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Khalida Bahadar

National Agricultural Research Centre

Saira Khan (✉ sairaasifkhan@yahoo.com)

University of Haripur

Anjum Munir

National Agricultural Research Centre

Shahzad Asad

National Agricultural Research Centre

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**Effect of foliar spray with *Eucalyptus* extracts on disease incidence and yield loss to spot blotch in Wheat
Bhakkar 2001 under greenhouse condition**

Khalida Bahadar¹, Saira Khan^{1, 2*}, Anjum Munir³, Shahzad Asad³,

¹ PARC Institute of Advanced Studies in Agriculture, National Agricultural Research Centre, Islamabad, Pakistan

² Department of Medical Lab Technology, University of Haripur, Pakistan

³ Crop Diseases Research Institute, Department of Plant and Environmental Protection, National Agricultural Research Centre, Park Road, Islamabad, Pakistan

*Corresponding Author: sairaasifkhan@yahoo.com

Abstract

The efficacy of foliar spray with different treatments of flowering buds extracts of *Eucalyptus camaldulensis* L. and *Eucalyptus torelliana* F. Muell on the yield performance of wheat (Bhakkar 2001) artificially infected by *Bipolaris sorokiniana* was evaluated in green house. The foliar aerosol of crude extract at 1, 5 and 10% concentrations were applied under 3 spray schedules. Untreated (Healthy) and unsprayed (Diseased) controls were also managed. The effect of treatments with different spray schedules was highly significant ($P < 0.05$) for both of physiological and yield parameters such as plant height, leaves length/width, grain yield/spike and 1000 grain weight. Weight of 1000-grain decreased with increasing level of disease severity. Maximum decrease in number of grains/spike (16-20) was recorded in unsprayed control. In case of number of grains/spike, for each unit increase in disease severity, 0.395 units decrease in number of grains/spike were observed. The R^2 (0.473) value indicates that 47.3% variations in grains yield/spike were caused by disease severity. Among the different spray schedules, spray I schedule with a 10 days gape spraying at 15, 25, 35, 45 and 55 days after inoculation appeared to be most effective, which was statistically similar to spray II schedule with a 15 days gape spraying at 15, 30, 45 and 60 DAI in reducing black point incidence and increasing grain yield. From economic point of view spray II schedule that containing four spray applications was found best followed by Spray III schedule that containing only three spray applications applied at 15, 35 and 55 DAI.

Key words: *Eucalyptus*, *Bipolaris sorokiniana*, Wheat, foliar spray, Aqueous and Organic plant extracts

Introduction

Wheat is one of mostly grown cereal crops and is used as staple food in many parts of the world especially in Pakistan (Hussain et al., 2012). Fungal pathogens caused foliar infections resulting in yield loss. In Pakistan, about 50 pathogens

infest wheat crops. The most common microflora of wheat seeds are *Alternaria alternata*, *Fusarium graminearum*, *Curvularia lunata*, *Bipolaris sorokiniana*, *Drechsleria*, *Helminthosporium sativum*, *Aspergillus* (Khan *et al.*, 2023). Black point caused mainly by *Bipolaris sorokiniana* and *Alternaria alternata*, is an important seed-borne disease of wheat in many wheat growing countries of the world (Zishan *et al.*, 2005; Hasabnis *et al.*, 2006; Hussain *et al.*, 2013; Raza *et al.*, 2014). The disease is characterized by brown to black discoloration usually restricted to the germ end of the seeds. Black point symptom may also develop on the endosperm, ventral crease or even on the brush end of the grain. In case of severe infection, particularly when *B. sorokiniana* is involved, the grain may be completely discolored and shriveled. Impaired seed germination and significant reduction in seedling vigor and grain yield to black point infection have been reported at home and abroad (Hossain, 2000; Malaker and Mian, 2002, Islam *et al.*, 2019). Black point also affects luster and plumpness of wheat grain and reduces its market value (Solanki *et al.*, 2006; Iqbal *et al.*, 2014).

The basic principle involved in the control of a seed-borne disease is reducing the population of primary inoculum of the pathogen. Infected seeds are one of the most important sources of primary inoculums that survive between wheat cropping seasons (Agarwal and Sinclair 1997; Brodal and Asdal 2021). The predominant pathogen *B. sorokiniana* is highly seed-transmitted and more than 80% seed to plant transmission have been established in wheat (Reis *et al.*, 1998, Li *et al.*, 2019). Uses of seed treating fungicide are an option to reduce primary inoculum of seed and soil-borne fungi (Ilyas *et al.*, 1998; Ansari *et al.*, 2017). Foliar spray with fungicide can control infection on foliage and reduce leaf blight severity of wheat (Rashid *et al.*, 2001), However, limited work has been done on the chemical control of black point disease of wheat. While significant reduction of infection and improvement in germination of infected seeds were achieved by seed treatment with fungicides (Malaker and Mian, 2009; Wei *et al.*, 2021; Dey *et al.*, 1992; Ali and Fakir, 1993), except in the subsequent crops using seed treating fungicides. The appropriate foliar spray schedule with effective fungicide is needed for proper management of the disease under field condition (Fakir 1988; Malaker and Mian, 2009)

The economic disease of wheat crop after rust is spot blotch in Pakistan. Biological control has emerged as an effective alternative, as *Bipolaris* show resistance against many fungicides. This research is less costly and safer than any other methods. It contains agents that give protection to the crop throughout the crop period and they do not cause toxicity as well are safer to the environment and to the person who applies them. These are natural and multiply easily in the soil and leave no residual problem. Therefore best for soil borne diseases. The present study is undertaken

to determine the effectiveness of different treatments of plant based fungicides with different application of foliar spray in reducing incidence under green house condition.

Material and Method

The most susceptible Wheat variety Bhakkar 2001 cultivar was planted in the green house at NARC Islamabad nursery during mid November to mid may crop seasons. The experiment was a randomized complete block design with three replications. Planting were made in mid of November with a 10 seed per pot filled with sterilized soil and peat moss at 1:1 ratio in a glasshouse at $17 \pm 2^{\circ}\text{C}$. Furrow irrigation was used and continued until the latest maturing genotype reached physiological maturity. Thirty days after seeding the growth stage having three to five leaves an artificial inoculation was applied to all the pots. Equal volumes of conidial suspension (50 ml) were sprayed on each pot using a hand sprayer. The spraying was carried out until the droplet of spore suspension was formed on all parts of plants (Maraite *et al.*, 1997). The environmental factors inside the greenhouse not controlled hundred percent. Therefor it was done in the evening when the temperature was $18-20^{\circ}\text{C}$ with no wind. Pots were watered after inoculation to maintain humidity and placed in a polyethylene humid chamber. After 48 hr pots were removed from the humidity chamber and placed on a bench in the glasshouse for 15 days. Spot blotch were evaluated 15 days after inoculation by counting all lesions on 3 to 5 leaves.

Beginning with the appearance of about 10% of infection, botanical treatments were applied though foliar sprayer. There were 54 botanical treatments and four control treatments setup, in one disease was allowed to develop; in the rests disease were suppressed by the application of control treatments. Treatments were applied through foliar spray with different treatment combinations under three different spray schedules (Fig 01). S I schedule with 10 days gap (Spray at 15, 25, 35, 45 and 55 DAI), S II schedule with 15 days gap (Spray at 15, 30, 45 and 60 DAI) and S III schedule with 20 days gap (Spray at 15, 35 and 55 DAI). (Malaker and Mian 2002; Nashwa and Abo-Elyousr, 2012).

