The Pharma Innovation Journal 2022; 11(5): 681-688

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(5): 681-688

www.thepharmajournal.com
Received: 15-03-2022
Accepted: 22-04-2022

Effect of vermicompost on yield, growth parameter and disease severity against spot blotch of wheat

Shivam Kumar, SK Biswas, Arshad Husain, Kishan Lal and Saurabh Kumar

Shivam Kumar
Department of Plant pathology, Chandra Shekhar Azad University of Agriculture and Technology. Kanpur, Uttar Pradesh, India

SK Biswas
Professor and Head, Department of Plant pathology, Chandra Shekhar Azad University of Agriculture and Technology. Kanpur, Uttar Pradesh, India

Arshad Husain
Department of Plant pathology, Chandra Shekhar Azad University of Agriculture and Technology. Kanpur, Uttar Pradesh, India

Kishan Lal
Department of Plant pathology, Chandra Shekhar Azad University of Agriculture and Technology. Kanpur, Uttar Pradesh, India

Saurabh Kumar
Department of Plant pathology, Chandra Shekhar Azad University of Agriculture and Technology. Kanpur, Uttar Pradesh, India

Corresponding Author:
SK Biswas
Professor and Head, Department of Plant pathology, Chandra Shekhar Azad University of Agriculture and Technology. Kanpur, Uttar Pradesh, India

Abstract
The effects of vermicompost with bio agent and bio fertilizer combinations as soil and foliar application with fungicide showed that the maximum shoot and root length of plant (cm) was recorded in T_{10} treatment as soil application with PGPR + Vermicompost (6gm+300gm) and two foliar spray with propiconazole at vegetative stage and booting stage representing 44.78 cm and 46.37cm of shoot length and 23.24 cm and 24.64 m of root length at 120 days after sowing during 2018-19 and 2019-20, respectively (Table 1). T_{10} treatment also effective on fresh weight of shoot and root as soil application with PGPR + Vermicompost (6gm+300gm) and two foliar spray with propiconazole at vegetative stage and booting stage, repersenting 7.67g and 7.98g of fresh weight of shoot and 2.18g and 2.32g of fresh weight of root, during 2018-19 and 2019-20, respectively. It has evident from the Table 2-3 showed that the maximum spike length as 12.20 cm and 14.97 cm was found in T_{10} treatment as soil application with PGPR + Vermicompost (6gm+300gm) and two foliar spray with propiconazole (vegetative stage and booting stage) during 2018-19 and 2019-20, respectively. Among the different treatments, highest grain yield per pot (g) and yield (q/ha) with 20.85g and 22.10g, and 41.70 q/ha and 44.20 q/ha was obtained in T_{10} treatment as soil application PGPR + vermicompost (6gm+300gm) and two foliar spray with propiconazole (vegetative stage and booting stage) during 2018-19 and 2019-20, respectively. The minimum disease severity was recorded in T_{10} treatment as soil application with PGPR + vermicompost (6gm+300gm) and two foliar spray with propiconazole (vegetative stage and booting stage) presenting 05.26 and 04.41 per cent during 2018-19 and 2019-20, respectively, which was followed by T_7 treatment (soil application with *T. harzianum* + Vermicompost (6gm+300 gm) and two foliar spray with propiconazole at vegetative stage and booting stage) presenting 06.70 and 06.42 per cent.

Keywords: Vermicompost, Bioagents, Disease severity, yield

Introduction
Wheat (*Triticum aestivum* L.) is belong to family Poaceae (Graminae) self-pollinated, C_3 and hexaploid plant. It is widely grown in temperate, irrigated dry, high rainfall, warm humid to cold region. Wheat crop considered as staple food in most of parts in the world. It ranked first among cereals in the word both in term of area and production. In India, wheat is the second most important food crop, after rice and so called as "King of cereals". According to Vavilow, the wheat have a multiple origin, the soft wheat have come from the mountains of Afghanistan and south-western Himalayas, the durum wheat from Abyssinia, Algeria and Greece and einkorn from Asia Minor. The archaeological evidences establish that the wheat has been cultivated for at least 6000 years ago. The many species of wheat together make up the genus *Triticum*. The wheat grains discovered as a result of Indus Valley excavations at Mohenjo-Daro indicate that north-western India was one of the ancestral lands of this cereal (Weber, 1998) [32]. About 91% of the total wheat production is contributed by northern states. Among them, Uttar Pradesh rank first in respect to area (9.645 m.ha.) and production of (30.00 m.t.) and but the average productivity (27.86 q/ha) is low as compare to Punjab and Haryana. The spot blotch pathogen was initially named as *Helmithosporium sorokinianum* Sacc. in Sorokin. Shoemaker (1959) [28] proposed the generic name *Bipolaris* for the Helminthosporium spices with fusoid, straight, or curved conidia, germinating by one germ tube from each end (Bipolar germination) and renamed the spot blotch pathogen as *Bipolaris sorokiniana* (sacc.) In eastern India under severe conditions the yield losses of wheat can reaches 100% (Pandey *et al*., 2005) [22]. Globally, an estimated 25 million ha of wheat cultivated land is affected by spot blotch disease (Van Loon *et al*. 1998; Snyder and Hansen, 1940) [31, 30]. The pathogen causes pre- and post-emergence damping off, seedling blight and root-rot but the major yield losses

