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Evaluation of Plant Activator and Chemical Fungicides on Leaf Blight (*Bipolaris sorokiniana*) Development and Yield of Wheat

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Abstract: Bion 50 WG (Benzothiodiazole), Tilt-250 EC (Propiconazole) and Amistar (Azoxystrobin) either alone and some of their combinations were evaluated against leaf blight/spot (*Bipolaris sorokiniana*) development and yield of wheat. All the treatments significantly reduced leaf spot reaction of wheat over untreated control. But Bion in combination with Amistar resulted significantly highest reduction of leaf spot reaction of wheat ($p = 0.05$) against all the tested pathotypes inoculated at flag leaf stage. In the field, Bion reduced leaf spot severity at heading and flowering stage in 2000-2001 and at hard dough stage in 2001-2002. Number of grains/ear not significantly increased by treating seeds with Bion though 1000-grain weight is significantly increased ($p = 0.05$) in 2000-2001 by Bion. Statistically higher grain yield was obtained from the experimental plot by treating seeds with Bion and Amistar. Bion resulted 53.33% higher grain yield in compare to untreated control.

Key words: Wheat, leaf blight, *Bipolaris sorokiniana*, Bion, Tilt, Amistar

INTRODUCTION

Wheat is considered as one of the most important cereal crops in the world. There are several constraints to the world wheat production. Among them leaf spot/blight caused by *Bipolaris sorokiniana* (Syn. *Cochliobolus sativus*) is the major and devastating disease of wheat in Bangladesh (Hossain and Azad, 1992). Hossain *et al.* (1998) reported that this disease reduced yield up to 40% in field condition whereas Bazlur Rashid and Fakir (1998) estimated yield reduction of wheat due to Bipolaris leaf blight was 57 and 65% in Kanchan and Sonalika varieties, respectively. Numerous reports have stressed the importance of HLB (Helminthosporium leaf blight) and in particularly, spot blotch caused by *Cochliobolus sativus* as major biotic constraint to wheat growing in warmer areas (Dubin and van Ginkel, 1991; Hetzler *et al.*, 1991). Mehta (1997) reported that spot blotch of wheat caused by *Bipolaris sorokiniana* adversely affect germination, development of the root system and kill the seedlings within a few days and capable of causing up to 100% yield loss.

In the last decades, a number of systemic fungicides with different modes of action and targets have been developed to reduce the losses caused by the diseases (Pasquer *et al.*, 2005). Management of leaf Blight is difficult as the fungus is seed-borne, soil borne as well as air borne. But some strategies have been made to combat this disease namely fungicidal spray, use of partially resistant varieties, sowing healthy seeds, choice of sowing date etc. (Hetzler *et al.*, 1991; Villareal *et al.*, 1995; Mahto, 1999; Hossain and Hossain, 2001). Several chemicals other than fungicides such as Bion (Benzothiadiazole), Salicylic acid and Isonicotinic acid have been found effective in inducing Systemic Acquired Resistance (SAR) in plants against pathogens (Agrios, 1997). Previous works showed the importance of Bion in inducing resistance to wheat and barley against powdery mildew (Pasquer *et al.*, 2005; Glazek and Krzyzinska, 1999; Jonczyk and Smagacz, 1999; Stadnik and Buchenauer, 1999; Jorgensen *et al.*, 1997). Strobilurins (Amistar) currently represent 10% of the fungicide market and are used by farmers to control fungal pathogens such as powdery mildew and rusts. Besides their anti-fungal action, strobilurins are also known for their greening effect on the crop which is defined as delayed leaf senescence and an increased grain filling period (Bartlett *et al.*, 2002). Tilt is very common fungicide to control leaf blight in Bangladesh. Use of Bion and Amistar against leaf blight (*Bipolaris sorokiniana*) of wheat is completely a new work in the country. The objective of this work was to investigate the effectiveness of Bion Tilt

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and Amistar either alone and some of their combinations against *Bipolaris sorokiniana*, the causal agent of leaf blight of wheat.