Data for disease severity index and percent control was recorded on the appearance of symptoms. Three plants with varying disease intensities were selected at random and tagged in each pot on the onset of disease development. Data for disease severity was recorded twice, firstly before treatments application and secondly after treatments application. Disease severity on foliar parts were recorded visually (Fig 02) and rated on 0-5 scale, where 0 = no symptoms, 1 = 1-5% spots on leaves, 2 = 6-20% spots on leaves, 3 = 21-40% spots on leaves, 4 = 41 - 60, 5 =

more than 60% spots on leaves (Anon., 1996). The disease severity index was calculated by the following formula (Singh, 1984).

$$\text{Disease severity index} = \frac{\sum (\text{Number on scale} \times \text{Number of plants on that scale})}{\sum (\text{Number of treated plant}) \times (\text{Maximum disease grade})} \times 100$$

From above observation the percent disease control was calculated with following formula (Yadav *et al.* (2015).

$$\text{Percent disease control} = \frac{\text{DSI in control} - \text{DSI in Treatment}}{\text{DSI in control}} \times 100$$

The observations for morphological parameter were recorded on 31st March from randomly selected tagged plant of each unit pot along with control treatment in 10 replicates. Five traits were measured in each pot: (i) plant height (cm) using three measurements in each treatment from the ground to the spike apex excluding awns; (ii) spike length (cm); (iii) leaves length (iv) leaves width, (v) grain yield (number of grains per pot), (vi) 1000 grain weight determine from 250 grain sample from each pot.,(vii) Percent yield decrease (%) Each pot was hand harvested close to the ground level before full maturity to minimize grain shattering. Harvested wheat was sun dried for 10 days, threshed the grain was cleaned and weighed.

Yield decrease was calculated from the following formula (William and Khan. 1992)

$$\text{Percent yield decrease (\%)} = \frac{\text{Yield in control} - \text{Yield in treatment}}{\text{Yield in control}} \times 100$$

RESULTS AND DISSCUSSION

The results summarized below are the treatments effect of *Eucalyptus* flowering buds extracts against *B. sorokiniana*; score were taken from the diseased pots of the test entries of bhakhar 2001 during mid November to mid May seasons at CDRI, NARC, Pakistan. The foliar application of all treatments in three different spray schedules effectively reducing the severity of disease in this study. Spray I at tiller and boot leaf stages gave the maximum reduction of disease incidence and severity followed by spray II schedule and spray III. These findings are in

agreement with the results of previous studies Yadav *et al.* (2015). The applications of Propiconazole at tiller and boot leaf stages reduced disease incidence and severity also reported by Kalappanavar and Patil (1998).

The mean disease severity on leaf surface before treatment and after treatment is presented in Fig 03. The most significant results were found in the sprayed pots with *E. camaldulensis* ethanol extracts; had disease score no more than 2; where disease severities index before treatment was 53% and after treatment was 53% in all spray I, spray II and spray II schedule as compared to control and all other treatments. After the application of these effective treatments, the disease stops progressing further, and remain the same on rating scale. While the largest disease severity index recorded was 100% for water treatment. Maximum infection 87-92% was found in pots treated by water extracts observed by Chowdhury *et al.* (2010) and Haider (2013). The mean highest leaf length observed was 28.5cm, width 0.93cm and plant height 63.7cm by using *E. camaldulensis* ethanol extract at 10% concentration compared to all other and control treatments. There was significant difference among three different spray schedules as shown in (Table 1).

All parameters of yield and other measures were significantly reduced by spot blotch disease. Overall grain yield was reduced 70% in the diseased pot without any treatment. Mean yield reduction in term of number of grains/spike due to the disease ranged from 2-21%. However, the highest yield in diseased pots was seen with *E. camaldulensis* flowering buds ethanolic extract at 10% concentration during all of three different spray schedules (Fig. 04). These results are supported by Yadav *et al.*, 2015; Tania, 2013; Chowdhury *et al.*, 2010. The lowest yield recorded for *E. torelliana* water extract was 28 grains/spike, 24 grains/spike and 21 grains/spike as shown in Fig. 05. Significant variations were found with respect of 1000 KWT under different treatments. The highest grain weight reduction recorded in treated pots was 24% (Fig 06). The great losses in the weight of 1000 seeds may be due to discoloration of seed as a result of pathogen infection as explained by Gora *et al.*, (1987).

The reason for yield increase may be due to the protection provided to the flag leaf which contributes significantly to the high yield. However, the greatest yield losses may be occur when the flag leaf and the leaf below the flag leaf become infected before the emergence of head (Acharya *et al.*, 2012; Ali *et al.*, 2010; CiuHua *et al.*, 2010; Rawson *et al.*, 1983).

Disease severity is strongly related to high temperature and high humidity, particularly high temperature for many days prior to flowering stage results maximum losses of yield in the flowering as well as milk stage of wheat crop; Zaman *et al.* (2009) reported similar results of yield losses. In present study it was noticed that in case of severe infection (black points) whole grains of the wheat become discolored and that results shriveled seeds, entirely discolored seeds and wrinkled seeds.

The morphological study reveals that; *B. Sorokiniana* first colonizes upon the older leaves at the base of the wheat plant (Fig. 02) and then move to the upper part of the canopy (Joshi *et al.*, 2002). That also affected plants height and leaves length/width. Similar results were also observed by Karwasra *et al.* (2007) and Malaker and Mian (2002). In case of initial infection the response of the non toxic secondary metabolite within plants body serve up as precursors for natural compounds necessary for the expression of fight (Perumalla and Heath, 1991). Phenolic compounds are needed by plants for growth, pigmentation, reproduction and resistance to pathogens (Lattanzio *et al.*, 2006).

Relationship between disease severity and yield performance

The correlation study was done to determine the correlation between disease severity index and yield contributing parameters such as number of grains/spike, 1000 grains weight (g) at 5% Significance Level. It was observed that the relationship of disease severity was negatively correlated with yield contributing parameters. Such as with the increase in disease severity, the number of grains/spike and 1000 grains weight going to be decreases. The correlation co-efficient for number of grains/spike was $r = -0.615^*$ and 1000 grains weight (gm) was $r = -0.642^*$ (Fig 07 & 08). The multiple regression for number of grains/spike is $y = 50.729 + 84.576^* \text{treatment} - 0.226^* \text{disease severity}$ indicated that for each unit (%) increase in treatment application, number of grains/spike increases with 84.576 units and for each unit increase in disease severity number of grains/spike decreases with 0.226 units. Slops show strong positive correlation with treatments while weak negative correlation with disease severity such as with the increase of disease severity decreases the performance of yield contributing parameters. The simple regression line is $y = 1000 \text{ grains weight} = 51.03 - 0.269^* \text{disease severity}$. It indicates that with each unit's (%) increase of disease severity there is a 0.269 unit's decrease of 1000-grains weight (gm).