are due to foliar blight phase of *D. sorokiniania*. The pathogen is responsible for 3-20% reduction in yield under different agro-climatic conditions (Nema and Joshi, 1971) [20]. The soil amendment and crop nutrition are most important for disease management like compost, FYM, green manure, vermicompost etc. organic amendments to promote sustainable agriculture. Fertile soils are crucial for sustainable food crop production. Few agricultural soils are naturally fertile, requiring regular addition of plant-essential nutrients such as nitrogen (N), phosphorus (P) and potassium (K) (Hilton & Dawson, 2011; Rathod *et al*., 2013) [9, 25]. On this content *Trichoderma viride*, *Chatomium globosum*, *T. Harzianum*, *Gliocladoum virens*, *Pseudomonas fluoresences* have been exploited for management of several diseases (Mondal *et al*., 2016, Agarwal *et al*., 2020; Mondal, G. and Aggarwal, R., 1995) [18, 2]. but biological control has some draw back that slight fluctuation of environmental conditions like temperature, humidity, sun light and rainfall, they are unable to manage the disease. Therefore, chemical application is the last and foremost important method for management of plant disease. Propiconazole was also found to be effective in reducing the level of disease and enhancing crop yield followed by Carbendazim and Hexaconazole (Yadav *et al*. 2015) [34]. Seed treatment with vitavax power @ 3g kg of seed followed by two spray of propiconazole @ 0.1% at the time of disease initiation on Flag -1 leaf and at soft dough stage were best and per cent disease intensity (39.03%) was minimum (Singh *et al*. 2017) [29]. But in case of chemical management of disease through bactericides and fungicides, have resulted in serious health implications to man and his environment. There is now overwhelming evidence that some of these chemicals do pose a potential risk to humans and other life forms and unwanted side effects to the environment (Forget, 1993; Igbedioh, 1991) [7, 12]. The application of vermicompost significantly enhanced the growth, yield of wheat and can reduce the synthetic specially urea fertilizer up to 25% (Yousefi and Sadeghi, 2014) [35]. The mixture of zinc sulphate and urea completely inhibition mycelial growth of *B. sorokiniana* and 78% growth inhibition of *A. triticia* (Chowdhury *et al.* 2017) [5]. A experiment was conducted using organic manure as fertilizer and to find out the comparative impact of organic manure, chemical fertilizer and their combination on the growth, production and quality of wheat on the black cotton soil (Sheikh and Dwivedi, 2018) [27]. Arsaln *et al.* (2020) [3] to evaluate the integrated impact of vermicompost (VC) and microbial inoculants on wheat yield and economics. The combined application of VC (vermicompost), PSB (Phosphorus Solubilising Bacteria) and recommended rate of fertilizer (RDF) increased the wheat yield over in control. According to them yield attributes i.e. no. of tillers m-2, spike length, no. of grains spike per spike also increased due to effect of combined application of FYM (Farm Yard Manure), VC (vermicompost), PSB (Phosphorus Solubilising Bacteria), recommended rate of fertilizer (RDF), Bio control agent and chemical.

Material and Methods

Laboratory as well as glasshouse experiments were undertaken at Department of Plant Pathology, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during 2018-2020. The procedures and techniques applied during the course of investigation were elucidated as below:-

Preparation of vermicomposting

Vermicompost was prepared by bed method, in which size of the bed was 5 meter long, 1 meter width and 0.5 meter deep. The place selected for vermicompost preparation unit is cool, moist and shady areas. The cow dung and spent mushroom substrate materials are mixed which is partially decomposition for 15 -20 days. A layer of Spent Mushroom Substrate (SMS) of about 15-20cm thickness was spread over the polythene sheet at the bottam of the bed. The earthworm (*Eisenia foetida*) of one kg was release upper layer of bad then sprinkle water on bed to maintain moisture content. The bed was covered with gunny bags to maintain the moisture level during dry condition, for their growth and reproduction. Aeration should be maintained for proper growth and reproduction. The moisture level of 30-40% and temperature of 18-25^{0}c was maintained for proper decomposition. Normally, the minimum 12 months are required to prepare good quality vermicompost. When harvesting of vermicompost, the materials was fully decomposed, show black colour and granular form and used for present investigation (Fig. 1-2).

Collection of diseased leaf samples

Wheat leaves showing characteristic blight symptoms were collected from Nawabganj Farm, C S Azad University of Agriculture and Technology, Kanpur. The samples were kept dry paper envelopes and brought to laboratory for isolation of pathogen. Each envelope was marked clearly to show details of the location, variety, crop growth stage, reaction type and date of collection etc. Excess surface moisture from the samples was dried by blotter paper and preserved at 6 to 8^{0}C for further study.

Sterilization of metal and glass wares

Clean inoculation needles were dipped in sprit and heated red thrice. Glass wares, such as, Petri dishes, culture tubes, funnels, glass rods, beakers and flasks etc., were cleaned in Chromic acid (Potassium di-chromate 60 g, concentrated Sulphuric acid 60 ml and water 100 ml) followed by thorough washing in running water. Dry glass wares were sterilized at 160^{0}C for 2 hrs. in an electric oven.

Preparation of medium

PDA medium consisting following composition was prepared and sterilized using method described by Johnston and Booth (1983) [13].

Peeled potato- 200g**,** Dextrose- 20g, Agar-agar- 20g, Distilled water- 1000 ml.

The peeled potato was cut in 12 mm cubes. Two hundred grams of potato cubes were rinsed in water and boiled for 20 minutes in 500 ml water. Potato broth was filtered through cheese cloth and kept in measuring cylinder. Agar was dissolved in 200 ml of water by slight heating and added to potato broth. Dextrose was added in it. The final volume was made up to 1000 ml by adding distilled water. The pH was adjusted to 7.0. The PDA was poured in test tube for preparation of PDA slant and also in flask. Then, prepared PDA media was sterilized at 15 psi for 20 minutes in an autoclave.

Experimental details

Application of vermicompost in Soil

The application of vermicompost in soil along with FYM, *Azotobacter*, *Trichoderma harzianum* and PGPR were used in different doses. The doses in FYM with vermicompost (200gm +200gm, 400gm +200gm, 200gm +400gm), *Azotobacter* with vermicompost (6gm +300gm, 4gm +200gm, 2gm +100gm), *T. harzianum* with vermicompost (6gm +300gm, 4gm +200gm, 2gm +100gm), PGPR with Vermicompost (6gm +300gm, 4gm +200gm, 2gm +100gm) and alone vermicompost as control (control-2) were used to conduct the experiment (Fig. 3).

Application of A*zotobactor* in Soil

In soil, *Azotobactor* with vermicompost were used in 3 treatments in different doses as 6gm+300gm, 4gm+200gm and 2gm+100gm in three replications and foliar spray of propiconazole at vegetative stage and booting stage.