MATERIALS AND METHODS

Test site: The laboratory experiment was carried out in the Seed Pathology Center, Department of Plant Pathology, Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh. The field trial was carried out at the Field Laboratory, Department of Plant Pathology, BAU, Mymensingh, Bangladesh during 2000-2001 and 2001-2002 wheat growing seasons. The soil of the experimental plot was sandy loam in texture belonging to Old Brahmaputra Flood plain under Agro Ecological Zone 9.

Laboratory experiment:

Preparation of inoculum: Three virulent pahotype of *Bipolaris sorokiniana* (S-HS-2-3-4-5-6-7, MS-HS-2-6 and MS-S-3-5-8-9-10-12) were used in this study. The pathotypes were identified in 1999-2000 from Bangladesh (Aminuzzaman, 2004; Aminuzzaman and Hossain, 2005). Inocula were prepared following the CIMMYT method (Gilchrist, 1984). The conidia of *Bipolaris sorokiniana* were collected from 10 day old PDA culture incubated at 22-24°C under alternate cycle of NUV and normal light (12/12 h) and conidial suspension were prepared with sterilized water. The suspension was sieved through a double layer of cheese cloth to remove mycelial fragments and conidiophores. One drop of tween-20 (Polyoxyethylene 20 sorbitan monolaurate) was added to the suspension to maintain uniform dispersion of conidia in suspension. The concentration of conidial suspension was adjusted to 6×10^4 conidia p mL^{-1} as reported by Hossain and Azad (1992).

Treatment used: There were 15 treatment combination which were as follows:

T_1 = Control,
T_2 = Bion @ 50 mg p L^{-1},
T_3 = Bion @ 25 mg p L^{-1},
T_4 = Tilt @ 0.1%,
T_5 = Tilt @ 0.05%,
T_6 = Amistar @ 0.1%,
T_7 = Amistar @ 0.05%,
T_8 = Tilt @ 0.1% + Bion @ 50 mg p L^{-1},
T_9 = Tilt @ 0.1% + Bion @ 25 mg p L^{-1},
T_{10} = Tilt @ 0.05% + Bion @ 50 mg p L^{-1},
T_{11} = Tilt @ 0.05% + Bion @ 25 mg p L^{-1},
T_{12} = Amistar 0.1% + Bio n @ 50 mg p L^{-1},
T_{13} = Amistar @ 0.1% + Bion @ 25 mg p L^{-1},
T_{14} = Amistar @ 0.05% + Bion @ 50 mg p L^{-1} and
T_{15} = Amistar @ 0.05% + Bion @ 25 mg p L^{-1}.

Laboratory assay of leaf spot reaction: Under this experiment the seeds were treated as per treatment combination for 6 h by dipping method and allowed to dry up on filter paper for 12 h. The treated seeds were sown in pots, where the pot soil contains soil and compost in 4:1 ratio. Plants of three leaf stages were inoculated with a spore suspension (6×10^4 spore p mL^{-1}) using a self-compressed hand sprayer (Hossain and Azad, 1992). Then pots were covered with previously moistened plastic bags for 24 h in darkness. Continuous misting was provided by humidifiers during every 20 min interval. Inoculated leaves were then cut into pieces (8 cm). The cut pieces were placed on Benzimidazole agar medium (150 mg Benzimidazole in 1000 ml of 1% water agar) and incubated at 25°C for 5 days. After incubation on Benzimidazole agar, percent Leaf Area Diseased (LAD) for each leaf segment was measured.

Field experiment

Land preparation: The experimental plot was prepared by thoroughly ploughing followed by laddering to have a good tilth and finally the land was properly leveled before sowing. Weeds and stubbles were removed from the field. Fertilizers and manures were applied to the field as per recommendation of BARC (1997). The sources of fertilizers used for N, P, K, S and Zn were urea, TSP, MP, Gypsum and Zinc oxide. The full dose of TSP, MP, Gypsum and Zinc oxide were applied at final land preparation before sowing. Urea was applied in three splits, the first split was applied during final land preparation, and the second and third splits were applied at active tillering stage and panicle initiation stage, respectively. Cow dung @ 10 ton p ha^{-1} was applied during final land preparation. The experiments were laid out in RCBD having three replication for each treatment. The individual plot size was 1×1 m. There were six rows in each unit plot having 15 cm distance between the rows. There were 15 treatment combinations as described above. Block to block and plot to plot distances were 1 and 1 m, respectively.

