest disease incidence occurred at later growth stages, particularly flowering and grain filling. In Bangladesh, higher trend of the diseases was recorded with the increased in plant age under field condition (Kundu, 1995 and Nahar, 1995).

Mondal *et al.* (1994) examined the effectiveness of four commercial fungicides in controlling Bipolaris leaf blight of wheat under natural environments. Tilt 25 EC (0.05%) was the most effective and profitable option, having the 36 highest profit margin. Dithane M-45 (0.2%) and Mencozeb (0.15%) both also decreased disease severity but Rural (0.2%) was determined to benon-effective and provided the lowest gross margin.

Experiments were conducted in three wheat locations to determine yield loss due to Bipolaris leaf blight, with four sprays of Tilt 100 EC @ 0.125% applied at 15-day intervals starting when initial symptoms of the disease appeared. (Anon, 1992a). Tilt application with seed treatment (three times) resulted in less yield reduction than the other application. Tilt application during the post-anthesis stage boosted yield by 17%, which was much higher than at the booting stage. Three Tilt treatments, with or without seed treatment, were comparable to post-anthesis treatments (Anon. 1992b). The average yield loss was 24%. The 1000 grain weight of non-sprayed and sprayed plots varied from 39.6 to 42.59g and 43.3 to 47.39, respectively (Anon. 1993).

Mahto and Bimb (1993), Singh *et al. (*1997), Anon. (1999) stated that, *D. sorokiniana* has become the most significant spot blotch fungus in Nepal during the wheat season 1990-91.

Mehta (1993) said that massive losses caused by leaf blight disease occur in Bangladesh, Bolivia, Brazil, Paraguay, and Zambia. The 19 pathogen infects all plants and can result in productivity of up to 100%.

Rashid *et al.* (1992) discovered that 27 types of fungus linked to wheat seeds, with *B. sorokiniana* being the most prevalent disease-causing agent.

Wildermuth *et al.* (1992) reached in a calculation that yields reduction on 8 varieties and lines varying in vulnerability to *B. sorokiniana.* Seed yield, tiller and no. of seed but not weight of seed declined as disease severity amplified *B. sorokiniana* causes leaf blight of wheat all over the world.

In a study by Ali and Fakir (1992), they discovered 16 different types of fungi from 9 genera in the seeds of seven specific varieties of wheat. These3 seeds were collected from five agricultural research centers located in Gazipur, Ishwardi, Jamalpur, Jessore and Mymensingh over the course of two different seasons. *Bipolaris sorokiniana* was discovered to be one of the most common fungi found in wheat seeds.

Hossain (1991) stated that none of the cultivated wheat material in this country is free from leaf spot disease. He also rescored cultivated wheat varieties either as moderately susceptible, susceptible or highly susceptible to leaf spot disease.

Alam and Saha (1991) reported that leaf rust (*Puccinia recondita*) was found to the most notorious wheat disease in the country. However, currently, *Helminthosporium* leaf blight (HLB) caused by *H. sativum* (*Bipolaris* leaf blight caused by *B. sorokiniana*) has emerged as the most concerning disease in Wheat and the occurrence of the disease has increased significantly. They discovered that all the recommended wheat variety were prone to HLB. They also stated that less than 50% of field had HLB during the early growth phase, with less than 5% of the leaf area being affected. At the booting stage, HLB affected all the fields, causing 50% of lower foliage and 10-15% of upper foliage to be infected. At the grain filling stage, all fields were severely affected by HLB disease. They mentioned that harmful amounts of 10 HLB predominantly occurred late in the season when wheat crop was reaching its maturity.

Dubin and van Ginkel (1991) examined the status of wheat diseases in some countries such as Bangladesh, Brazil, Burundi, China, India, Indonesia, Madagascar, Somalia, Tanzania, Thailand, Vietnam, Zambia and Zimbabwe. They concluded that *B. sorokiniana* was the most economically important leaf pathogen. They also claimed that *B. sorokiniana* is the most significant biotic constraint to wheat in South Asia. Due increasing the demand of wheat in these places, it has been expanded into areas where wheat farming is not traditionally practiced (North-west India and Pakistan).

Dubin and van Ginkel (1991) explained that in the recent years the largest region of Bangladesh, Nepal and India are facing the issue of leaf blight disease of wheat. In Bangladesh, it was first recorded in 1977 by Fakir. Among all the wheat diseases, leaf blight (*Drechslera sorokiniana*) and leaf rust (*Puccinia recondita*) were the most serious. Both the diseases occurred widely on almost all the varieties grown in the country and cause considerable losses to the crop.

Razzaque and Hossain (1990) stated that leaf blight affected 4–21% profit fall in seed yield in some cultivars like Sonalika (20%), Akbar (14%), Kanchan (8%) and Aghrani (4%) in Bangladesh.

Ashok *et al.* (1989) found that the best and affordable method to treat Mancozeb was to use three applications, spread out every 20 days, and then followed by three applications every 15 days. The yield increased by using three treatments was two times greater than using only single spray.

Anon (1989) Stated that Dithane M-45 (Mancozeb) at a concentration of 0.2%, Tilt 250 EC at a concentration of 0.1% were tested for their efficacy in managing leaf blight disease in wheat. Three applications were carried out with interval of 15 days. Tilt was highly successful and improved the amount of crop production.

Ahmed (1985) claimed that there was always a significant chance of early monsoon rainfall, which caused a delay in wheat harvesting and negatively impacted the seeds' ability to grow in the field. Even if the harvesting was completed on schedule, rainfall could hamper the threshing process, leading to decline the in quality of crops and make them more susceptible to fungal diseases. He recommended planting wheat in Bangladesh around the middle of November instead of March, When the humidity increases significantly to prevent the fungal disease.

Dehne and Oerke (1985) stated that leaf infections (blade and sheath) grow as individual elliptical to oblong light to dark brown splotches. When light intensity is little, the fungus may settle host tissue intercellularly without producing obvious harm. At later phases of development, the infection speedup leaf senescence. Disease severity is deeply related to temperature and humidity, specifically hot and humid weather a few days before blooming.

Mehta (1985) explained that spot blotch caused by *Cochiliobolus sativus (Bipolaris sorokiniana) syn. H. sativum* was one of the most important diseases in a number of countries, such as Brazil, Paraguay, Bolivia India, Bangladesh and Thailand.

Bazlur Rashid *et al.* (1983) conducted a lengthy study on the leaf disease of wheat in seven regions of Bangladesh, which was caused by *B. sorokiniana*. They found that the occurrence of the disease was 100% irrespective of the variety or the location.

Zillinsky (1983) observed that, *B. sorokiniana* affects small grain crops such as wheat and barley, with rye being less susceptible and oats being rarely affected.

Mehta (1981) reported that Leaf blight appears 5–8 weeks after wheat sowing and in the case of *B. sorokiniana*, symptoms appear after booting and spread quickly. At early growth stages, the initial symptom appears as a lot of chlorotic lesions with light brown dots, mainly on the lower foliage of the plant.

Singh *et al*. (1980) stated that out of 350 leaf blight samples, 259 samples were reported pathogenic involving *B. sorokiniana*, *A. triticina*, *D.* tetramera and *D. sorokiniana*, which involved 74% samples, appeared to be a major pathogen and was prevalent in sub-mountainous region of northern India**.**

Fakir *et al.* (1977) proved that *B. sorokiniana* caused seed to plant transmission in wheat. They emphasized the importance of establishing a wheat seed health testing program in Bangladesh.

Verma *et al.* (1976) reported the effect of *Cochliobolus sativus* on components of grain yield in naturally infected wheat cultivar. The number of tillers per plant, number and weight of grains per head and thousand kernel weight in each category were determined.