Soil application with *T. harzianum*

Bioformulation of *T. viride* was applied @ 4gm applies in the soil. The sterilized soil was filled up in earthen pots having 30cm diameter. The soil was treated with the bioformulation of *T. viride* @ 4gm before filling the pots. The treated seeds were then sown in earthen pots and after 40 days of sowing, seedlings were inoculated with conidial suspension of *B. sorokiniana*.

Treatments detail.

T_1	Soil application with FYM + Vermicompost (200gm+200gm) and two foliar spray with propiconazole at vegetative stage and booting stage.
T_2	Soil application with FYM + Vermicompost (400gm+200gm) and two foliar spray with propiconazole at vegetative stage and booting stage.
T_3	Soil application with FYM + Vermicompost (200gm+400gm) and two foliar spray with propiconazole at vegetative stage and booting stage.
T_4	Soil application with *Azotobacter* + Vermicompost (6gm +300gm) and two foliar spray with propiconazole at vegetative stage and booting stage.
T_5	Soil application with *Azotobacter* + Vermicompost (4gm+200gm) and two foliar spray with propiconazole at vegetative stage and booting stage.
T_6	Soil application with *Azotobacter* + Vermicompost (2gm +100gm) and two foliar spray with propiconazole at vegetative stage and booting stage.
T_7	Soil application with *Trichoderma harzianum* + Vermicompost (6gm+300 gm) and two foliar spray with propiconazole at vegetative stage and booting stage.
T_8	Soil application with *T. harzianum* + Vermicompost (4gm+200 gm) and two foliar spray with propiconazole at vegetative stage and booting stage.
T_9	Soil application with *T. harzianum* + Vermicompost (2gm+100 gm) and two foliar spray with propiconazole at vegetative stage and booting stage.
T_{10}	Soil application with PGPR + Vermicompost (6gm+300 gm) and two foliar spray with propiconazole at vegetative stage and booting stage.
T_{11}	Soil application with PGPR + Vermicompost (4gm+ 200gm) and two foliar spray with propiconazole at vegetative stage and booting stage.
T_{12}	Soil application with PGPR + Vermicompost (2gm+100gm) and two foliar spray with propiconazole at vegetative stage and booting stage.
T_{13}	Without vermicompost (control-1)
T_{14}	Soil application with Vermicompost alone (control-2)

The observation pertaining the effect of different treatments was recorded as per following parameters.

I) Seed germination:- (a) Germination (%) (b) Emergence of seed (%) (c) Vigor index

II) Growth parameters:- (a) Shoot length (cm) (b) Root length (cm) (c) Fresh weight of Shoot (g) (d) Fresh weight of root (g) (e) Dry weight of Shoot (g) (f) Dry weight of root (g)

III) Disease development:- (i) Disease severity (%)

IV) Yield attributing characters and yield (a) Spike length (cm)(b) Number of grains/spikelet (c) Grain length (mm) (d) Grain weight (mm) (e) 1000-grain wt. (g) (f) Yield (g/pot) (g) Yield q/ ha

Measurement of disease severity

Observation to measure the disease severity of spot blotch was assessed of ten plants from each treatment separately at 40 days after sowing (DAS), 60 days after sowing (DAS) and 80 days of sowing (DAS). Disease severity was measured by using 0-5 scale formula described by Saari & Prescott (1975) [26].

Rating	Reaction Description
0	Free from infection
1	One or two spots on a few lower leaves of plants, covering nearly 1-10% of the surface area of the plant
2	A few isolated spots on leaves, covering nearly 11-25% of the surface area of the plant
3	Many spots coalesced on the leaves, covering 26-50% of the surface area of the plant
4	Irregular, spotted leaves and lesion with prominenton the leaves, covering 51-75% leaf area of the plant.
5	Whole plants leaves spotted with lesions and fall, covering more than 75% leaf area of plant

$$\text{Per cent Disease Severity} = \frac{\sum \text{Class rating} \times \text{Class Frequency}}{\text{Total no. of leaves} \times \text{Maximum class rating}} \times 100$$

Result and Discussion

The data on shoot and root length of plant (cm) of wheat at 120 days of plant as influenced by different treatments presented in the Table 1, Showed that the maximum shoot and root length of plant (cm) was recorded in T_{10} treatment as soil application with PGPR + Vermicompost (6gm+300gm) and two foliar spray with propiconazole at vegetative stage and booting stage representing 44.78 cm and 46.37cm of shoot length and 23.24 cm and 24.64 m of root length at 120 days after sowing during 2018-19 and 2019-20, respectively. The T_7 treatment as soil application with *T. harzianum* + Vermicompost (6gm+300gm) and two foliar spray with propiconazole at vegetative stage and booting stage representing 43.46cm and 45.15cm of shoot and 21.15cm and 22.87cm of root length indicating second highest among the treatments. The minimum shoot and root length of plant (cm) was recorded in T_{13} (Control-1), representing 28.46cm and 30.65cm of shoot and 11.35cm and 12.50cm of root length during 2018-19 and 2019-20, respectively. The maximum fresh weight of shoot and root per plant (g) were recorded in T_{10} treatment as soil application with PGPR + Vermicompost (6gm+300gm) and two foliar spray with propiconazole at vegetative stage and booting stage, repersenting 7.67g and 7.98g of fresh weight of shoot and 2.18g and 2.32g of fresh weight of root, during 2018-19 and 2019-20, respectively. The T_7 treatment (Soil application with *T. harzianum* +

Vermicompost (6gm+300gm) and two foliar spray with propiconazole at vegetative stage and booting stage, repersenting 7.45g and 7.82g fresh weight of shoot and 2.15g and 2.28g fresh weight root indicating second highest among the treatments which was followed by T_{11} treatment (soil application with PGPR+ Vermicompost (4gm+200gm) and two foliar spray with propiconazole at vegetative stage and booting stage, representing 7.20g and 7.77g fresh weight of shoot and 2.11g and 2.25g fresh weight root, during both the years. Maximum dry weight of shoot and root per plant (g) was found in T_{10} treatment (Soil application with PGPR+ Vermicompost (6gm+300gm) and two foliar spray with propiconazole at vegetative stage and booting stage as 3.96 g and 4.05 g of shoot and 1.25 g and 1.34 g of root against 1.75g and 1.84g of shoot and 0.51g and 0.54g of root in case of control-1 and control-2 during 2018-19 and 2019-20, respectively. The T_7 treatment as soil application with *T. harzianum*+ Vermicompost (6gm+300 gm) and two foliar spray with propiconazole (vegetative stage and booting stage) 3.90g and 3.98g of shoot and 1.18g and 1.26g of root found second highest among treatment followed by T_{11} treatment as soil application with PGPR + Vermicompost (4gm+200gm) and two foliar spray with propiconazole at vegetative stage and booting stage) 3.83g and 3.86g of shoot and 1.06g and 1.20g of root.