Seed sowing: Kanchan a popular variety of wheat was used in this experiment. Seeds were treated with inducer as well as with different chemical combinations for 6 h and then were allowed to dry up on filter paper for 12 h. Seeds for each plot were sown at the rate of 120 kg p ha^{-1} The seeds were sown in the field continuously in lines and were covered by soil with the help of hand.

Intercultural operations: The field micro plots were irrigated twice. First irrigation was performed at maximum tillering stage and second irrigation was done at panicle

initiation stage. Weeding was done twice; Firstly at 25 days after sowing and secondly at 45 days after sowing.

Recording data on disease severity: Leaf blight severity was determined at three growth stages of plant namely, heading stage, flowering stage and hard dough stage. Evaluation of leaf blight severity was done by double digit scale of Saari and Prescott (1975) as used by Goel *et al.* (1999). The first digit (D1) indicates the disease progress in height of the plant in 0-9 scale. The second digit (D2) represents the percentage area covered by the blight pathogen on the flag leaf and one below it, which is as follows: 10% = 1, 20% = 2, 30% = 3, 40% = 4, 50% = 5, 60% = 6, 70% = 7, 80% = 8, 90% = 9. Data on yield contributing characters were determined following the method of Hossain and Azad (1992). Data was collected from 18 tagged plants of each unit of plot.

Analysis of data: The data on various parameters were analyzed using analysis of variance to find out variation obtained from different treatments. Treatment means were compared by DMRT.

RESULTS AND DISCUSSION

Laboratory experiments: In case of pathotype S-HS-2-3-4-5-6-7 the highest and lowest % leaf area diseased was recorded under the treatment T_1 (untreated control) and T_{13} (Amistar @ 0.1% + Bion @ 25 mg p L^{-1}), respectively. Seed treatment with Bion @ 50 mg p L^{-1} (T_2) and @ 25 mg p L^{-1} (T_3) significantly reduced leaf spot reaction over untreated control though the result of Bion was not influenced by it is doses (Table 1). Bion also improved the properties of Tilt and Amistar regarding suppression of leaf spot severity over control. Similar trend was observed in case of pathotype MS-HS-2-6 and pathotype MS-S-3-5-8-9-10-12 where highest and lowest % LAD were obtained under treatment T_1 (control) and T_{13} (Amistar @ 0.1% + Bion @ 25 mg p L^{-1}), respectively. Treating seeds with Bion significantly reduced leaf spot severity though the defense response did not significantly influenced by its doses. Tally *et al.* (1996) reported that CGA-245704, benzo (1,2,3) thiadiazole-7-Carbothioic acid S-methyl ester (Bion), is the first compound of a new generation of plant protection products which activates the plants own defense mechanisms leading to an increased plant resistance against diseases. The present study is also supported by Oostendorp *et al.* (1996), Bassi Jr, *et al.* (1996) and Leadbeater *et al.* (1997). Jonczyk and Smagacz (1999) investigated the effect of Bion on the yield and health of selected spring barley varieties cultivated in ecological and conventional systems. The occurrence of pathogens infecting leaves was reduced by spraying Bion for Rodos and Start cultivars in conventional system.