Bidari and Govinda (1975) observed that mature plants are more prone to leaf blight of wheat caused by *Bipolaris sorokiniana* compared to younger plants.

Nema and Joshi (1974) examined that temperature and humidity influenced intensity of spot blotch disease of wheat caused by *Helminthosporium sativum.*

The infection of leaf was quickened and more intense at 28°C than at 20°C or 25°C.

Huguelet and Kiesling (1973), Razzaque (1982), Zhang *et al.* (1990), Tinline *et al.* (1994) mentioned that, *Bipolaris sorokiniana* has been widely regarded as a significant disease-causing agent of cereals and grasses.

Singh and Singh (1971) noticed that leaf blight of wheat was effectively controlled by six applications of Dithane Z-78 (Zineb) and Dithane M-45 (Mancozeb) with corresponding increase in yield.

Mitra (1931) stated that *Drechslera sorokiniana* caused leaf spot, leaf blotch, leaf blight, seedling blight, black point and root rot diseases of wheat.

Christensen (1922) discovered that *H. sativum* could damage 7 types of *Triticum*, 7 types of *Avena*, 3 types of *Hordium*, *Secale cereale* L., *Zea mays* L., and over a hundred types of grasses.

Chapter 3

MATERIALS AND METHOD

This chapter represents a short description about the experimental site, design, treatment, variety, land preparation, intercultural operations, design, replication, collection of data, statistical analysis etc. followed in the conduction of the experiment.

3.1 Experimental site

The experiment was conducted at the experimental field of Hajee Mohammad Danesh Science and Technology University, Dinajpur under the department of Plant Pathology.

3.2 Experimental period

The field experiment was conducted during November 2022 to April 2023. The data analysis was done after harvest of wheat in April 2023.

3.3 Variety used in the experiment

BARI released variety BARI Gom 30 was considered for the experiment.

3.4 Location of seed collection

Wheat seeds were collected from Bangladesh Wheat and Maize Research Institute (BWMRI), Nashipur, Dinajpur.

3.5 Collection of seed

Seed samples of the wheat variety were collected from the mentioned location and brought to Plant Pathology Laboratory, HSTU.

3.6 Land preparation

The experimental land was prepared by spade and irrigated before sowing of seed. All the stubbles and weeds were collected and removed from the field manually. The land was finally prepared and levelled two days before sowing.

3.7 Application of fertilizer

During preparation of land recommended dose of fertilizers were applied. The soil was fertilized with Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MOP). Two third urea and full doses of TSP and MOP were applied at the final land preparation before sowing. The rest urea was applied at active tillering stage and spike initiation stage respectively.

3.8 Treatment of the experiment

Factor A = Application of three fungicides which was sprayed as treatment on the crop after first symptom observed at heading stage.

- ✓ T_1=Tilt 250 EC (Propiconazole)@ 0.5 ml/L water,
- ✓ T_2= Cabrio Top (Pyraclostrobin+ Metiram) @ 3 g/L and
- ✓ T_3= Amistar Top (Azoxystrobin+ Difenoconazole) 325 SC @ 1 ml/L

Factor B = Number of applications of fungicides.

- ✓ D_1= Spraying of fungicides 1 time
- ✓ D_2=Spraying of fungicides 2 times
- ✓ D_3= Spraying of fungicides 3 times
- ✓ D_0= Without spraying of fungicides

3.9 Design of the experiment

The experiment was conducted in Randomized Complete Block Design (RCBD).

3.10 Replication

The treatment of the experiment was replicated at three times.

3.11 Plot size

The plot size was 2.5m × 1.2m. There were 36 number of plots for the experiment having row to row distance 20 cm and plot to plot distance 1m. Different treatment was assigned randomly to the unit plot.

3.12 Sowing of seeds

Seeds are sown in line at the rate of the 120 kg/ha as per recommended for wheat in 21 November, 2022. 6g seeds are sown continuously in each line at 3 cm depth approximately. After sowing, the seeds were covered by soil with gentle hand pressure.

3.13 Intercultural operations

Weeding and irrigation were done in the experimental plot as intercultural operations. Weeding was performed two times (30 DAS and 50 DAS). Irrigations were applied three times, first at germination stage, second at tillering stage and third at booting stage.

3.14 Data collection

The data was collected from the selected 5 tagging plants on the following parameters:

Vegetative parameters

Plant height and spike length both the parameters were recorded at vegetative stages of plant growth.

Disease parameters:

- % Disease leaf area of flag leaf and penultimate leaf was calculated.

- % Disease severity of flag leaf and penultimate leaf was recorded at different dates of observations. The Percent Disease Index was recorded following 0-7 scale (Hezler, 1992) and it was calculated by following formula:

  PDI = $\frac{Sum\ of\ all\ disease\ ratings}{Total\ ratings \times Maximum\ disease\ grade} \times 100$

Ratings for leaf blight severity caused by *Bipolaris sorokiniana* on wheat were as follows-

Scale/ Rating grade	Description
0	Leaf free from lesion
1	Few isolated lesions covering not more than 1% leaf area
2	5% leaf area covered
3	10% leaf area covered
4	25% leaf area blighted
5	50% leaf area blighted
6	75% leaf area blighted
7	Severe infection with more than 80% leaf area damaged

Yield parameters:

Yield and yield contributing characters were also recorded after harvest of the crops as follows-

- Total number of grains per spike
- Number of healthy grains per spike
- Number of black pointed grains per spike
- Number of undersized grains per spike
- Yield ton per ha.

- Thousand grain weight

3.15 Statistical analysis

Collected data were analyzed statistically following computers STATISTIX-10 package program. Means were separated by DMRT (Duncan's Multiple Range Test) with 5% level of probability.