It has evident from the Table 2-3 showed that the maximum spike length as 12.20 cm and 14.97 cm was found in T_{10} treatment as soil application with PGPR + Vermicompost (6gm+300gm) and two foliar spray with propiconazole (vegetative stage and booting stage) during 2018-19 and 2019-20, respectively. Which was followed by T_7 treatment as soil application with *T. harzianum* + Vermicompost (6gm+300gm) and two foliar spray with propiconazole (vegetative stage and booting stage) representing 11.86cm and 13.56cm. The rest of the treatments were also showing superior over control-1 and control-2 but inferior to treatment T_{10} and T_7. (Table 2-3) showed that the highest spike weight was found in T_{10} treatment as soil application with PGPR + vermicompost (6gm+300gm) and two foliar spray with propiconazole (vegetative stage and booting stage) representing 3.54g and 3.92g against 1.95g and 2.15g in case of control-1 and 2.07g and 2.26g in case of control-2 during 2018-19 and 2019-20, respectively. The treatment T_7 (soil application with *T. harzianum* + Vermicompost (6gm+300 gm) and two foliar spray with propiconazole at vegetative stage and booting stage) representing 3.24g and 3.84g indicating second highest among the treatment during both the years. Among different treatments, the maximum grain length and grain width was recorded in value as 6.56, 3.33 and 7.60, 3.47 in T_{10} treatment (soil application with PGPR + Vermicompost (6gm+300gm) and two foliar spray with propiconazole at vegetative stage and booting stage), followed by 6.30, 3.28 and 7.37, 3.42 in T_7 treatment (soil application with *T. harzianum* + Vermicompost (6gm+300gm) and two foliar spray with propiconazole at vegetative stage and booting stage) during 2018-19 and 2019-20, respectively. The data on grain per spike was presented in Table 2-3, found that the highest grain/ spike was found in T_{10} treatment (soil application with PGPR + Vermicompost (6gm+300gm) and two foliar spray with Propiconazole at vegetative stage and Booting stage) repersenting 45.61 and 47.18 during 2018-19 and 2019-20, respectivly. The T_7 treatment as soil application with *T. harzianum* + Vermicompost (6gm+300 gm) and two foliar spray with propiconazole at vegetative stage and Booting stage) repersenting 42.52 and 45.87 second highest among the treatments, respectively. Data indicated that the maximum 1000 grain weight as 42.60g and 45.80g was found in T_{10} treatment as soil application with PGPR + Vermicompost (6gm+300gm) and two foliar spray with propiconazole (vegetative stage and booting stage) during 2018-19 and 2019-20, which was followed by T_7 treatment (Soil application with *T. harzianum* + vermicompost (6gm+300gm) and two foliar spray with propiconazole at vegetative stage and booting stage) indicating 40.85 and 43.33. The minimum 1000 Grain weight (g) was recorded as 34.04g and 35.10g in T_{13}- (Control-1) and 35.12 and 36.24 in T_{14}- (Control-2). Among the different treatments, highest grain yield per pot (g) and yield (q/ha) with 20.85g and 22.10g, and 41.70 q/ha and 44.20 q/ha was obtained in T_{10} treatment as soil application PGPR + vermicompost (6gm+300gm) and two foliar spray with propiconazole (vegetative stage and booting stage) during 2018-19 and 2019-20, respectively. This is increased by 63.27 and 44.09 per cent over control, respectively. The treatment T_7 (soil application with *T. harzianum* + Vermicompost (6gm+300 gm) and two foliar spray with propiconazole at vegetative stage and booting stage) indicating 19.97g and 21.22g, and 39.94 q/ha and 42.44 q/ha indicating second highest among the treatment which is also increased by 56.38 and 38.00 per cent during 2018-19 and 2019-20, respectively.