Table 1: Effect of seed treatment with Bion, Tilt and Amistar either alone and some of their combinations on leaf spot reaction of wheat cv. Kanchan inoculated with three pathotypes of *Bipolaris sorokiniana* at flag leaf stage (Excised leaf method)

	Diseased leaf area (%)		
	Pathotype of *Bipolaris sorokiniana*		
Treatments	S-HS-2-3-4-5-6-7	MS-HS-2-6	MS-S-3-5-8-9-10-12
T_1	54.0(65.4)	47.2(70.8)	64.4(81.0)
T_2	44.7(49.6)	41.9(65.0)	40.9(43.0)
T_3	42.6(46.0)	40.7(28.0)	43.2(47.0)
T_4	35.9(34.6)	36.8(28.6)	44.9(50.0)
T_5	40.0(41.4)	39.2(45.0)	40.1(41.6)
T_6	31.2(27.0)	33.9(21.6)	27.1(21.0)
T_7	25.7(19.0)	30.4(16.2)	29.2(24.0)
T_8	29.6(24.6)	32.9(29.0)	39.7(41.0)
T_9	39.5(40.6)	38.9(27.0)	36.2(35.0)
T_{10}	22.7(15.0)	28.4(14.2)	33.0(30.0)
T_{11}	23.4(16.0)	28.9(15.2)	31.8(28.0)
T_{12}	24.1(17.0)	29.3(18.0)	33.2(31.0)
T_{13}	20.6(12.6)	26.9(16.0)	22.6(15.0)
T_{14}	26.3(20.0)	30.8(18.0)	33.7(31.0)
T_{15}	25.8(19.2)	30.5(16.4)	30.3(26.0)
LSD (p = 0.05)	3.752	2.392	5.458

Data represents are sine transformed value, Data in parentheses indicate original mean

Field experiments: Bion reduced the leaf blight severity from 71 to 41 and 92 to 91 in heading and flowering stage, respectively, during 2000-2001 cropping season whereas it reduced disease severity from 95 to 92 at hard dough stage in 2001-2002 (Table 2). Seed treatment with Bion clearly indicates its good effect in reducing leaf blight severity of wheat. Braun-Kiewnick *et al.* (1998) reported that application of benzothiadiazole (Bion) to barley (cv. B 2601) flag leaves Induced Systemic Resistance (ISR) and protection of barley heads and kernels to latter challenge with the kernel blight pathogen *Pseudomonas syringae* pv. *syringae*. Barley kernels from induced plants displayed significantly reduced disease severity by 43-56% compared to non-induced plants. Jorgensen *et al.* (1997) found that dipping germinating seeds in Bion gave significant reduction of mildew compared with untreated seeds. Raum (1997) also reported Bion as a new plant activator that can improve the natural resistance of plants to diseases. Stadnik and Buchenauer (1999) investigated the effect of benzothiadiazole-7 carbothioic acid -S methyl ester (BTH; Bion-R) on the autofluorescence responses of adaxial epidermal cells, activity of Phenylalanine Ammonia-lyase (PAL) as well as fungal penetration efficiency after inoculation of the wheat cultivars monopol (susceptible) and Zentos (resistance) with *Blumeria graminis* f. sp. *tritici* (Bgt). The frequency of Bgt-attacked

Table 2: Effect of seed treatment with Bion, Tilt and Amistar either alone and some of their combinations on leaf blight severity of wheat cv. Kanchan under field condition in 2000-2001 and 2001-2002

	Leaf blight severity (00-99)					
	Heading stage		Flowering stage		Hard dough stage	
Treatments	00-01	01-02	00-01	01-02	00-01	01-02
T_1	71	71	92	71	99	95
T_2	41	71	91	71	99	93
T_3	41	71	91	71	99	92
T_4	71	71	81	71	97	92
T_5	71	71	81	71	97	91
T_6	71	71	81	71	93	92
T_7	71	71	91	71	93	91
T_8	72	71	82	71	98	91
T_9	71	71	81	71	98	91
T_{10}	71	71	81	71	97	92
T_{11}	71	71	82	71	99	92
T_{12}	71	71	91	71	96	91
T_{13}	71	71	82	71	97	91
T_{14}	71	71	91	71	94	91
T_{15}	71	71	91	71	96	91

Table 3: Effect of seed treatment with Bion, Tilt and Amistar either alone and some of their combinations on grain formation and grain weight of wheat cv. Kanchan under field condition (2000-2001)