Conclusion

Spot blotch of wheat, being one of the most devastating diseases, highly affects the yield of crop. The application of different botanical extracts showed different results in the crop yield. Among different doses of treatments at the rate of 1, 5 and 10% showed significant result for the efficient management of black spot of wheat with higher test weight and economic yield. A remarkable effect has also been found on the yield performance in term of number of grains/spike and weight of 1000 grains compared to control treatments in green house which may be affecting the market value of the crop. The hand spray inoculation method was found best for simple, rapid, reliable and economical evaluation of wheat cultivar against pathogen during green house assay. Among three different spray schedules of treatments applications in green house experiment, spray II and III schedules were found best from economic point of view.

As botanicals being efficient, economical and easily accessible, it could be suggested to the farmers that this pest management strategy of agricultural importance can significantly contribute to minimize the risk of toxic chemical pesticides, especially sprayed on economically important field crops and vegetables.

Author contribution:

SA contributed in lab work and inoculum preparation and application; AM and KB performed green house trials, experimental designs, treatment applications and data recording, SK done statistical analysis and manuscripts writing, review and formatting.

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Declaration of competing interest

There are no conflicts of interest or competing interests.

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References

Acharya, A. Arun, K.D. Pradhan. P. 2012. Bipolarissorokiniana (Sacc.) Shoem.: The most destructive wheat fungal pathogen in the warmer areas. Aus. J. Crop Sci. 5(9):1064-1071.

183 Agarwal V.K., Sinclair J.B. Principles of Seed Pathology. 2nd ed. CRC Lewis Publishers; Boca Raton, FL, USA: New
 184 York, NY, USA: London, UK: Tokyo, Japan: 1997. 539p

185 Ali, M.A. Hussain, M. Khan, M.I. Ali, Z. Zulkiffal, M. Anwar, J. Sbir, W. Zeeshan, M. 2010. Source-sink
 186 relationship between photosynthetic organs and grain yield attributes during grain filling stage in spring
 187 wheat (*Triticum aestivum*), Int. J. Agric. Biol. 12 No. 4, pp. 509-515, ISSN 1560- 8530

188 Ali, M.H. Fakir. G. A. 1993. Control of seed-borne fungi of wheat with fungicides. Bangladesh.J. Bot. **22**(2): 135-
 189 141.

190 Anonymous. 1996. Standard Evaluation System for Rice. 4th Edition. International Rice Research Institute,
 191 Philippines.

192 Ansari M. S. Q., Pandey A., Mishra V. K., Joshi A. K., Chand R. 2017. “Black point of wheat caused by *Bipolaris*
 193 *sorokiniana* and its management,” in Management of Wheat and Barley Diseases (Florida, USA: Apple
 194 Academic Press;), 239–255.

195 Brodal G, Asdal Å. 2021.Longevity of Plant Pathogens in Dry Agricultural Seeds during 30 Years of Storage.
 196 Microorganisms 19;9(10):2175. doi: 10.3390/microorganisms9102175. PMID: 34683496; PMCID:
 197 PMC8539852.

198 Chowdhury, S.R., Aminuzzaman, F.M. Islam, M.R. Zaman. R. 2010. Effect of Different Levels of Seed Infection by
 199 *Bipolaris sorokiniana* on Leaf Blight Severity, Grain Formation, Yield and Subsequent Seed Infection of
 200 Wheat, Int. J. Agric. Environ. Biotechnol. 3: 219-224.

201 Ciu Hua, G. ZhiQiang, G. GuoYuan. M. 2010. Effect of shading at post flowering on photosynthetic characteristics
 202 of flag leaf and response of grain yield and quality to shading in wheat. Acta.Agron.Sin. 36(4): pp. 673-679,
 203 ISSN 0496- 3490.

204 Dey, T.K., Chowdhury, N. Ayub, A. Goswami. B.K. 1992. Black point of wheat: Occurrence, effect of fungicidal
 205 seed treatment on germination and quality characters. Bangladesh J. Bot. **21**(1): 27-32.

206 Fakir, G.A. 1988. Report on investigation into black point disease of wheat in Bangladesh. Bangladesh-German Seed
 207 Development Project.Dhaka.99 pp.

208 Gora, M.A., Parsad, Y.Singh B.N. 1987. Loss in rice seed weight due to *Trichoniella padwickii*. Int. Rice Res. New.
 209 12(2): 28-29.

210 Haider, M. 2013. Management of health and quality of wheat seed samples collected from Sadarupazilla of Barisal
 211 district. MS Thesis. Department of Plant Pathology, Bangladesh Agricultural University Mymensingh.

212 Hasabnis, S.N. Ilhe, B.M. Shinde. V.K. 2006. Incidence of black point disease in wheat varieties. *J. Maharashtra*
 213 *Agric. Univ.* **31**(1): 114-115.

214 Hossain, M.M. 2000. Effect of different levels of black pointed seeds on germination, seedling vigour, plant stand and
 215 seed quality of wheat. M.S. Thesis. Department of Plant Pathology, Bangladesh Agricultural University,
 216 Mymensingh. 82 pp.

217 Hussain, A. Saboor, A. Khan, M.A. Mohsin, A.Q. Sahi, F. ul H. 2012. Technical efficiency of wheat production in
 218 rain-fed areas: A case study of Punjab, Pakistan. *Pakistan J. Agric. Sci.* (2012)

219 Hussain, M. Ghazanfar, M.U. Hamid, M.I. Raza, M. 2013. Seed Borne Mycoflora of Some Commercial Wheat
 220 (*Triticum aestivum* L.) Cultivars in Punjab, Pakistan. *Int. J. Phytopathol.* 10.33687/phytopath.002.02.0198

221 Ilyas, M.B. Bokhari, S.A.A. Khan, M.A 1998. Fungi detected from wheat seeds exhibiting black point symptoms and
 222 their control by seed treatment. *Pakistan J. Phytopathol.* **10**(2): 86-89.

223 Iqbal, M.F. Hussain, M. Ali, M.A. Nawaz, R. Iqbal, Z. 2014. Efficacy of fungicides used for controlling black point
 224 disease in wheat crop, *Int. J. Adv. Res. Bio. Sci.* 1,59-64

225 Islam et al., 2019. Effect of Black Pointed Seed and Vermicompost on Leaf and Seed Infection of Wheat caused by
 226 *Bipolaris sorokiniana*. *International Journal of Bio-resource and Stress Management*, 10(3):266-275.
 227 [HTTPS://DOI.ORG/10.23910/IJBSM/2019.10.3.1987a](https://doi.org/10.23910/IJBSM/2019.10.3.1987a)

228 Joshi, A.K. Chand, R. Arun. B. 2002. Relationship of plant height and days to maturity with resistance to spot blotch
 229 in wheat. *Euphytica* 123, 221–8.

230 Kalappanavar, I.K. Patil, N.K. 1998. Field evaluation of fungicides against leaf rust of wheat. *J. Maharashtra*
 231 *Agricultural Universities* 22(3):335

232 Karwasra, S.S., Beniwal M.S. Singh. R. 2007. Effect of black point on vigor components and qualitative characters in
 233 Bold and small- seeded varieties of wheat. *Crop Res.* 33(1/3) 210-212.