The minimum disease severity was recorded in T_{10} treatment as soil application with PGPR + vermicompost (6gm+300gm) and two foliar spray with propiconazole (vegetative stage and booting stage) presenting 05.26 and 04.41 per cent during 2018-19 and 2019-20, respectively, which was followed by T_7 treatment (soil application with *T. harzianum* + Vermicompost (6gm+300 gm) and two foliar spray with propiconazole at vegetative stage and booting stage) presenting 06.70 and 06.42 per cent. Among all the treatments the maximum disease severity (%) was recorded in T_{13}-(Control-1), representing 68.87 and 67.45 and in T_{14}-(Control-2), representing 55.46 and 54.17 during 2018-19 and 2019-20, respectively (Table 4). Biswas *et al*., (2015) [4] also found that seed treatment with bio-fertilizers *viz*., *Azotobacter chroococum*, PGPR, *T. harzianum*, *T. viride*, PSB, *Rhizobium*, significantly increased germination of wheat seed, seedling emergence and increased number of tiller per plant. PGPR helps in root expansion, improve uptake of plant nutrients, protects plants from root diseases and most important improves biomass production in the rhizosphere are found in almost all the crops (Kloepper *et al.*, 1989; Okon *et al.*, 1994; Glick *et al*., 1995) [14, 21, 8]. Singh *et al*. (2017) [29] revealed that the different bio-fertilizers alone or in combination with others as seed, soil and foliar spray have stimulatory effect on germination, sprouting behaviour and growth parameter with the best as soil application FYM @ 150gm/pot + Mustard cake @ 150 gram/pot + tuber treatment with *T. viride* + foliar spray with bio-formulation of *T. viride*. Morajdhwaj *et al.*, (2016) [19] also found that the IDM practices found best in stimulating germination, increase plant height of potato at different days after sowing. Prasad *et al.* (2017) [24] the high vigour index in wheat was observed after PGPR inoculation and the percent seed germination of wheat got augmented by two fold and vigour index observed was much higher. Kumar *et al.* (2021) [16] evaluated that the IDM practice also significantly increased the shoot and root length of linseed plant than untreated treatment (check). Hossain *et al.*, (2016) [10] reported that effect of seed treatment + foliar spray showed superior effect by BAU-Biofungicide including higher 1000-grain weight (43.92g) and grain yield (2.75 t/ha), foliar spray with Tilt showed 47.12g and 3.0 t/ha, respectively, 1000-grain weight and grain yield. Wroble (2009) [33] reported that the both soil and foliar applications of micronutrients were increased the wheat grain yield. Dibya *et al.* (2020) [6] evaluated that the maximum grain yield and maximum thousand seed weight was obtained from seed treatment with fungicide and 2 foliar sprays of propiconazole. Yadav *et al.* (2015) [34] reported that propiconazole especially have proven to be very effective against spot blotch disease and increased grain yield. Biswas *et al.*, (2015) [4] also reported that seed treatment and soil application with bio fertilizers of *Azotobacter* significantly increase grain and straw yield of wheat. Mehta, (2004) found that seed treatment, soil application of FYM and foliar application of neem seed extract is best for management of wheat rust. Use of fungicides *Viz* Propiconazole, Carbendazim, Tabuconazole with bio-agents *T. harzianum* and botanicals (Neem leaf extract and Neem cake extract) were found to be effective in reducing the disease incidence, severity of brown and yellow rust of wheat and increasing grain yield (Kumar, *et al.*, 2020) [15]. Paul *et al.* (2005) [23], reported Tilts and folicur are highly effective against wheat stem rust and brown rust when used as a part of an integrated management programmed. Husain (2021) [11] found that the minimum disease severity soil application of *Trichoderma* through FYM + seed treatment with *Azotobactor* +2 spray of Zinc (1st is CRI stage and 2nd at booting stage) of Rust of wheat. Singh *et al.* (2017) [29] results showed that the seed treatment with vitavax power @ 3 g kg of seed followed by two spray of propiconazole @ 0.1% at the time of disease initiation on flag -1 leaf and at soft dough stage were best to minimize disease intensity of wheat.

Table 1: Effect of vermicompost on growth parameters of wheat at 120 DAS under wire house condition.

Treatment	2018-19						2019-20					
	Plant length (cm.)		Fresh weight per Plant(g)		Dry Weight per Plant(g)		Plant length (cm.)		Fresh weight per Plant(g)		Dry Weight per Plant(g)	
	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root
T_1	36.16	15.46	5.10	1.75	2.34	0.78	38.12	16.78	6.18	1.81	3.11	0.84
T_2	40.78	17.28	6.96	1.95	3.78	0.95	42.25	20.40	7.69	2.14	3.82	1.10
T_3	32.18	13.37	4.80	1.24	2.09	0.62	33.53	14.12	4.54	1.37	2.25	0.65
T_4	34.87	14.28	4.82	1.58	2.15	0.66	35.60	14.44	5.12	1.60	2.58	0.69
T_5	38.39	17.15	6.36	1.92	3.66	0.90	40.53	20.28	6.75	2.10	3.76	0.96
T_6	35.86	14.69	5.90	1.70	2.27	0.75	36.89	16.66	6.05	1.68	2.96	0.77
T_7	43.46	21.15	7.45	2.15	3.90	1.18	45.15	22.87	7.82	2.28	3.98	1.26
T_8	36.29	16.54	5.16	1.82	3.45	0.86	38.85	17.21	6.37	1.95	3.54	0.90
T_9	35.75	14.41	5.86	1.64	2.18	0.69	36.72	15.11	5.28	1.65	2.64	0.74
T_{10}	44.78	23.24	7.67	2.18	3.96	1.25	46.37	24.54	7.98	2.32	4.05	1.34
T_{11}	41.58	20.86	7.20	2.11	3.83	1.06	45.92	21.34	7.77	2.25	3.86	1.20
T_{12}	36.45	16.80	6.28	1.88	3.57	0.88	40.28	18.15	6.54	1.97	3.68	0.92
T_{13} (Control-1)	28.46	11.35	3.45	1.04	1.75	0.51	30.65	12.50	3.60	1.15	1.84	0.54
T_{14} (Control-2)	30.14	12.28	3.78	1.20	1.87	0.56	31.08	13.37	4.10	1.26	2.16	0.58
SE (m)	0.925	0.660	0.228	0.141	0.168	0.044	1.155	0.771	0.415	0.156	0.178	0.060
SE (d)	1.309	0.933	0.322	0.199	0.238	0.063	1.633	1.091	0.587	0.220	0.252	0.085
CD	2.682	1.913	0.660	0.411	0.487	0.134	3.346	2.235	1.202	0.451	0.518	0.178

T_1 = Soil application with FYM + Vermicompost (200gm+200gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_2= Soil application with FYM + Vermicompost (400gm+200gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_3= Soil application with FYM + Vermicompost (200gm+400gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_4= Soil application with *Azotobacter* + Vermicompost (6gm +300gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_5= Soil application with *Azotobacter* + Vermicompost (4gm+200gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_6= Soil application with *Azotobacter* + Vermicompost (2gm +100gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_7= Soil application with *T. harzianum* + Vermicompost (6gm+300 gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_8= Soil application with *T. harzianum* + Vermicompost (4gm+200 gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_9= Soil application with *T. harzianum* + Vermicompost (2gm+100 gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_{10}= Soil application with PGPR + Vermicompost (6gm+300 gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_{11}= Soil application with PGPR + Vermicompost (4gm+ 200gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_{12}= Soil application with PGPR + Vermicompost (2gm+100gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_{13}= Without vermicompost (control-1). T_{14}= Soil application with Vermicompost alone (control-2).