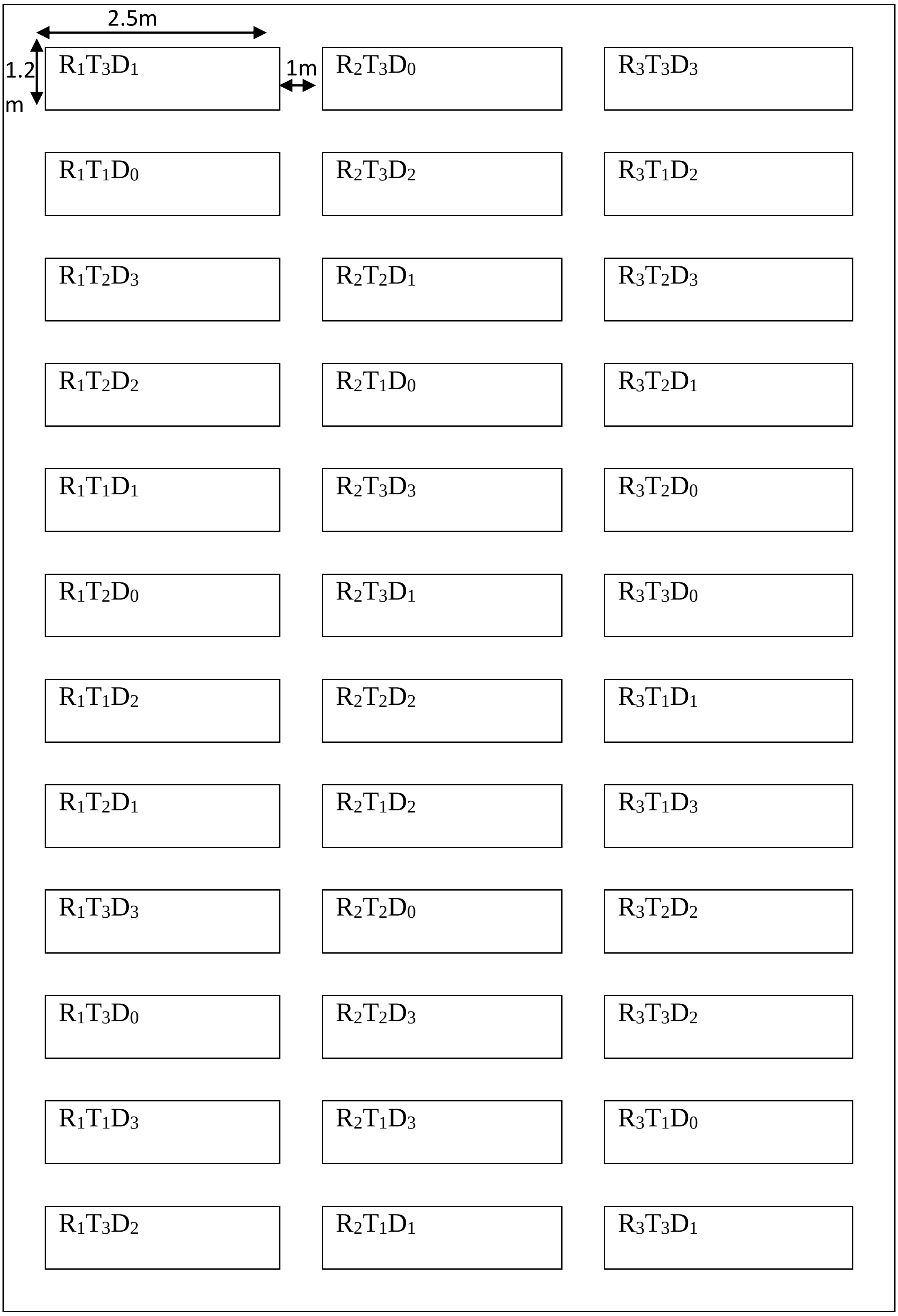

Fig 3.1. Field layout and randomization of the experimental treatments

Chapter 4

RESULTS

Effect of three different fungicides with various frequencies of applications and their interactions on wheat to found the significance of vegetative parameters, disease parameters and yield contributing parameters were studied in the experiment.

4.1 Effect of different fungicides, number of applications and their interactions on plant height of wheat

4.1.1 Effect of fungicides on plant height (cm) of wheat

Plant height of wheat was recorded at different dates of observations and data were presented in table-1.

Table-1 Effect of fungicides on plant height (cm) of wheat

Fungicide	Plant height (cm)		
	First	Second	Third
Tilt 250 EC	82.93 ns	79.17 ns	94.07 ns
Cabrio Top	81.85	78.57	94.41
Amister Top	84.13	78.55	94.63
CV (%)	3.45	3.33	2.84

From the table-1, it was observed that, typically the data were showed different values of plant height at 65, 77 and 85 DAS. Though it expressed different values for each treatment, plant height was not statistically different among the treatment at all. Fungicides could not produce any significant increase in plant height. So, it was statistically non-significant.

4.1.2 Effect of number of applications of fungicides on plant height (cm) of wheat

Plant height of wheat was recorded at different dates of observations and data were presented in table-2.

Table-2 Effect of number of applications of fungicides on plant height (cm) of wheat

Frequency	Plant height (cm)		
	First	Second	Third
Control	79.70 b	78.00 ns	93.57 ns
1 spray	84.10 a	78.95	94.45
2 spray	84.95 a	78.94	94.69
3 spray	83.15 a	79.16	94.77
CV (%)	2.46	1.62	1.32

From the table-2, it was observed that, only at 65 DAS plant height showed significantly varied among the number of fungicide applications where the lowest height was recorded with control (0 sprays) and the highest plant height (84.95 cm) was recorded at two spray of fungicide that was similar with one and three spray. At 77 and 85 DAS, typically, the data were showed different values of plant height and in both observations 3 sprays brought the highest plant height having 79.16 cm and 94.77 cm respectively. Though it expressed different values for each number of applications, plant height was not statistically different among the treatment at all. Number of applications of fungicide could not produce any significant increase in plant height. So, it was statistically non-significant.

4.2 Effect of different fungicides, number of applications and their interactions on percent leaf area diseased (%LAD) for flag leaf of wheat

4.2.1 Effect of fungicides on percent leaf area diseased (%LAD) for flag leaf

The percentage of diseased leaf area for flag leaf was measured at different dates of observations and data were shown in Table-3.

Table-3 Effect of fungicides on percent leaf area diseased (%LAD) for flag leaf

Fungicide	% Diseased leaf area of flag leaf			
	First	Second	Third	Final
Tilt 250EC	0.08 a	2.00 a	12.25 a	58.75 b
Cabrio Top	0.00 a	0.50 b	10.55 a	67.25 a
Amister Top	0.00 a	1.12 ab	7.55 a	56.37 b
CV (%)	6.00	9.01	6.02	3.99

Percentage leaf area diseased (%LAD) on flag leaf was recorded at different dates of observations and the data were presented in table-3. The data were significantly varied among the treatments at second and final observation but it was not significant at first and third observation. At second observation the highest percentage diseased leaf area was noted with Tilt 250 EC having 2.00% and it was lowest with Cabrio Top having 0.50%. But in final observation the highest percentage leaf area damage was found with Cabrio Top having 67.25% and the lowest value found in Tilt 250 EC having 58.75% which was similar with Amister Top having 57.37%.

4.2.2 Effect of number of applications of fungicides on percent leaf area diseased (%LAD) for flag leaf

The percentage of diseased leaf area for flag leaf was measured at different dates of observations and data were shown in Table-4.

Table-4 Effect of number of applications of fungicides on percent leaf area diseased (%LAD) for flag leaf

Frequency	% Disease leaf area of flag leaf			
	First	Second	Third	Final
Control	0.11 a	4.83 a	19.16 a	88.83 a
1 spray	0.00 a	0.00 b	7.83 bc	60.00 b
2 spray	0.00 a	0.00 b	9.46 b	58.83 b
3 spray	0.00 a	0.00 b	4.00 c	35.50 c
CV%	6.00	3.58	7.16	7.67

At first and second observation disease of flag leaf was observed only in control treatment. Disease of flag leaf was not found where fungicides were applied. But at third and final observation infection of flag leaf was observed. Here the disease leaf area was varied among the number of applications of fungicide. At third observation it was recorded that, the highest disease percentage was noted with control (0 sprays) having 19.16% the moderate diseased percentage was noted with one application and two applications of fungicide having 7.83% and 9.46% respectively. Here the lowest percentage diseased leaf area was noted with three applications of fungicides having 4.00%. Again at final, the highest percent leaf area diseased was recorded with control (0 spray) having 88.83% where the lowest disease percent was recorded with three application of fungicides having 35.50%. Here moderate diseased leaf area percentage was recorded for one and two applications of fungicides which were 60.00% and 58.83% respectively.

4.2.3 Interaction effect between different fungicides and their number of applications on percent leaf area diseased (%LAD) for flag leaf

The percentage of diseased leaf area for flag leaf was measured at different dates of observations and data were shown in Table-5.