234 Khan, A.M.; Khan, M.; Salman, H.M.; Ghazali, H.M.Z.U.; Ali, R.I.; Hussain, M.; Yousaf, M.; Hafeez, Z.; Khawja,
 235 M.S.; Alharbi, S.A.; Alfarraj, S.; Arif, M.; Nabeel, M. 2023.. Detection of seed-borne fungal pathogens
 236 associated with wheat (*Triticum aestivum* L.) seeds collected from farmer fields and grain market. *Journal of*
 237 *King Saud University-Science* 2023, 35(4), 102590.

238 Lattanzio, V., Lattanzio and V.M.T. Cardinali, A. 2006. Role of phenolics in the resistance mechanisms of plants
239 against fungal pathogens and insects. *Phytochemistry: Advances in Research* 23-67.

240 Li Q. Y., Xu Q. Q., Jiang Y. M., Niu J. S., Xu K. G., He R. S. 2019. The correlation between wheat black point and
241 agronomic traits in the North China Plain. *Crop Prot.* 119, 17–23. 10.1016/j.cropro.2019.01.004

242 Malaker, P. Mian, I. 2009. Effect of seed treatment and foliar spray with fungicides in controlling black point disease
243 of wheat. *Bangladesh J. Agric. Res.* 34, 425–434. 10.3329/bjar.v34i3.3968

244 Malaker, P. Mian. I. 2002. Effect of black point on seed quality and yield of wheat. *Bangladesh J. Plant Pathol.*
245 **18**(1&2): 65-70.

246 Nashwa, S.M.A. and Abo-Elyousr. K.A.M 2012. Evaluation of various plant extracts against the early blight disease
247 of tomato plants under greenhouse and field conditions. *Plant Protect. Sci.* 48(2): 74-79.

248 Perumalla, C.J. Heath. M.C. 1991. The effect of inhibitors of various cellular processes on the wall modifications
249 induced in bean leaves by the cowpea rust fungus. *Physiol. Mol. Plant. Pathol.* 38: 293-300.

250 Rashid, A.Q.M.B. Sarker, K. Khalequzzaman. K. M. 2001. Control of *Bipolaris* leaf blight of wheat with foliar spray
251 of Tilt 250 EC. *Bangladesh J. Plant Pathol.* **17**(1&2): 45-47.

252 Rawson, H.M., Hindmarsh, J.H. Fischer, R.A. Stockman. Y.M. 1983. Changes in leaf photosynthesis with plant
253 ontogeny and relationships with yield per year in wheat cultivars and 120 progeny. *Aus. J. Plant Physiol.*
254 0(6): pp. 503-514, ISSN 0310-7841

255 Raza, M. Hussain, M. Ghazanfer, M.U. 2014. Characterization and pathogenicity of *Bipolaris sorokiniana* caused
256 spot blotch of wheat in Pakistan. *FUUAST J. Biol.*, 4, pp. 97-100

257 Reis, E.M. Medeiros, C.A. Casa. R.T. 1998. Control of leaf blights of wheat by Helmintho of the inoculum source.
258 pp. 327-332. *In: Helmintho sporium* Blights of Wheat: Spot Blotch and Tan Spot (E. Duveiller, H.J. Dubin
259 and A. McNab, Eds.). Mexico, D.F.: CIMMYT.

260 Singh, R.S. 1984. Assessment of disease incidence and loss. In “Introduction to the Principles of Plant Pathology” (3rd
261 Edn.), Oxford and IBH Publishing Company, New Delhi.

262 Solanki, V.A. Augustine, N. Patel. A.A. 2006. Impact of black point on wheat trade and its management. *Indian*
263 *Phytopath.* **59**(3): 44-47.

Tania, F.T. 2013. Effects of seed borne variable isolates of *Bipolaris sorokiniana* on the field performance of Bari gom 21 (shatabdi). MS Thesis. Department of plant pathology Bangladesh agricultural university mymensingh.

Wei X., Xu Z., Zhang N., Yang W., Liu D., Ma L. 2021. Synergistic action of commercially available fungicides for protecting wheat from common root rot caused by *Bipolaris sorokiniana* in China. Plant Dis. 105. 10.1094/PDIS-03-20-0627-RE

William W. Donald, Mohammad Khan. 1992. Yield Loss Assessment for Spring Wheat (*Triticum aestivum*) Infested with Canada Thistle (*Cirsium arvense*). Weed Science, 40(4), 590–598. <http://www.jstor.org/stable/4045252>

Yadav, B., Singh, R. Kumar, A. 2015. Management of spot blotch of wheat using Fungicides, Bio-agents and Botanicals. Afr. J. Agric. Res. 10(25): pp 2494-2500

Zaman, R., Aminuzzaman, F.M. Islam, M.R. Chowdhury. S.R. 2009. Eco-friendly management of leaf blight (*Bipolaris sorokiniana*) of wheat. Am- Eurasian J. Sustain. Agric. 3: 597-603.

Zishan, U. Shah, S.J.A. Shaikat. H. 2005. Studies on incidence of black point in different wheat cultivars grown in Pakistan. Sarhad J. Agric. 21(4): 723-728.



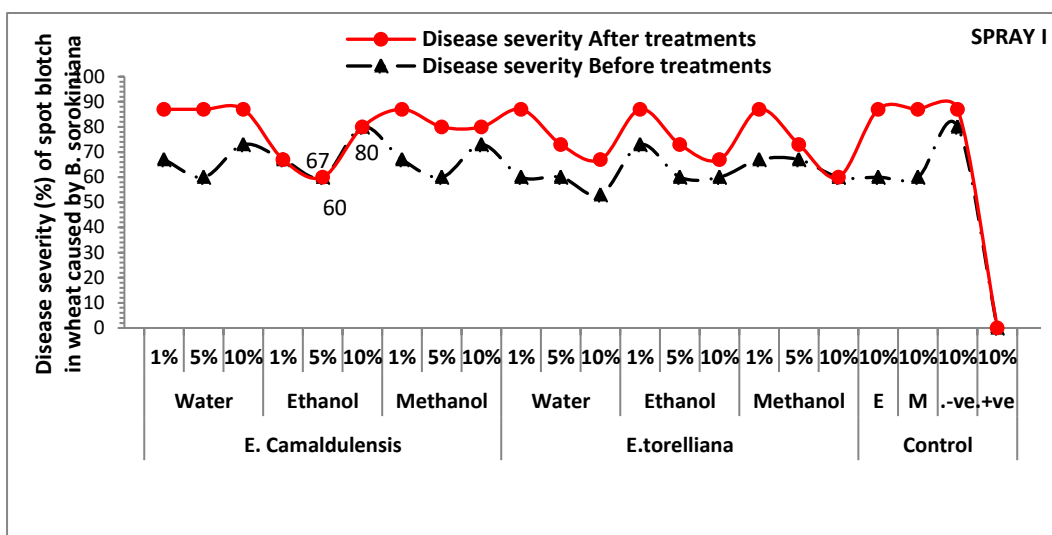
Fig. 01: Height of wheat plants treated with 1% *E. camaldulensis* ethanol extract L-R (sprayI schedule, sprayII schedule, sprayIII schedule)