Table 2: Effect of vermicompost on yield parameters of wheat after harvesting under wire house condition during year 2018-19.

Treatment	2018-19										
	Spike length (cm)	Spike weight (g)	Number of spikelet's / plant	Grain length (mm)	Grain width (mm)	No. of grain / spike	Test weight (g)	Grain Yield / Pot (g)	Yield q/ha	Yield increase over control-1 (%)	Yield increase over control-2 (%)
T_1	08.43	2.76	17.95	5.36	2.44	36.68	36.65	18.34	36.68	43.61	26.74
T_2	10.41	2.81	18.84	5.78	3.20	40.85	39.86	19.06	38.12	49.25	31.72
T_3	07.59	2.14	15.67	5.07	2.07	32.62	35.30	15.59	31.18	22.08	07.74
T_4	07.64	2.44	16.35	5.12	2.12	33.20	35.48	15.90	31.80	24.51	09.88
T_5	10.23	2.97	18.68	5.73	3.05	39.33	39.44	19.43	38.86	52.15	34.27
T_6	08.11	2.65	17.21	5.24	2.40	35.57	36.33	17.86	35.72	39.85	23.42
T_7	11.86	3.24	20.67	6.30	3.28	42.52	40.85	19.97	39.94	56.38	38.00
T_8	09.64	2.82	18.05	5.53	2.65	38.18	38.27	18.74	37.48	46.75	29.50
T_9	07.89	2.59	16.73	5.20	2.23	33.84	36.10	17.30	34.60	35.47	19.55
T_{10}	12.20	3.54	21.33	6.56	3.33	45.61	42.60	20.85	41.70	63.27	44.09
T_{11}	11.55	3.00	20.18	6.27	3.22	41.08	40.46	19.63	39.26	53.71	35.65
T_{12}	09.87	2.81	18.25	5.70	2.87	38.65	38.76	18.88	37.76	47.84	30.47
T_{13} (Control-1)	07.10	1.95	13.20	4.70	1.90	30.33	34.04	12.77	25.54	-	-
T_{14} (Control-2)	07.43	2.07	14.38	4.93	2.05	32.17	35.12	14.47	28.94	13.31	-
SE (m)	0.220	0.091	0.362	0.054	0.018	0.771	0.409	0.361	0.669	-	-
SE (d)	0.311	0.129	0.512	0.077	0.025	1.091	0.578	0.510	0.946	-	-
CD	0.639	0.263	1.050	0.160	0.089	2.235	1.185	1.046	1.940	-	-

T_1 = Soil application with FYM + Vermicompost (200gm+200gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_2= Soil application with FYM + Vermicompost (400gm+200gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_3= Soil application with FYM + Vermicompost (200gm+400gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_4= Soil application with *Azotobacter* + Vermicompost (6gm +300gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_5= Soil application with *Azotobacter* + Vermicompost (4gm+200gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_6= Soil application with *Azotobacter* + Vermicompost (2gm +100gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_7= Soil application with *T. harzianum* + Vermicompost (6gm+300 gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_8= Soil application with *T. harzianum* + Vermicompost (4gm+200 gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_9= Soil application with *T. harzianum* + Vermicompost (2gm+100 gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_{10}= Soil application with PGPR + Vermicompost (6gm+300 gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_{11}= Soil application with PGPR + Vermicompost (4gm+ 200gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_{12}= Soil application with PGPR + Vermicompost (2gm+100gm) and two foliar spray with propiconazole at vegetative stage and booting stage. T_{13}= Without vermicompost (control-1). T_{14}= Soil application with Vermicompost alone (control-2).

Table 3: Effect of vermicompost on yield parameters of wheat after harvesting under wire house condition during year 2019-20.

Treatment	2019-20										
	Spike length (cm)	Spike weight (g)	Number of spikelet's/ plant	Grain length (mm)	Grain width (mm)	No. of grain/ spike	Test weight (g)	Grain Yield /Pot (g)	Yield q/ha	Yield increase over control-1 (%)	Yield increase over control-2 (%)
T_1	09.40	3.10	17.86	6.05	2.83	38.56	38.43	18.66	37.32	39.25	23.41
T_2	12.47	3.68	21.24	6.63	3.37	42.64	41.30	20.44	40.88	52.53	35.18
T_3	08.26	2.48	16.25	5.64	2.50	35.18	36.33	16.43	32.86	22.61	08.66
T_4	08.54	2.63	16.96	5.78	2.51	35.47	36.89	16.70	33.40	24.62	10.44
T_5	11.20	3.63	20.10	6.47	3.30	42.35	39.56	19.65	39.30	46.64	29.96
T_6	09.25	2.85	17.72	5.93	2.67	37.69	38.20	17.95	35.92	34.02	18.78
T_7	13.56	3.84	22.80	7.37	3.42	45.87	43.33	21.22	42.44	58.35	40.34
T_8	09.73	3.28	18.57	6.20	2.97	40.78	38.80	18.96	37.92	41.38	25.39
T_9	08.73	2.80	17.25	5.82	2.97	37.04	37.76	17.32	34.64	29.25	14.55
T_{10}	14.97	3.92	24.96	7.60	3.47	47.18	45.80	22.10	44.20	64.92	46.16
T_{11}	12.64	3.72	21.37	7.20	3.39	45.52	42.86	20.86	41.72	55.67	37.96
T_{12}	10.05	3.42	18.70	6.33	3.14	42.10	39.12	19.10	38.20	42.53	26.32
T_{13} (Control-1)	07.40	2.15	14.18	5.00	2.10	32.52	35.10	13.40	26.80	-	-
T_{14} (Control-2)	07.60	2.26	15.65	5.36	2.33	33.54	36.24	15.12	30.24	12.83	-
SE (m)	0.237	0.104	0.494	0.073	0.051	0.925	0.463	0.385	0.771	-	-
SE (d)	0.335	0.148	0.698	0.103	0.073	1.309	0.654	0.545	1.091	-	-
CD	0.688	0.304	1.430	0.210	0.147	2.682	1.341	1.117	2.235	-	-