Treatments	No. of grains/ear	No. of healthy grains/ear	No. of diseased grains/ear	Weight of grains/ear(g)	Weight of healthy grains/ear(g)	Weight of diseased grains/ear(g)	1000-grain weight(g)
T_1	25.06	17.05	8.00	1.20	0.77	0.33	45.11
T_2	26.44	23.00	3.44	1.23	1.00	0.18	45.36
T_3	26.00	19.78	6.22	1.22	0.91	0.27	47.27
T_4	27.39	23.00	4.39	1.28	1.04	0.19	46.76
T_5	25.12	20.45	4.67	1.18	0.86	0.32	44.92
T_6	27.61	20.67	6.94	1.31	0.95	0.31	47.35
T_7	31.95	26.50	5.44	1.53	1.24	0.26	48.33
T_8	32.17	29.78	2.39	1.28	1.09	0.10	38.86
T_9	40.06	34.61	5.44	1.55	1.27	0.17	38.86
T_{10}	32.45	30.06	2.39	1.46	1.32	0.11	45.16
T_{11}	32.61	28.22	4.39	1.44	1.24	0.17	43.73
T_{12}	33.00	30.67	2.33	1.54	1.38	0.09	46.55
T_{13}	30.55	25.67	4.89	1.53	1.23	0.23	50.04
T_{14}	27.39	20.67	6.72	1.33	0.98	0.32	48.58
T_{15}	25.72	20.94	4.78	1.20	0.98	0.21	46.84
LSD (p = 0.05)	3.921	3.379	2.099	NS	0.2481	0.09161	2.144

NS = Not Significant

Table 4: Effect of seed treatment with Bion, Tilt and Amistar either alone and some of their combinations on grain formation and grain weight of wheat cv. Kanchan under field condition (2001-2002)

Treatments	No. of grains/ear	No. of healthy grains/ear	No. of diseased grains/ear	Weight of grains/ear (g)	Weight of healthy grains/ear (g)	Weight of diseased grains/ear (g)	1000-grain weight (g)
T_1	32.17	25.73	7.05	1.41	1.10	0.29	43.38
T_2	32.84	27.50	5.34	1.49	1.22	0.24	43.27
T_3	36.17	28.51	7.67	1.53	1.19	0.34	42.69
T_4	37.22	28.22	9.00	1.62	1.24	0.39	42.54
T_5	37.23	28.17	9.06	1.50	1.11	0.40	43.44
T_6	35.45	30.06	5.39	1.64	1.32	0.25	46.57
T_7	33.72	26.45	7.28	1.60	1.26	0.36	47.26
T_8	37.00	30.11	6.67	1.47	1.21	0.27	39.60
T_9	34.61	30.23	4.39	1.44	1.08	0.20	39.38
T_{10}	35.45	29.67	5.78	1.24	1.01	0.20	40.80
T_{11}	36.23	28.55	7.67	1.58	1.23	0.33	44.97
T_{12}	36.23	30.34	5.89	1.56	1.25	0.28	43.15
T_{13}	33.49	27.11	6.39	1.41	1.14	0.27	43.97
T_{14}	37.78	31.22	6.56	1.59	1.31	0.28	41.17
T_{15}	34.00	27.39	6.62	1.32	1.10	0.23	40.33
LSD (p = 0.05)	NS	NS	2.365	0.1979	NS	0.1183	2.264

NS = Not Significant

Table 5: Effect of seed treatment with Bion, Tilt and Amistar either alone and some of their combinations on yield of wheat cv. Kanchan under field condition (2000-2001 and 2001-2002)