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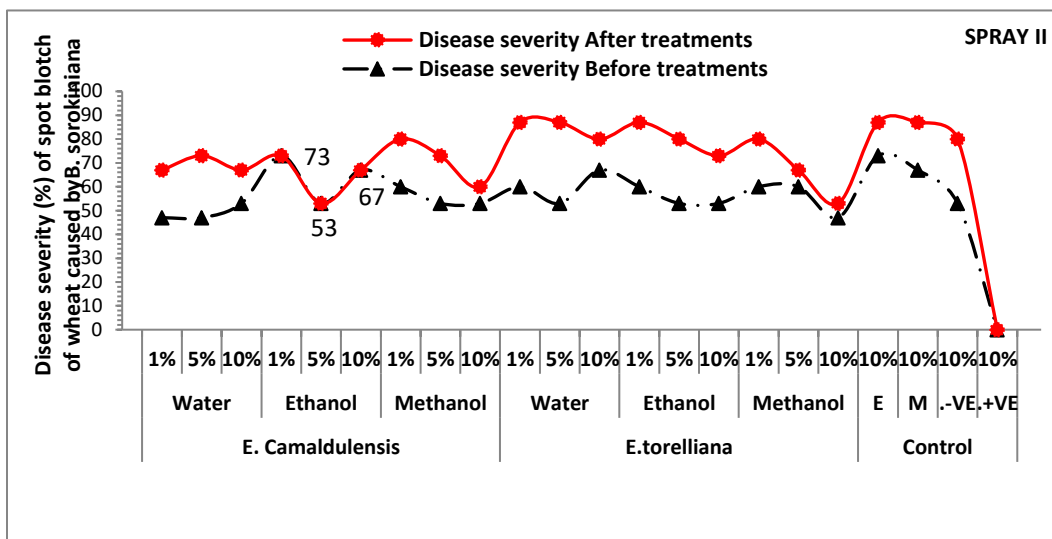


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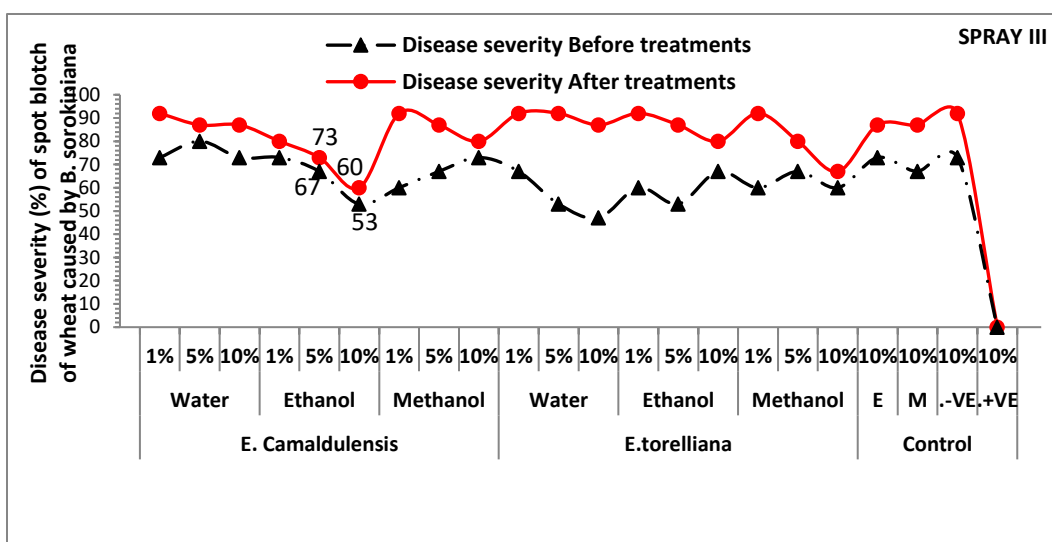
284 **Fig. 02: Initial symptoms appeared as patches and later symptoms become blotchy**



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288 **Fig. 03: Disease progression curve before treatments and after treatments during three**
289 **different spray schedules**

Table1. Morphological characteristics of wheat bukhari 2001 cultivar in the presence of spot blotch or when protected by botanical treatments. And the percent reduction due to disease average over 1 year at NARC.

MORPHOLOGICAL PARAMETER Mean±S.Error (cm)											
	Treatments		S1 SCHEDULE			S2 SCHEDULE			S3 SCHEDULE		
S.N	Doses	Con.	Leaves length	Leaves width	Plant height	Leaves length	Leaves width	Plant height	Leaves length	Leaves width	Plant height
1	CFW	1%	21.0±0.58	0.57±0.03	47.67±0.33	17.67±1.85	0.53±0.03	49.0±1.52	15.33±2.18	0.5±0.00	47.0±1.73
2		5%	24.17±1.92	0.76±0.08	51.0±0.00	23.0±2.08	0.60±0.10	53.0±2.88	21.33±1.85	0.63±0.13	48.67±1.33
3		10%	24.66±1.42	0.73±0.14	52.66±2.40	24.67±2.60	0.73±0.08	54.67±1.20	22.67±0.33	0.63±0.13	50.67±1.20
4	CFE	1%	25.0±1.15	0.80±0.17	58.33±2.96	21.0±3.78	0.57±0.03	56.67±1.33	21.67±0.33	0.53±0.03	53.0±5.00
5		5%	26.0±2.64	0.83±0.06	59.0±1.15	24.0±2.30	0.70±0.15	61.0±1.52	23.0±1.52	0.67±0.08	55.67±1.45
6		10%	28.50±1.80	0.93±0.18	62.0±1.52	26.67±0.33	0.83±0.08	63.67±5.23	25.0±1.00	0.80±0.05	59.33±2.33
7	CFM	1%	21.0±0.58	0.60±0.15	54.0±2.30	17.33±1.76	0.57±0.06	54.33±2.18	21.67±3.18	0.63±0.13	45.33±2.18
8		5%	21.33±0.92	0.70±0.11	56.0±2.08	21.0±0.57	0.67±0.16	58.33±2.18	21.33±2.96	0.70±0.10	53.33±1.66
9		10%	22.50±2.02	0.73±0.06	56.66±0.08	22.33±0.08	0.70±0.00	59.0±1.00	23.0±2.08	0.77±0.16	56.67±1.76
10	TFW	1%	20.67±2.18	0.63±0.14	45.33±2.18	19.0±3.05	0.57±0.03	48.33±2.90	16.67±1.85	0.50±0.00	41.67±3.17
11		5%	21.67±2.02	0.66±0.16	52.0±3.21	22.0±1.52	0.67±0.12	51.0±4.58	20.0±2.00	0.50±0.00	45.33±2.90
12		10%	23.0±3.05	0.76±0.14	54.0±3.05	22.33±1.33	0.70±0.15	51.33±4.40	21.33±1.85	0.53±0.08	49.33±2.60
13	TFE	1%	20.33±2.60	0.57±0.12	50.0±1.73	21.0±2.08	0.60±0.05	48.33±2.90	19.33±2.18	0.53±0.06	42.67±2.84
14		5%	21.67±0.67	0.73±0.18	50.66±2.02	22.67±0.08	0.73±0.13	52.0±3.21	21.33±1.85	0.57±0.03	51.0±1.52
15		10%	25.33±1.85	0.83±0.18	56.0±2.00	23.0±1.15	0.77±0.12	57.0±1.52	22.0±1.00	0.70±0.11	54.0±0.57