T_1 = Soil application with FYM + Vermicompost (200gm+200gm) and two foliar spray with propiconazole at vegetative stage and booting stage.$T_{2=}$ Soil application with FYM + Vermicompost (400gm+200gm) and two foliar spray with propiconazole at vegetative stage and booting stage. $T_{3=}$ Soil application with FYM + Vermicompost (200gm+400gm) and two foliar spray with propiconazole at vegetative stage and booting stage. $T_{4=}$ Soil application with *Azotobacter* + Vermicompost (6gm +300gm) and two foliar spray with propiconazole at vegetative stage and booting stage. $T_{5=}$ Soil application with *Azotobacter* + Vermicompost (4gm+200gm) and two foliar spray with propiconazole at vegetative stage and booting stage. $T_{6=}$ Soil application with *Azotobacter* + Vermicompost (2gm +100gm) and two foliar spray with propiconazole at vegetative stage and booting stage. $T_{7=}$ Soil application with *T. harzianum* + Vermicompost (6gm+300 gm) and two foliar spray with propiconazole at vegetative stage and booting stage. $T_{8=}$ Soil application with *T. harzianum* + Vermicompost (4gm+200 gm) and two foliar spray with propiconazole at vegetative stage and booting stage. $T_{9=}$ Soil application with *T. harzianum* + Vermicompost (2gm+100 gm) and two foliar spray with propiconazole at vegetative stage and booting stage. $T_{10=}$ Soil application with PGPR + Vermicompost (6gm+300 gm) and two foliar spray with propiconazole at vegetative stage and booting stage. $T_{11=}$ Soil application with PGPR + Vermicompost (4gm+ 200gm) and two foliar spray with propiconazole at vegetative stage and booting stage. $T_{12=}$ Soil application with PGPR + Vermicompost (2gm+100gm) and two foliar spray with propiconazole at vegetative stage and booting stage. $T_{13=}$ Without vermicompost (control-1). $T_{14=}$ Soil application with Vermicompost alone (control-2).

Table 4: Impact of vermicompost alone or in combination on disease severity of spot blotch of wheat.

Treatment	2018-19 Disease Severity (%)					2019-20 Disease Severity (%)				
	40 days	60 days	80 days	Disease severity (%) decrease over control-1	Disease severity (%) decrease over control-2	40 days	60 days	80 days	Disease severity (%) decrease over control-1	Disease severity (%) decrease over control-2
T_1	08.05	18.92	33.60	51.21	39.41	07.38	18.30	31.46	53.35	41.92
T_2	06.76	12.50	20.12	70.78	63.72	05.52	10.76	19.74	70.73	63.55
T_3	10.49	25.67	43.32	37.09	21.88	10.10	26.05	40.34	40.19	25.53
T_4	09.94	25.21	42.70	37.99	23.00	09.49	24.40	39.58	41.31	26.93
T_5	07.10	13.74	20.50	70.23	63.03	06.23	12.18	21.50	68.12	60.31
T_6	09.28	20.75	35.38	48.62	36.20	08.41	18.92	33.69	50.05	37.80
T_7	03.53	04.90	06.70	90.27	87.91	03.47	04.24	06.42	90.48	88.14
T_8	07.56	16.17	29.51	57.15	46.79	06.70	15.62	28.30	58.04	47.75
T_9	09.67	22.18	40.93	40.56	26.19	08.74	21.76	38.87	42.37	28.24
T_{10}	02.26	04.57	05.26	92.36	90.51	02.05	03.75	04.41	93.46	91.85
T_{11}	05.57	06.26	08.54	87.59	84.60	04.80	05.37	07.92	88.25	85.37
T_{12}	07.23	15.86	28.43	58.71	48.73	06.86	14.37	26.72	60.38	50.67
T_{13}(Control-1)	12.44	32.12	68.87	-	-	12.28	28.34	67.45	-	-
T_{14}(Control-2)	11.40	28.96	55.46	19.47	-	11.04	26.07	54.17	19.68	-
SE(m)	0.617	1.234	2.006	-	-	0.676	1.388	2.315	-	-
SE(d)	0.872	1.745	2.836	-	-	0.955	1.963	3.272	-	-
CD	1.788	3.577	5.812	-	-	1.958	4.024	6.706	-	-

References

1. Abbasi MK, Sharif S, Kazmi M, Sultan T, Aslam M. Isolation of plant growth promoting rhizobacteria from wheat rhizosphere and their effect on improving growth, yield and nutrient uptake of plants. Plant Biosyst. 2011;145:159-168.
2. Agarwala M, Singhb A, Arjariac S, Sinhad A, Gupta S. Tomato Leaf Disease Detection using Convolution Neural Network. International Conference on Computational Intelligence and Data Science (ICCIDS), Procedia Computer Science. 2020;167:293-301.
3. Arsaln M, Sarwar S, Latif R, Chauhdary JN, Yousra M, Ahmad S. Effect of vermicompost and microbial inoculants on yield, soil fertility and economics of wheat under rainfed conditions. Pakistan Journal of Agricultural Research. 2020;33(4):858-865.
4. Biswas SK, Shankar U, Kumar S, Kumar A, Kumar V, Lal K. Impact of bio-fertilizers for the management of spot blotch disease and growth and yield contributing parameters of wheat. Journal of Pure and Applied Microbiology. 2015;9(4):3025-3031.
5. Chowdhary AK, Bhattacharya PM, Bandyopadhyay S, Dhar T. Holistic management of foliar blight disease of Wheat and Barley, Department of Plant Pathology, *Uttar Banga Krishi Viswavidyalaya*, Pundibari, West Bengal, 2017, 14-15.
6. Dibya Singh SP, Kumar S, Singh S, Maurya MK, Ali I. Management of spot blotch disease of wheat in Eastern Uttar Pradesh. International Journal of Chemical Studies. 2020;8(6):1457-1461.
7. Forget G. Balancing the need for pesticides with the risk to human health. Forget, G; Goodman, T; de Villiers, A.; eds. Impact of Pesticide Use on Health in Developing Countries. *I.D.R.C.*, Ottawa, 1993.
8. Glick BR. Plant Growth-Promoting Bacteria: Mechanisms and Applications. Scientifica, 2012, 15.
9. Hilton J, Dawson CJ. Fertilizer availability in a resource-limited world, Production and recycling of nitrogen and phosphorus, Food Policy. 2011;36:14-22.
10. Hossain M, Hossain I, Khalequzzaman KM. Effect of seed treatment with biological control agent against Bipolarisleaf blight of wheat. Int. J. Scien. Res. Agric. Sci. 2016;2(7):151-158.
11. Husain A, Biswas SK, Kumar S, Kumar R, Salman Moh, Kumar S. Effect of integrated disease management (Module) on yield and disease incidence of wheat against brown rust of wheat (Triticum aestivum L.). The Pharma Innovation Journal. 2021;10(7):108-112.