Table-5 Interaction effect between different fungicides and their number of applications on percent leaf area diseased (%LAD) for flag leaf

Fungicide× Frequency	% Disease leaf area of flag leaf			
	First	Second	Third	Final
Tilt 250 EC× control	0.33 a	8.00 a	22.50 a	83.00 a
Tilt 250 EC × 1 spray	0.00 b	0.00 d	12.50 bcd	62.00 b
Tilt 250 EC × 2 spray	0.00 b	0.00 d	9.50 bcd	61.00 bc
Tilt 250 EC × 3 spray	0.00 b	0.00 d	4.50 d	29.50 e
Cabrio Top× control	0.31 a	2.00 c	16.00 abc	92.00 a
Cabrio Top× 1 spray	0.00 b	0.00 d	7.00 cd	54.00 bcd
Cabrio Top× 2 spray	0.00 b	0.00 d	3.50 d	50.00 cd
Cabrio Top× 3 spray	0.00 b	0.00 d	4.00 d	48.00 d
Amister Top× control	0.32 a	4.50 b	19.00 ab	91.50 a
Amister Top× 1 spray	0.00 b	0.00 d	12.70 abcd	64.00 b
Amister Top× 2 spray	0.00 b	0.00 d	7.00 cd	65.50 b
Amister Top× 3 spray	0.00 b	0.00 d	3.20 d	29.00 e
CV (%)	6.00	7.64	5.40	1.27

Significant variation was found between interaction of fungicide and number of applications on percent diseased leaf area (%LAD) of flag leaf at different dates of observations which were recorded in table-5. At first observation, the highest disease was recorded in the plot with control (0 sprays) for Tilt 250 EC. At second, the highest disease was again recorded in the plot with control (0 sprays) for Tilt 250 EC. At 95 DAS, the highest disease was noted with control (0 spray) for Tilt 250 EC having 22.50% which is statistically similar to control (0 spray) for Cabrio Top and control (0 spray) for Amister Top. Here, the lowest disease was recorded with three application of Amister Top having 3.2% which is statistically similar to three application of Tilt 250 EC and two and three applications of Cabrio Top. In final observation, the highest disease was recorded with all fungicides where no spray (control) was applied. Here, the lowest disease was recorded with three applications of Amister Top having 29.00% which is statistically similar to three applications of Tilt 250 EC.

4.3 Effect of different fungicides, number of applications and their interactions on percent leaf area diseased (%LAD) for penultimate leaf of wheat

4.3.1 Effect of fungicides on percent leaf area diseased (%LAD) for penultimate leaf

The percentage of diseased leaf area for penultimate leaf was measured at different dates of observations and data were shown in Table-6.

Table-6 Effect of fungicides on percent leaf area diseased (%LAD) for penultimate leaf

Fungicide	% Disease leaf area of penultimate leaf			
	First	Second	Third	Final
Tilt 250 EC	26.55 ab	47.67 b	60.75 b	85.12 b
Cabrio Top	31.30 a	56.75 a	65.75 a	92.00 a
Amister Top	23.40 b	43.37 b	51.37 b	79.12 c
CV (%)	41.33	18.95	14.75	5.61

The study showed the significant variation among all treatments on percentage leaf area diseased (%LAD) in penultimate leaf which was presented in table-6. The (%LAD) of penultimate leaf significant at different dates of observations. This recorded data showed that, the highest percentage of diseased leaf area was in Cabrio Top treated plants in all observations having value 31.30%, 56.75%, 65.75% and 92.00%. At first, second and third observation the lowest percentage of diseased leaf area was noted with Amister Top having 23.40%, 43.37%, and 51.37% which was similar with Tilt 250 EC having 26.55%, 47.67%, and 60.75%, respectively. In the last day observation, the lowest percentage diseased leaf area was noted with Amister Top having 79.12%.

4.3.2 Effect of number of applications of fungicides on percent leaf area diseased (%LAD) for penultimate leaf

The percentage of diseased leaf area for penultimate leaf was measured at different dates of observations and data were shown in Table-7.

Table-7 Effect of number of applications of fungicides on percent leaf area diseased (%LAD) for penultimate leaf

Frequency	% Disease leaf area of penultimate leaf			
	First	Second	Third	Final
Control	49.93 a	63.50 a	87.33 a	99.33 a
1 spray	30.73 b	62.00 a	67.16 b	90.50 b
2 spray	33.50 b	43.16 b	58.50 b	88.50 b
3 spray	34.16 b	35.06 b	42.83 c	82.23 c
CV%	19.93	11.94	15.07	7.57

The results showed the significant variation among the number of applications of fungicides on percentage leaf area diseased (%LAD) in penultimate leaves which were presented in table-7. At first observation, the highest disease percent was found with control (0 spray) having 49.93%. At second, the highest disease was recorded with control (0 spray) having 63.50% which is similar with one applications of fungicide having 62.00%. However, the lowest disease was recorded with three applications of fungicide having 35.06% which was similar with two applications of fungicide having 43.16%. At third observation, the highest disease was again recorded with control (0 spray) having 87.33%

where the lowest disease percentage was noted with three applications of fungicide having 42.83%. In the final observation, the highest percentage of diseased leaf area was noted with control (0 spray) having 99.33% where the lowest disease was recorded with three applications of fungicide having 82.23%.

4.3.3 Interaction effect between different fungicides and their number of applications on percent leaf area diseased (%LAD) for penultimate leaf

The percentage of diseased leaf area for penultimate leaf was measured at different dates of observations and data were shown in Table-8.

Table-8 Interaction effect between different fungicides and their number of applications on percent leaf area diseased (%LAD) for penultimate leaf

Fungicide × Frequency	% Disease leaf area of penultimate leaf			
	First	Second	Third	Final
Tilt 250 EC× control	15.70 de	76.00 a	86.50 a	99.00 ab
Tilt 250 EC × 1 spray	34.50 bc	64.00 ab	61.00 c	92.50 abcd
Tilt 250 EC × 2 spray	37.00 b	53.00 bcde	63.00 bc	89.00 bcde
Tilt 250 EC × 3 spray	19.00 de	34.00 fg	40.50 d	87.50 cde
Cabrio Top× control	4.90 f	55.00 bcd	89.50 a	100.00 a
Cabrio Top× 1 spray	19.70 d	47.00 cdef	60.00 c	84.00 de
Cabrio Top× 2 spray	37.50 b	39.50 def	64.50 bc	87.00 cde
Cabrio Top× 3 spray	31.50 bc	49.20 bcdef	49.00 cd	86.00 cde
AmisterTop× control	9.20 ef	71.50 a	86.00 a	99.00 ab
AmisterTop× 1 spray	38.00 b	63.00 abc	80.50 ab	95.00 abc
AmisterTop× 2 spray	26.00 cd	37.00 efg	68.00 bc	89.50 bcde
AmisterTop× 3 spray	52.00 a	22.00 g	39.00 d	80.00 e
CV (%)	20.48	20.16	15.71	6.53

The study also showed the significant variation between the interactions of fungicide and number of applications on percentage leaf area diseased (%LAD) in penultimate leaves which were recorded in table-8. At first observation, the highest disease was found in the plot where three applications of Amister Top were done and the lowest disease was found in the plot where no spray was applied (control) with Cabrio Top. But at second observation, the highest disease was found in the plot where no spray (control) was applied with Tilt 250 EC and the lowest disease was found in the plot with three applications of Amister Top. Again, at third observation, the highest disease was recorded with all fungicides where no spray (control) was applied. Here the lowest disease was recorded with three applications of Amister Top having 39.00% which is statistically similar to three applications of Tilt 250 EC and Cabrio Top having 40.50% and 49.00%. In the final observation, the highest disease was found with control (0 sprays) of Cabrio Top having 100.00% which is statistically similar to control and one application of Tilt 250 EC and Amister Top. Here the lowest disease was noted with three applications of Amister Top having 80.00% which is statistically similar two and three applications of all fungicides.