16	TFM	1%	23.33±1.20	0.63±0.06	47.67±0.33	17.67±1.76	0.67±0.16	55.33±0.88	16.33±1.45	0.57±0.03	45.67±1.20
17		5%	24.0±1.00	0.70±0.11	57.33±0.66	24.67±0.33	0.73±0.13	56.0±1.00	21.33±0.66	0.57±0.03	49.67±2.66
18		10%	26.66±1.76	0.73±0.08	57.66±1.66	25.0±2.64	0.70±0.15	58.67±2.40	24.0±2.51	0.63±0.03	50.33±4.84
19	Control	Ethanol	14.67±2.02	0.53±0.08	49.33±1.45	17.33±1.76	0.53±0.08	50±1.15	18.00±1.52	0.53±0.08	49.67±1.20
20		Methanol	22.33±4.09	0.60±0.10	53.33±4.66	24.33±4.09	0.60±0.10	52.67±4.97	24.33±4.33	0.63±0.08	52.67±4.63
22		-Ve	14.67±0.88	0.53±0.03	47.67±1.45	17.00±1.15	0.56±0.03	47±1.73	17.33±0.67	0.46±0.03	48±1.15
23		+Ve	26.00±1.52	0.87±0.08	60.33±2.18	23.67±1.67	0.90±0.00	61.33±1.67	26.00±1.52	0.86±0.08	60.33±1.67

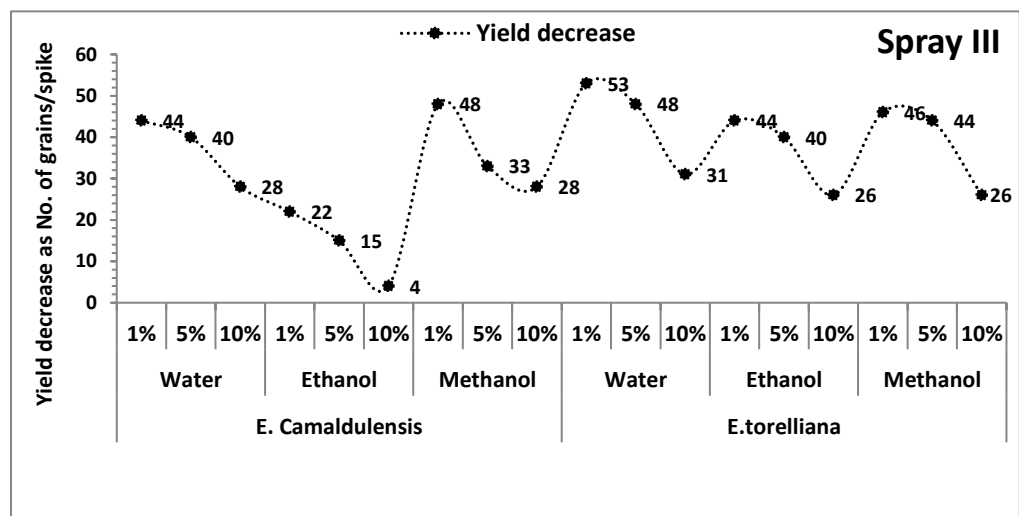
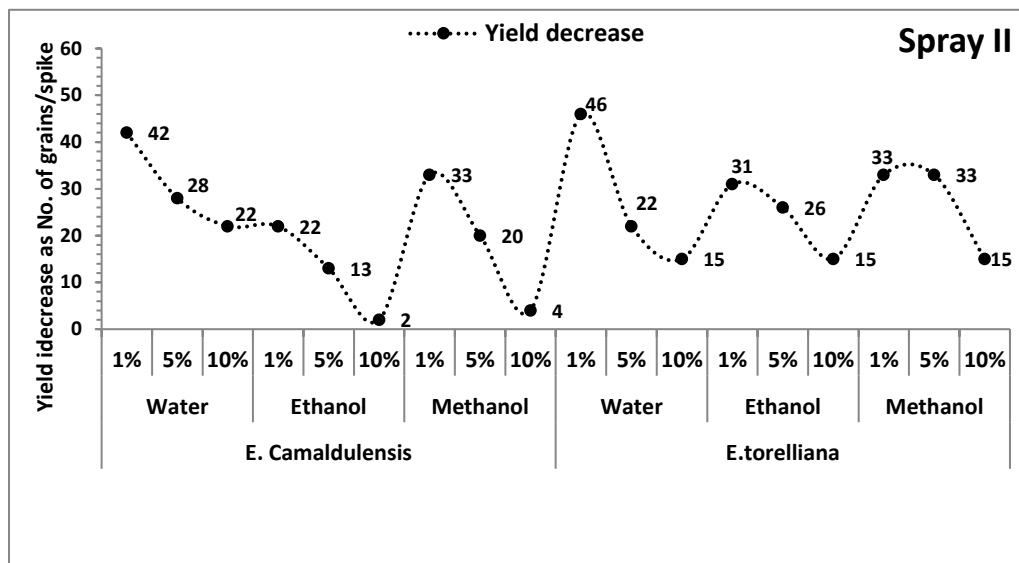
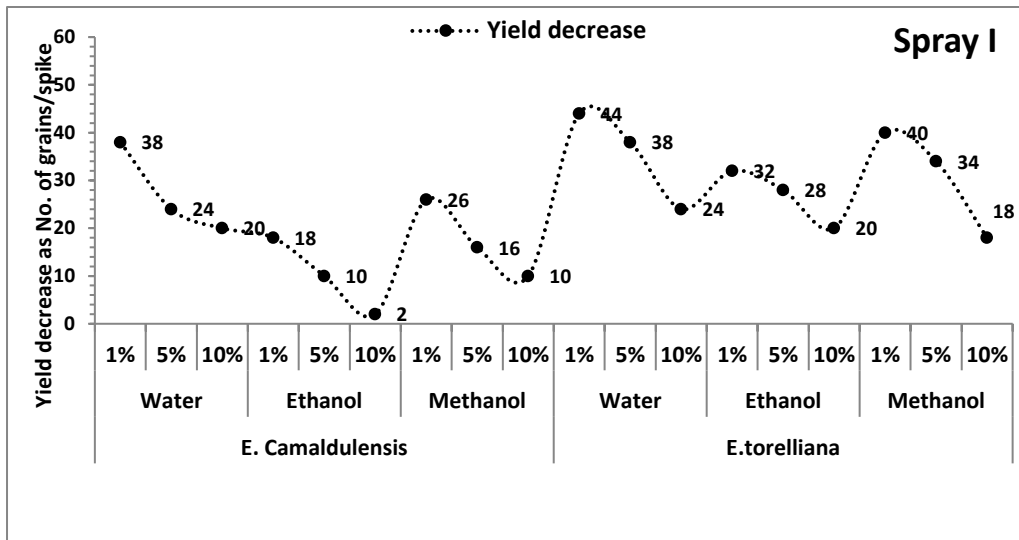


Fig. 04: effects of different treatments on yield performance of wheat affected by spot blotch in green house