12. Igbedioh SO. Effects of agricultural pesticides on humans, animals and higher plants in developing countries. Arch. Environ. Health. 1991;46:218.
13. Johnston A, Booth C. Plant pathologist's pocketbook. 2 nd ed. Commonwealth Agricultural Bureaux, The Commonwealth Mycological Institute, Kew, 1983.
14. Kloepper JW, Schroth MN, Miller TD. Effects of rhizosphere colonization by plant growth promoting rhizobacteria on potato plant development and yield. Ecol. Epidemiol. 1980;70:1078-1082.
15. Kumar B, Suman H, Madakemohekar AH, Tamatam D. Combining ability and Heterosis analysis for grain yield and yield associated traits in Pea (*Pisum sativum* L.). Legume Research-An International Journal. 2020;43(1):25-31.
16. Kumar N, Biswas SK, Shukla A. Integrated disease management (IDM) approaches for management of Alternaria blight disease in linseed (*Linum usitatissimum* L.) caused by *Alternaria lini* Dey. The Pharma Innovation Journal. 2021;10(4):314-319
17. Mondal G, Srivastava KD, Aggarwal R. Antagonistic effect of Trichoderma spp. on *Ustilago segetum* var.*tritici* and their compatibility with fungicides and biocides. Indian Phytopath. 1995;48(4):466-470.
18. Mondal KK. Emerging Phytobacterial Diseases in India: Research Status and Challenges. Today & Tomorrow's Printers and Publishers, New Delhi, 2016.
19. Morajdhwaj Singh, Biswas SK, Lal K, Singh J, Naresh P. Development of suitable package using bio-fertilizers for management of late blight of potato under climate change, Journal of Pure and Applied Microbiology. 2016;10(1):761-765.
20. Nema KG, Joshi LM. The spot blotch disease of wheat caused by Helminthosporium sativum. Proceedings of the 2nd International Symposium on Plant Pathology, January 27-February 3, 1971, IARI., New Delhi, 1971, 42.
21. Okon Y, Labandera-Gonzalez CA. Agronomic applications of *Azospirillum*. In: Ryder, M.H., Stephens, P.M. and Bowen, G.D., editors. Improving Plant Productivity with Rhizosphere Bacteria. Adelaide, Australia, Common Wealth Scientific and Industrial Research Organization, 1994, 274-8.
22. Pandey SP, Kumar S, Kumar U, Chand R, Joshi AK. Sources of inoculum and reappearance of spot blotch of wheat in rice-wheat cropping systems in eastern India. European Journal of Plant Pathology. 2005;111:47-55.
23. Paul PA, Lipps PE, Madden LV. Relationship between visual estimates of Fusarium head blight intensity and deoxynivalenol accumulation in harvested wheat grain: A meta-analysis. Phytopathology. 2005;95:1225-1236.
24. Prasad JK, Gupta SK, Raghuwanshi Richa. Research Article Screening Multifunctional Plant Growth Promoting Rhizobacteria Strains for Enhancing Seed Germination in Wheat (*Triticum aestivum* L.), Int. J. Agric. Res. 2017;12:64-72.
25. Rathod DD, Rathod PH, Patel KP, Patel KC. Integrated use of organic and inorganic inputs in wheat-fodder maize cropping sequence to improve crop yields and soil properties. Archives of Agronomy and Soil Science. 2013;59(11):1439-1455.
26. Saari EE, Prescott JM. A scale for appraising the foliar intensity of wheat diseases. Plant Disease Report. 1975;59:377-80.
27. Sheikh MA, Dwivedi P. - Response of Wheat (*Triticum aestivum* L.) to Organic manure and Chemical fertilizer, Thesis, Research scholar Department of Botany, Govt. Madhav Science PG College Ujjain, M.P, 2018.
28. Shoemaker A. Nomenclature of *Dreehslera* and *Bipolaris*, grass parasites segregated from Helminthosporium, Canadian Journal of Botany. 1959;37:879-87.
29. Singh CK, Singh D, Singh RK, Chaudhary AK, Kumar RR. Effect of chemicals and bioagent on spot blotch disease of wheat (*TriticumaestivumL*.), Int. J. Bio-Resources & Stress Man. 2017;7:712-715.
30. Snyder WC, Hansen HW. The species concept in Fusarium. Am. J. Bot. 1940;27:64-67.
31. Van Loon LC, Bakker PAHM, Pieterse CMJ. Systemic resistance induced by rhizosphere bacteria. Annu. Rev. Phytopathol. 1998;36:453-483.
32. Weber S. Seeds of urbanism, paleoethnobotany and the Indus Civilization, department of Anthropology. Washington State University. 1999;73:813-26.
33. Wroble S. Response of spring wheat to foliar fertilization with boron under reduced boron availability. J. Elementol. 2009;14:395-404.
34. Yadav B, Singh R, Kumar A. Management of spot blotch of wheat using Fungicides, Bio-agents and Botanicals, Department of Plant Pathology, Afri. J. Agril. Rese. 2015;10(25):2494-2500.
35. Yousefi AA, Sadeghi M. Effect of vermicompost and urea chemical fertilizers on yield and yield components of wheat *(Triticum aestivum)* in the field condition, Interl. J. of Agri. and Crop Sci, 2014, 1227-1230.