4.4 Effect of different fungicides, number of applications and their interactions on percent leaf disease index (PDI) for flag leaf of wheat

4.4.1 Effect of fungicides on percent disease index (PDI) for flag leaf

The Percent Disease Index (PDI) of flag leaf was measured at different dates of observations and data were shown in Table-9.

Table-9 Effect of fungicides on percent disease index (PDI) for flag leaf

Fungicide	Percent disease index (PDI) of flag leaf			
	First	Second	Third	Final
Tilt 250 EC	0.47 a	3.57 ab	32.13 ab	83.56 ab
Cabrio Top	0.00 b	4.28 a	41.78 a	86.10 a
Amister Top	0.00 b	1.42 b	28.56 b	79.99 b
CV (%)	6.00	7.05	3.21	5.95

Significant variation was found on Percent Disease Index (PDI) of flag leaf among all the treatments which were presented in table- 9. The data were significantly varied among the treatments at 77, 88, 91 and 95 DAS. At 88, 91, and 95 DAS the highest result performed by Amister Top having the lowest percent disease index (PDI) on flag leaf 1.42%, 28.56% and 79.99% respectively, followed by Tilt 250 EC. The highest disease severity was found with Cabrio Top treated plants.

4.4.2 Effect of number of applications of fungicides on percent disease index (PDI) for flag leaf

The percent disease index (PDI) of flag leaf was measured at different dates of observations and data were shown in Table-10.

Table-10 Effect of number of applications of fungicides on percent disease index (PDI) for flag leaf

Frequency	Percent disease index (PDI) of flag leaf			
	First	Second	Third	Final
Control	0.63 a	12.37 a	48.57 a	98.09 a
1 spray	0.00 b	0.00 b	35.70 b	85.28 b
2 spray	0.00 b	0.00 b	31.90 b	81.42 b
3 spray	0.00 b	0.00 b	20.47 c	68.09 c
CV%	6.00	2.65	4.47	5.69

Significant variation was found on percent disease index (PDI) on flag leaf among the number of applications of fungicides which are shown in table- 10. At second observation, the sprayed plots have no disease severity while the unsprayed plots showed the disease severity. At third observation, the highest disease severity was recorded with unsprayed plots having 48.57%. Here the lowest disease severity was recorded with three applications of fungicides having 20.47%. Similar result also noted at final where the highest disease severity was recorded with unsprayed plots having 98.09% and lowest disease severity was recorded with three applications of fungicide having 68.09%.

4.4.3 Interaction effect between different fungicides and their number of applications on percent disease index (PDI) for flag leaf

The percent disease index (PDI) for flag leaf was measured at different dates of observations and data were shown in Table-11.

Table-11 Interaction effect between different fungicides and their number of applications on percent disease index (PDI) for flag leaf

Fungicide× Frequency	Percent disease index (PDI) of flag leaf			
	First	Second	Third	Final
Tilt 250 EC× control	1.90 a	14.28 a	52.85 a	94.29 ab
Tilt 250 EC × 1 spray	0.00 b	0.00 c	41.42 abc	84.28 bcd
Tilt 250 EC × 2 spray	0.00 b	0.00 c	49.99 ab	92.85 abc
Tilt 250 EC × 3 spray	0.00 b	0.00 c	22.85 d	65.71 ef
Cabrio Top× control	1.85 a	15.71 a	50.85 a	100.00 a
Cabrio Top× 1 spray	0.00 b	0.00 c	32.85 bcd	77.13 de
Cabrio Top× 2 spray	0.00 b	0.00 c	18.57 d	77.14 de
Cabrio Top× 3 spray	0.00 b	0.00 c	19.99 d	75.71 de
Amister Top× control	1.70 a	17.14 a	50.00 a	100.00 a
Amister Top× 1 spray	0.00 b	0.00 c	32.85 bcd	82.85 cd
Amister Top× 2 spray	0.00 b	0.00 c	27.13 cd	85.86 bcd
Amister Top× 3 spray	0.00 b	0.00 c	18.56 d	62.85 f
CV (%)	6.00	5.95	2.96	8.11

Significant variation was found on percent disease index of flag leaf between the interactions of fungicide and number of applications which are recorded in table- 11. At first and second observation, the disease severity was only observed with unsprayed plots. At third observation, the highest disease severity was found in control with Tilt 250 EC having (52.85%). Here the lowest disease severity was recorded with three applications with Amister Top having (18.65%) followed by three applications with Tilt 250 EC having (22.85%). Again at final, similar result was noted. Here the highest disease severity was found with unsprayed plots. And the lowest disease severity was found with three applications with Amister Top having (62.85%) followed by three applications with Tilt 250 EC having (65.71%).

4.5 Effect of different fungicides, number of applications and their interactions on percent leaf disease index (PDI) for penultimate leaf of wheat

4.5.1 Effect of fungicides on percent disease index (PDI) for penultimate leaf

The Percent disease index (PDI) of penultimate leaf was measured at different dates of observations and data were shown in Table-12.

Table-12 Effect of fungicides on percent disease index (PDI) for penultimate leaf

Fungicide	Percent disease index (PDI) of penultimate leaf			
	First	Second	Third	Final
Tilt 250 EC	55.71 a	80.35 a	84.99 a	99.64 a
Cabrio Top	54.14 ab	74.28 ab	82.13 a	96.42 b
Amister Top	47.49 b	70.71 b	82.49 a	96.42 b
CV (%)	12.68	9.65	10.81	2.57

Significant variation was found on Percent Disease Index (PDI) of flag leaf among all the treatments which were shown in table-12. The data were significantly varied among the treatments at first, second and final observation but it was not significant at third observation. At first and second observation, the data table showed that there was not much significant difference among the treatments. But at final, the highest disease severity was recorded with Tilt 250 EC having (99.64 %) and the lowest disease severity was recorded with Amister Top having (96.42%) followed by Cabrio Top having (96.42%).

4.5.2 Effect of number of applications of fungicides on percent disease index (PDI) for penultimate leaf

The percent disease index (PDI) of penultimate leaf was measured at different dates of observations and data were shown in Table-13.

Table-13 Effect of number of applications of fungicides on percent disease index (PDI) for penultimate leaf

Frequency	Percent disease index (PDI) of penultimate leaf			
	First	Second	Third	Final
Control	59.92 a	85.71 a	98.09 a	100.00 a
1 spray	59.33 b	84.75 a	86.18 b	98.09 a
2 spray	53.87 ab	63.32 b	79.04 c	97.62 a
3 spray	36.66 c	66.66 b	69.51 d	94.28 b
CV%	9.35	11.03	7.02	3.99

Significant variation was found on percent disease index (PDI) on penultimate leaf among the number of applications of fungicides which are presented in table- 13. Here the data table showed that as the day progressed, the unsprayed plot showed highest disease severity than the sprayed plots. It was clearly observed that at third observation, the highest disease severity was recorded with control (unsprayed plot) having (98.09%) and the lowest disease severity was recorded with three applications of fungicide having (69.51%). In last observation, the lowest disease severity was recorded with the three applications of fungicide having (94.28 %).

4.5.3 Interaction effect between different fungicides and their number of applications on percent disease index (PDI) for penultimate leaf

The percent disease index (PDI) for penultimate leaf was measured at different dates of observations and data were shown in Table-14.