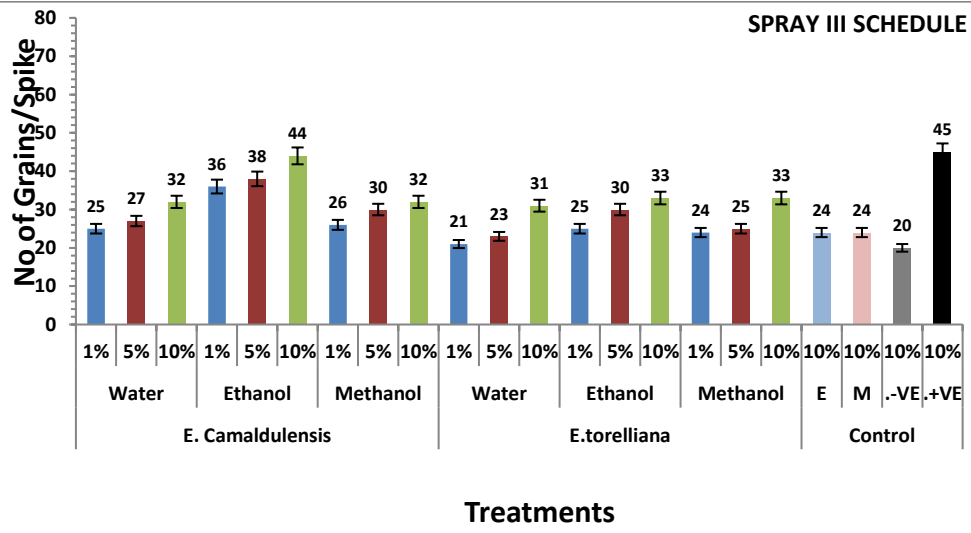
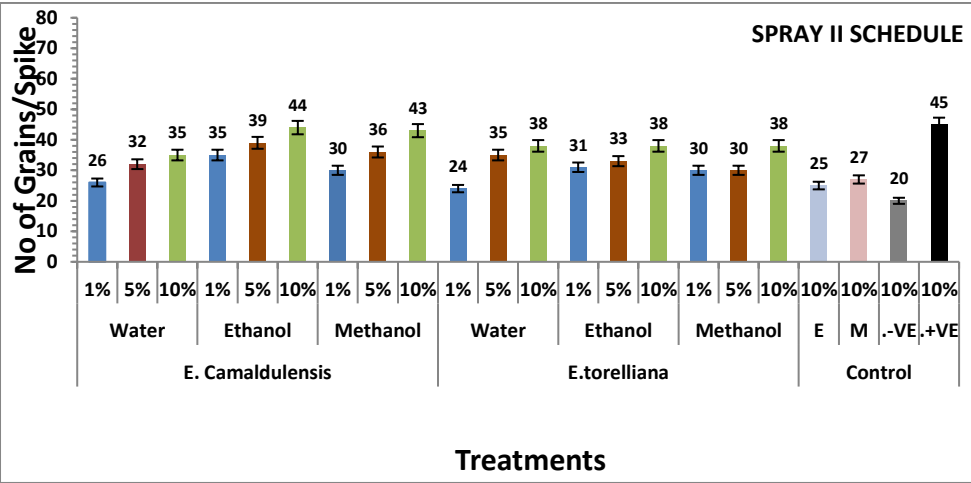
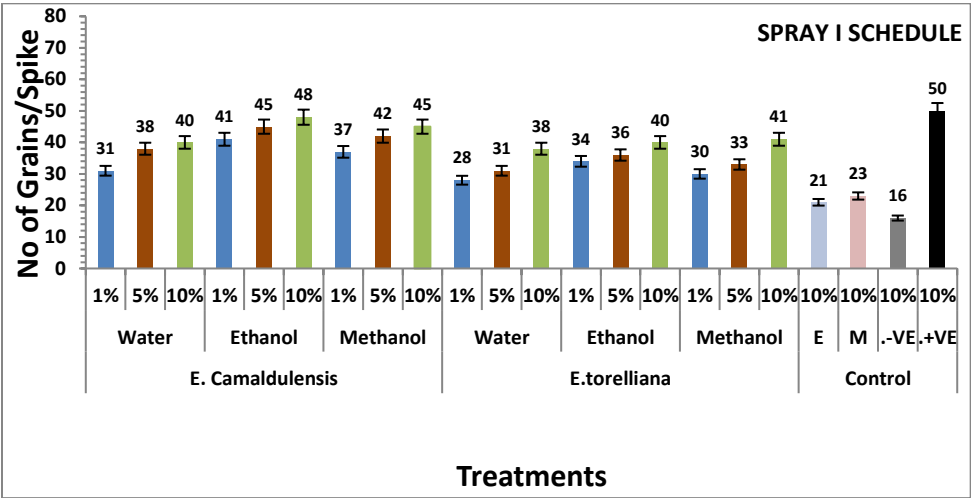