Table-14 Interaction effect between different fungicides and their number of applications on percent disease index (PDI) for penultimate leaf

Fungicide × Frequency	Percent disease index (PDI) of penultimate leaf			
	First	Second	Third	Final
Tilt 250 EC× control	67.14 a	84.28 abc	97.14 a	100.00 a
Tilt 250 EC × 1 spray	62.85 a	94.28 a	84.28 cd	100.00 a
Tilt 250 EC × 2 spray	47.71 bc	74.28 bcde	85.71 bc	100.00 a
Tilt 250 EC × 3 spray	45.14 c	54.28 f	72.85 ef	98.57 ab
Cabrio Top× control	62.85 a	79.99 abcd	100.00 a	100.00 a
Cabrio Top× 1 spray	62.57 a	71.42 cde	78.57 cde	94.28 b
Cabrio Top× 2 spray	38.85 c	68.56 def	77.14 cde	94.28 b
Cabrio Top× 3 spray	25.71 d	77.14 bcd	72.80 ef	97.14 ab
Amister Top× control	69.78 a	92.85 a	97.14 a	100.00 a
Amister Top× 1 spray	58.57 ab	88.57 ab	95.71 ab	100.00 a
Amister Top× 2 spray	49.64 bc	61.42 ef	74.28 de	98.57 ab
Amister Top× 3 spray	38.57 c	54.28 f	62.86 f	87.14 c
CV (%)	12.68	11.87	7.32	3.04

Significant variation was found on percent disease index of penultimate leaf between the interactions of fungicide and number of applications which are recorded in table- 14. Here at first observation, the disease severity was noticeable almost all plots. At second observation, the highest disease severity was recorded with unsprayed plots. Here the lowest severity was recoded with three times applications of Amister Top and Tilt 250 EC having (54.28%). Again at third observation, the highest disease severity was noted in unsprayed plots and the lowest severity was found in the plot where Amister Top was sprayed for three times (62.86%) followed by three applications of Tilt 250 EC (72.85%) and Cabrio Top (72.80%). At the final observation, the lowest disease severity was recorded with three applications of Amister Top having (87.14%).

4.6 Effect of different fungicides, number of applications and their interactions on different yield contributing characters of wheat

4.6.1 Effect of fungicides on different yield contributing characters of wheat

Total number of grains per spike, number of healthy grains per spike, percent of undersized grains per spike and percent of black pointed grains per spike etc. were recorded and results were shown in table-15.

Table-15 Effect of fungicides on different yield contributing characters of wheat

Fungicide	Total number of grains per spike (%)	Number of healthy grains per spike (%)	Number of undersized grains per spike (%)	Number of black pointed grains per spike (%)
Tilt 250 EC	34.32 a	25.14 b	3.90 b	4.65 a
Cabrio Top	32.15 a	24.55 b	5.25 a	4.85 a
Amister Top	35.65 a	31.22 a	3.55 b	2.95 b
CV (%)	13.12	18.66	23.30	25.50

Effect of fungicide on different yield contributing characters were varied significantly and presented in table-15. In case of total number of grains per spike, though it expressed different values for each treatment, it was not statistically different among the treatments. The highest value was recorded for total number of grains with Amister Top having 36.65% typically which is non-significant.

But In case of number of healthy grains per spike, the data were showed significant value. Here, the highest value was recorded with Amister Top which was 31.22% and the lowest value was recorded with Cabrio Top having 24.14% which is similar to Tilt 250 EC having 24.55%.

In case of, undersized grains per spike, the highest percent undersized grain was found with Cabrio Top having 5.25% and the lowest percent undersized grain was found with Amister Top having 3.55% which was similar with Tilt 250 EC having 3.90%.

Again, in case of black pointed grains per spike, the best performance was recorded with Amister Top having the lowest percent black pointed grains per spike which was 2.95%. The highest percent black pointed grains per spike was found with Cabrio Top and Tilt 250 EC having 4.85% and 4.65% respectively.

4.6.2 Effect of number of applications of fungicides on different yield contributing characters of wheat

Total number of grains per spike, number of healthy grains per spike, percent of undersized grains per spike and percent of black pointed grains per spike etc. yield contributing parameters were recorded and results were shown in table-16.

Table-16 Effect of number of applications of fungicides on different yield contributing characters of wheat

Frequency	Total number of grains per spike (%)	Number of healthy grains per spike (%)	Number of undersized grains per spike (%)	Number of black pointed grains per spike (%)
Control	40.30 a	20.36 b	6.40 a	7.56 a
1 spray	31.90 b	27.46 a	3.80 b	2.97 b
2 spray	32.70 b	25.80 a	3.73 b	3.16 b
3 spray	33.23 b	27.53 a	3.00 b	2.93 b
CV%	14.24	11.04	4.06	4.41

Effect of number of applications of fungicides on different yield contributing characters was varied significantly that was presented in table-16. In case of total number of grains per spike, the highest result was observed in control (0 sprays) and non- significant results were observed where fungicide sprays were applied several times. On the other hand, in case of number of healthy grains per spike, the lowest result was observed with control (0 sprays) and highest result was observed with three applications of fungicide having 27.53% which is similar with one and two applications having 27.54% and 25.80%.

In case of number of undersized grains per spike, the highest undersized grains were found with control (0 sprays) with 6.40% where lower results were found where fungicide sprays were applied. Here the lowest result was noted with three applications of fungicide. Again, in case of number of black pointed grains per spike, the highest black pointed grains were found with control (0 sprays) having 7.56% where the lowest result was recorded with three applications of fungicide having 2.933% which is similar with one and two applications of fungicide.

4.6.3 Interaction effect between different fungicides and their number of applications on different yield contributing characters of wheat

Total number of grains per spike, number of healthy grains per spike, percent of undersized grains per spike and percent of black pointed grains per spike etc. yield contributing parameters were recorded and results were shown in table-17.

Table-17 Interaction effect between different fungicides and number of applications on different yield contributing characters of wheat

Fungicide × Frequency	Total number of grain per spike (%)	Number of Healthy grains per spike (%)	Number of Undersized grains per spike (%)	Number of Black pointed grains per spike (%)
Tilt 250 EC× control	28.90 d	23.20 b	4.60 bcde	6.20 bc
Tilt 250 EC × 1 spray	38.50 abc	27.70 ab	3.50 cde	4.30 cd
Tilt 250 EC × 2 spray	34.10 abcd	26.20 ab	3.90 cde	2.20 def
Tilt 250 EC × 3 spray	35.80 abcd	28.70 ab	3.60 cde	1.90 ef
Cabrio Top× control	30.50 cd	23.10 b	7.60 a	9.80 a
Cabrio Top× 1 spray	31.30 cd	25.30 ab	4.80 abcd	4.10 cd
Cabrio Top× 2 spray	31.70 cd	22.90 b	5.10 abc	3.70 de
Cabrio Top× 3 spray	41.00 ab	26.90 ab	3.50 cde	2.60 def
Amister Top× control	32.30 bcd	27.80 ab	7.00 ab	6.70 b
Amister Top× 1 spray	35.50 abcd	27.60 ab	3.00 cde	4.10 cd
Amister Top× 2 spray	33.40 abcd	25.80 ab	2.20 de	4.30 cd
Amister Top× 3 spray	41.40 a	33.30 a	2.00 e	1.50 f
CV (%)	14.32	15.54	39.44	28.57

Interaction effect between different fungicides and number of applications on different yield contributing characters were varied significantly and presented in table-17. In case of Total number of grains per spike, the highest grain was recorded with three applications of Amister Top having 41.00% which is statistically similar with those plots where Tilt 250 EC and Amister Top was sprayed and three spray of Cabrio Top was applied. Here the lowest grains were noted with control (0 sprays) for Tilt 250 EC having 28.90% which is statistically similar with all controls. In case of number of healthy grains per spike, the highest grain was noted with three applications Amister Top and lowest grains were found with control (0 sprays) with Tilt 250 EC.

In case of number of undersized grains per spike, the highest undersized grains were recorded with control (0 sprays) with Cabrio Top having 7.6% which is statistically similar to control for Amister Top and two and three applications for Cabrio Top. Here the lowest undersized grains were recorded with three applications of Amister Top having 2.00% which is statistically similar to the plots where Tilt 250 EC were sprayed, Cabrio Top was sprayed three times and Amister Top was sprayed one and two times.

In case of, number of black pointed grains per spike, the highest black pointed grains were noted with control of Cabrio Top having 9.8%. Here the lowest black pointed grains were recorded with three applications of Amister Top having 1.50% which is statistically similar to two and three applications for Tilt 250 EC and three applications for Cabrio Top.

4.7 Effect of different fungicides, number of applications and their interactions on yield of wheat

4.7.1 Effect of fungicides on total yield and thousand grain weight of wheat

Total yield per sq. m and thousand grain weight of wheat were recorded and data were shown in Table-18.

Table-18 Effect of fungicides on total yield per sq. m and thousand grain weight of wheat

Fungicide	Total yield per sq. m (kg)	Thousand grain weight (g)
Tilt 250 EC	0.44 a	39.04 a
Cabrio Top	0.36 b	39.66 a
Amister Top	0.45 a	39.98 a
CV (%)	3.65	3.67

Significant variation was found on total yield and thousand grain weight among all the treatments which are recorded in table-18. In case of total yield, higher response was noted with Amister Top having 0.45 kg which was similar with Tilt 250 EC having 0.44 kg. The Cabrio Top performs lower response here with 0.36 kg.

In case of thousand grain weight, it was observed that, typically the data were showed different values where the highest weight was performed with Amister Top having 39.98 g. But it is statistically non-significant.

4.7.2 Effect of number of applications of fungicides on total yield and thousand grain weight of wheat

Total yield per sq. m and thousand grain weight of wheat were recorded and data were shown in table-19.

Table-19 Effect of number of applications of fungicides on total yield per sq. m and thousand grain weight of wheat

Frequency	Total yield per sq. m (kg)	Thousand grain weight (g)
Control	0.41 b	38.73 b
1 spray	0.46 a	40.10 ab
2 spray	0.42 ab	39.16 ab
3 spray	0.47 a	40.25 a
CV (%)	7.27	3.69

Significant variation was found on total yield per sq. m and thousand grain weight among all the treatments which are recorded in table-19. In case of total yield, the lowest yield was observed with control (0 sprays) and highest yield was observed with three applications of fungicide. In case of thousand grain weight, the highest result was recorded with three applications of fungicide where the lowest result was found with control (0 sprays).

4.7.3 Interaction effect between different fungicides and their number of applications on total yield and thousand grain weight of wheat

Total yield per sq. m and thousand grain weight of wheat were recorded and data were shown in table-20.

Table-20 Interaction effect between different fungicides and number of applications on total yield per sq. m and thousand grain weight of wheat

Fungicide × Frequency	Total yield per sq. m (kg)	Thousand grain weight (g)
Tilt 250 EC× control	0.38 ef	39.51 bc
Tilt 250 EC × 1 spray	0.41 cdef	40.03 abc
Tilt 250 EC × 2 spray	0.42 cde	37.10 d
Tilt 250 EC × 3 spray	0.44 cd	39.55 bc
Cabrio Top× control	0.36 f	38.29 cd
Cabrio Top× 1 spray	0.39 def	39.55 bc
Cabrio Top× 2 spray	0.40 cdef	40.04 abc
Cabrio Top× 3 spray	0.44 cd	42.06 a
Amister Top× control	0.41 cdef	38.41 bcd
Amister Top× 1 spray	0.42 bc	40.74 ab
Amister Top× 2 spray	0.46 bc	40.36 abc
Amister Top× 3 spray	0.53 a	39.15 bcd
CV (%)	8.87	4.34

Significant variation was found on total yield per sq. m and thousand grain weight among all the treatments which are recorded in table-20. In case of total yield, the highest yield was recorded with three applications of Amister Top. Here the lowest yield was recorded with control (0 sprays) of Cabrio Top which is statistically similar with control and one application for Tilt 250 EC, one and two application for Cabrio Top, control for Amister Top respectively.

4.8 Effect of different fungicides, number of applications and their interactions on spike length of wheat

4.8.1 Effect of fungicides on spike length (cm) of wheat

Spike length of wheat was recorded at different dates of observations and data were presented in table-21.

Table-21 Effect of fungicide on spike length (cm) of wheat

Fungicide	Spike length (cm)		
	First	Second	Third
Tilt 250 EC	17.86 b	18.68 a	18.71 ab
Cabrio Top	17.95 b	18.57 a	18.53 b
Amister Top	18.26 a	18.72 a	18.77 a
CV (%)	1.46	1.12	0.89

From the table-21 it was observed that spike length was significantly varied among the treatments when data was collected at 65 and 85 DAS. But it was not significant at 77 DAS. At 65 DAS, the highest spike length was found with Amister Top with 18.26 cm and lowest result was found in Tilt 250 EC with 17.86 cm which is similar with Cabrio Top with 17.95 cm. Again, at 85 DAS the highest value was noted in Amister Top having 18.77 cm which was tabulated by Tilt 250 EC (18.81 cm) and Cabrio Top (18.53 cm).

4.8.2 Effect of number of applications of fungicides on spike length (cm) of wheat

Spike length of wheat was recorded at different dates of observations and data were presented in table-22.

Table-22 Effect of number of applications of fungicides on spike length (cm) of wheat

Frequency	Spike length (cm)		
	First	Second	Third
Control	17.90 ns	18.41 ns	18.45 ns
1 spray	18.16	18.71	18.75
2 spray	17.89	18.66	18.68
3 spray	18.19	18.78	18.81
CV (%)	2.92	3.06	3.05

From the table-22, it was recorded that, at 65, 77 and 85 DAS spike length was generally showed the highest spike length for three applications of fungicide having 18.19 cm, 18.78 cm and 18.81 cm respectively and the lowest spike length was noted with control (0 spray) having 17.90 cm, 18.41 cm and 18.45 cm. But they were not showed any significant difference statistically.

Chapter 5

DISCUSSION

The leaf blight caused by *Bipolaris sorokiniana* considered as a hazardous disease globally. Mustarin *et al.* (2021) also found that it is one of the most harmful diseases for wheat in Bangladesh. In the study different types of fungicidal treatments with various frequency were applied in the field to control the leaf blight disease of wheat. The effect on plant height, spike length, % leaf area diseased of flag leaf and penultimate leaf, number of total grains per spike, number of healthy grains per spike, number of undersized grains per spike, number of black pointed grains per spike, total yield, thousand grain weight etc. were studied here. A good number of fungicides have been registered in our country to control the disease. Here three fungicidal treatments were used in the study named Tilt 250 EC (T_1), Cabrio Top (T_2) and Amister Top (T_3). And the doses of these fungicides were 1 spray (D_1), 2 sprays (D_2), 3 sprays (D_3) and control (D_0) which were applied at heading stage.