Fig. 05: Effects of different treatments on production of number of grains/spike

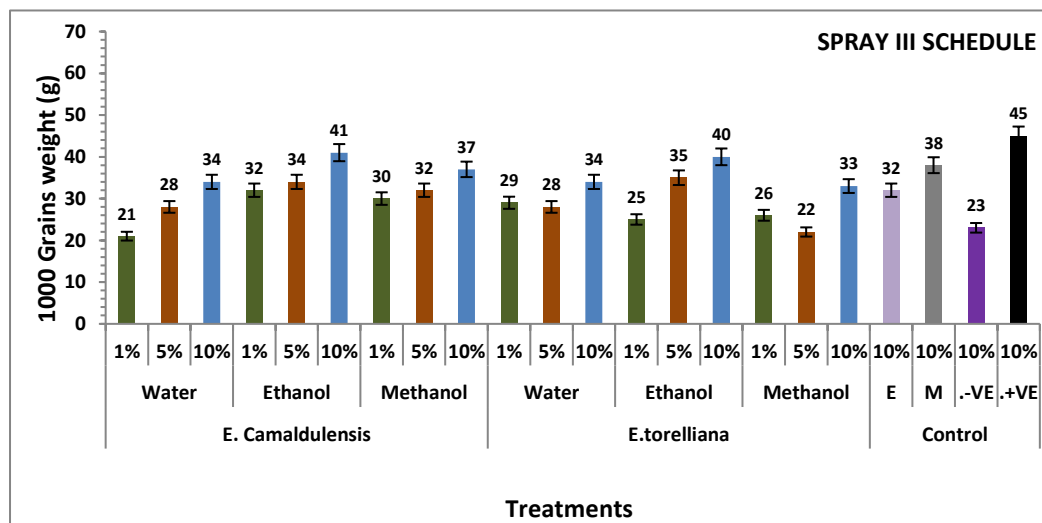
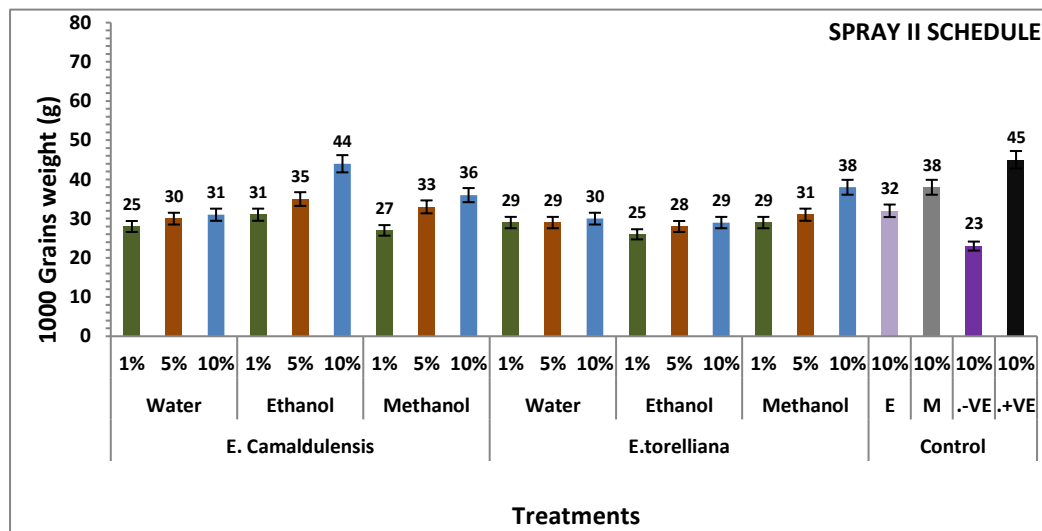
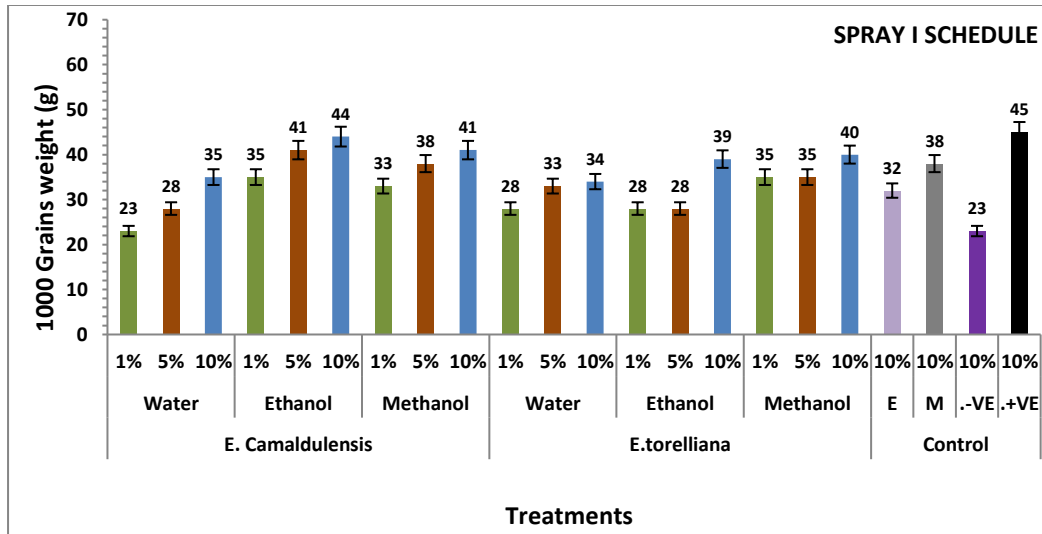


Fig. 06: Effects of different treatments on weight of 1000 grains under three spray schedules

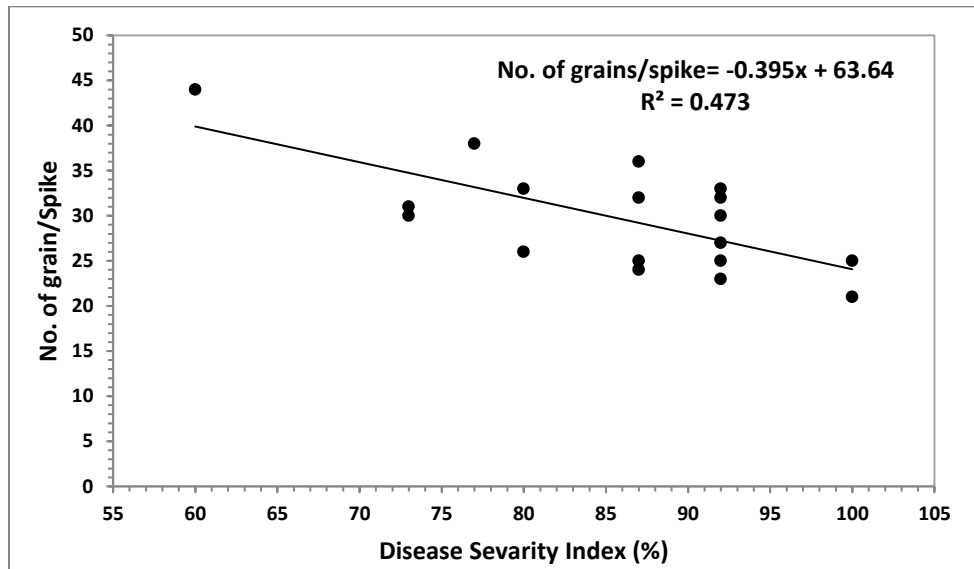


Fig. 07: Relationship between disease severity and number of grain/spike after treatments application in susceptible wheat variety

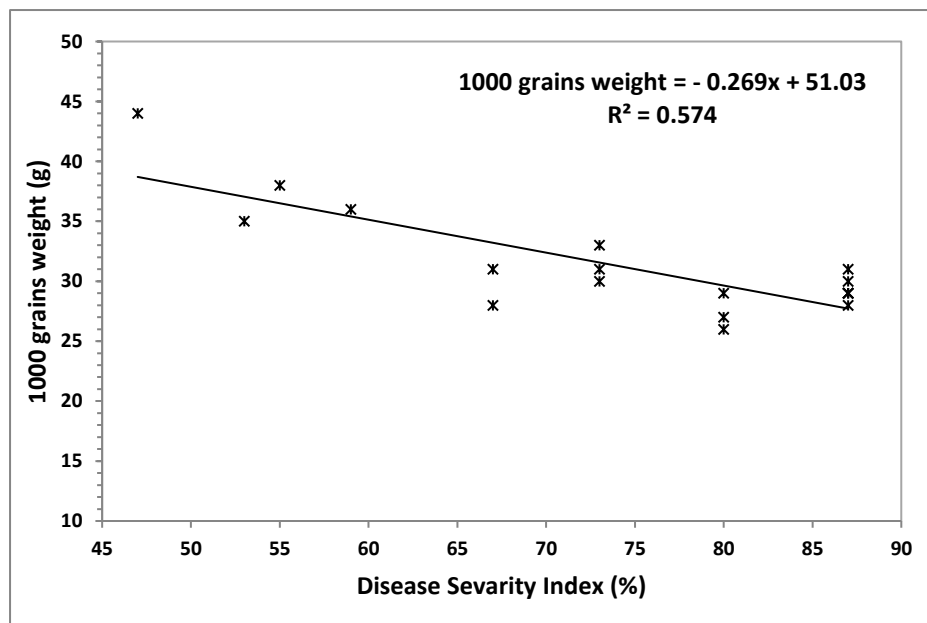


Fig. 08: Relationship between leaf infection severity and 1000- grain weight due to botanical applications in susceptible wheat variety