From the study it was found that fungicide treatments had positive response in reducing the leaf blight disease caused by *Bipolaris sorokiniana.* Similar finding was conducted by Angdembe *et al.* (2020), Magar *et al.* (2020), Yadav *et al.* (2015), Selvakumur wt al. (2015) who found the positive response of fungicides against leaf blight disease of wheat caused by *Bipolaris sorokiniana*. The sprayed plots showed less disease severity than the unsprayed plots. Fungicide application gave better result compared to the untreated plots. The finding was revealed that Amister Top (Azoxystrobin+ Difenoconazole) which is under Strobilurin group gave the best result to control leaf blight disease of wheat whereas the Cabrio Top gave the lowest result to control the disease. The finding of the present study had the similarity with the report of Bacmaga *et al.* (2015) who stated that Strobilurin fungicides have unique mechanism to attack the mitochondrial respiration of the fungi which is more effective now a days. But there were also dissimilarities with the findings of some experiments which were conducted by Mahto (1999); Rahman (1998); Singh and Chauhan (1995) who stated that Tilt 250 EC was very effective to control leaf blight of wheat. The reasons behind this, previous Tilt 250 EC (Propiconazole) was used worldwide to control the leaf blight disease of wheat but nowadays fungi made resistance mechanism against it. At that time strobilurin fungicides were not available. Similar finding was also concluded by Bartett (2001) who stated that strobilurin fungicides were not available in market until 1996.

It is important to understand the interaction between fungicide application and the number of applications to avoid the unnecessary application of fungicide and improve the economics of disease control. Here the finding also indicated that three applications of fungicide were more effective to reduce the disease incidence.

In case of plant height, fungicides could not produce any significant increase. No significant result observed in panicle length too. In case of percent diseased leaf area of flag leaf, the symptoms appeared at the end of February. Here the lowest disease observed where Amister Top was applied followed by Tilt 250 EC. Three applications showed better result compared to control. The Cabrio Top didn’t perform well to minimize the disease.

In case of penultimate leaf, it was more susceptible to disease than flag leaf and the symptoms appeared at the end of the January which is slowly progressed throughout February. Here the minimum percentage diseased leaf area was observed with the fungicidal treatment named Amister Top compared to Tilt 250 EC and Cabrio Top. In primary observation the Tilt 250 EC showed better performance. But as the day progress, the recovery of the disease leaf area was observed with Amister Top better than Tilt 250 EC. Three applications of

Amister Top gave the best result to control the disease. Similar result also found by Yadev (2015) who explored that propiconazole, carbendazim and hexaconazole is helpful in reducing disease levels of wheat.

In case of disease severity, it was found that, the fungicide treated plants showed less disease severity than the untreated plants. Similar finding also conducted by Malakar and Mian (2009) who observed that foliar treatment of Tilt 250 EC under all spray schedules effectively reduced disease severity compared to control. However, in the experiment, Amister Top was effectively reduced the disease severity of leaf blight of wheat.

In case of total number of grains per spike, the highest number of grains was found in those plots where no fungicidal spray was applied. Though highest grains were found in these plots, they were unhealthy grains. The sprayed plots gave partially lower number of grains than unsprayed plots, but they were healthy grains which is our concern.

In case of number of healthy grains per spike, clearly Amister Top gave significantly best result. But in case of interaction between fungicide and number of applications, there is no significant result observed. Here only the unsprayed plots gave unhealthy grains compared to sprayed plots which indicated yield loss. Bahadar (2016) also stated that leaf blight is believed to cause a significantly reduced average wheat yield. Though there were no significant results observed among the three fungicides, the three applications of Amister Top gave the highest result compared to others.

In case of total yield, the Cabrio Top gave lowest yield than other fungicidal treatments. The highest yield was recorded with Amister Top followed by Tilt 250 EC. Here the unsprayed plots gave poor yield compared to sprayed plots. Similar finding was reported by Sarri (1998) who found that the yield loss due to this disease amounted to 23% in Bangladesh. In case of interaction between fungicide and number of applications of spray, again the Amister Top with three applications gave best yield compared to others. The thousand gain weight also noticeable where fungicidal treatments were applied compared to untreated plots. Malakar (2007) also found that fungicidal treatments were most effective in controlling the disease with significant yield increase.

In case of number of undersized grains per spike, Tilt 250 EC and Amistr Top gave almost same results where results were non-significant. Less number of undersized grains were found where Tilt 250 EC and Amistr Top was sprayed whereas the Cabrio Top gave much number of undersized grains compared to others. In case of interaction between fungicide and number of applications, almost similar result found where fungicidal treatments were applied. The plots which were unsprayed, they gave highest number of undersized grains per spike. Among all treatments the Amister Top with three applications gave the lowest undersized grains which was desired. However, in case of black pointed grains, Amister Top treated plants gave the significant result followed by Tilt 250 EC. The lowest amount of black pointed grain was found. Similar finding was also concluded by Bazlur Rashid (2001) who reported that spraying Tilt 250 EC on leaves successfully controlled *B. sorokiniana* infection and lowered the occurrence of black pointed grains. In case of interaction between fungicide and number of applications, the highest black pointed grain was found with control (no spray) and the lowest number of black pointed grain was found with three applications of Amister Top.

From the overall studies, it may be said that the three applications of Amister Top (Strobilurin group) gave the best result in controlling the leaf blight disease of wheat and increase the yield improve the quality of grain by suppressing the black point of wheat.

Chapter 6

SUMMARY AND CONCLUSION

The experiment was undertaken in the experimental field of Hajee Mohammad Danesh Science and Technology University, Dinajpur during the period of November 2022 to April 2023 to find out the fungicidal effect and number of applications on Bipolaris leaf blight disease of wheat caused by *Bipolaris sorokiniana*. The experiment was conducted in Randomized Complete Block Design where it was replicated for three times. Here the plot size was 2.5m × 1.2m. Variety BARI Gom 30 was used in the experiment. Here two factors were considered where factor A was represented the application of three fungicides named Tilt 250 EC (T_1), Cabrio Top (T_2) and Amister Top (T_3). And factor B was represented the doses of these fungicides which were 1 spray (D_1), 2 sprays (D_2), 3 spray (D_3) and control (D_0). Weeding and irrigation were done as intercultural operations. For conducting the experiment several parameters were used to collect the data. Such as; plant height, spike length, % disease leaf area of flag leaf and penultimate leaf, total number of grains per spike, number of healthy grains per spike, number of undersized grains per spike, number of black pointed grains per spike, total yield, thousand grain weight etc. were recorded. Here the data were determined manually and the statistical analysis was done with the recorded data by using 'Statistix 10' software.

After analysis the data, the data table showed significant result to control the Bipolaris leaf blight of wheat. The results of the experiment showed that the fungicidal applications gave positive results to control this disease. Though the significant variation was not found in panicle length and plant height with fungicidal application, the analysis showed that there was significant result in reducing leaf blight disease. In the experiment the highest disease was found in those plots where no fungicidal spray was applied. Here the lowest disease severity (65.85% for flag leaf and 87.14% for penultimate leaf at 95 DAS) was found in the plots where fungicide was sprayed. The Amister Top gave the best result in reducing the severity of leaf blight of wheat. Besides the lowest black pointed grains per spike (2.9%) and undersized grains per spike (3.5%) was also recorded with Amister Top applications. The number of total healthy grains per spike (31.22%) and highest yield was noticeable with Amister Top applications than other fungicides.

Again, in case of number of application of fungicides, three times application was much better than 1-2 times application of fungicides. The analysis showed that three times application of Amister Top gave best result in reducing the Bipolaris leaf blight of wheat. The lowest disease percentage was observed (29.00% in flag leaf and 80.00% in penultimate leaf at 95 DAS) here. The lowest number of black pointed grains (1.5%) and undersized grains (2.00%) per spike was also found where Amister Top was sprayed for three times in the plot. This also gave the highest yield compared to other fungicide applications.

So, from the findings of the present experiment, it may be concluded that, *Bipolaris sorokiniana* is a serious pathogen responsible for leaf blight disease which results in significant yield loss of wheat. Fungicidal management can be helpful in reducing the disease. Three times application of Amister Top (Strobilurin fungicide) can be helpful for designing a proper management of leaf blight of wheat.

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