	Straw yield (kg p m^{-2})		Grain yield (kg p m^{-2})		Increased (+) or decreased (-) grain yield over untreated control	
Treatments	00-01	01-02	00-01	01-02	00-01	01-02
T_1	0.42	0.48	0.33	0.30	-	-
T_2	0.47	0.57	0.36	0.35	+9.09	+16.67
T_3	0.51	0.70	0.43	0.46	+30.30	+53.33
T_4	0.62	0.65	0.46	0.44	+39.39	+46.66
T_5	0.61	0.68	0.40	0.44	+21.21	+46.66
T_6	0.72	0.73	0.47	0.44	+42.42	+46.66
T_7	0.68	0.78	0.47	0.45	+42.42	+50.00
T_8	0.77	0.70	0.35	0.32	+6.06	+6.67
T_9	0.62	0.84	0.40	0.30	+21.21	0.00
T_{10}	0.54	0.77	0.37	0.30	+12.12	0.00
T_{11}	0.61	0.83	0.40	0.29	+21.21	-3.30
T_{12}	0.59	0.65	0.38	0.33	+15.15	+10.00
T_{13}	0.65	0.80	0.39	0.38	+18.18	+26.66
T_{14}	0.59	0.61	0.37	0.31	+12.12	+3.33
T_{15}	0.38	0.47	0.33	0.28	0.00	-6.66
LSD (p = 0.05)	0.053	0.0748	0.035	0.052		

epidermal cells showing whole-cell autofluorescence (hypersensitive cell death) which slightly enhanced by BTH only in cv. monopol. The results suggest that enhanced PAL activity and synthesis of autofluorogenic compounds, probable of phenolic nature, are involved in quantitative resistance and in BTH defense mechanisms of wheat plants where they act to inhibit penetration of attacked cells. Present study is also supported by Rahman (2002). He reported that seed treatment with Bion reduced seedling mortality of chilli var. Mymensingh local and Pabna local by 87.30 and 100%, respectively over untreated control. In the present study Bion, Tilt, Amistar and their different preparations reduced leaf spot severity in the laboratory but the result was not consistent to the field study. In heading and flowering stage of 2001-2002 experimental season none of the preparations of antifungal compounds are found to be effective against the disease. The findings of the study are supported by Pasquer *et al.* (2005). They found different result by treating wheat seeds with antifungal compounds Azoxystrobin, BTH (Benzothiadiazole) and fenpropimorph in respect of different growing conditions of the crop. They concluded that these differences in the expression patterns between the two environments demonstrate the importance of plant growth conditions for testing the impact of agrochemicals on plant metabolism.

Formation of grains/ear and healthy grains/ear varied from 25.06 to 40.06 and 17.05 to 34.61, respectively under different treatments. Number of diseased grains/ear under different treatments ranged from 2.33 to 8.00, where the lowest number of diseased grains/ear was recorded in plants that raised from the seeds treated with Amistar (0.1%) + Bion (50 mg p L^{-1}). Weight of grains/ear and weight of healthy grains/ear have been found to be increased due to application of Bion. Bion exerted significant influence in reducing weight of diseased grains/ear (Table 3). Bion and Amistar either alone and in combination increased 1000-grain weight where highest 1000-grain weight was obtained in the treatment T_{13}. Formation of grains/ear and healthy grains/ear in 2001-2002 varied from 32.17 to 37.78 and 25.73 to 31.22, respectively under different treatments (Table 4). Number of diseased grains/ear under different treatments ranged from 4.39 to 9.06, where the lowest number of diseased grains/ear was recorded in plants that raised from the seeds treated with Tilt (0.1%) + Bion (25 mg p L^{-1}). Weight of grains/ear and weight of healthy grains/ear have been found to be increased due to application of Bion. Bion did not exert any significant influence in reducing weight of diseased grains/ear and increasing 1000 grain weight under field condition in 2001-2002 experimental seasons.

The straw yield and grain yield of wheat cv. Kanchan under different treatments varied significantly in 2000-2001 and 2001-2002 experimental seasons (Table 5). Highest (0.77 kg m^{-2}) straw yield in 2000-2001 was recorded with the treatment T_8 (Tilt @ 0.1% + Bion @ 50 mg p L^{-1}) and in 2001-2002 the treatment T_9 (Tilt @ 0.1% +Bion @ 25 mg p L^{-1}) produced highest (0.84 kg m^{-2}) straw yield. Seed treatment with Bion resulted statistically higher straw yield over untreated control in both the experimental seasons. Highest (0.47 kg m^{-2}) and lowest (0.33 kg m^{-2}) grain yield were found in treatment T_7 (Amistar @ 0.05%) and T_1 (untreated control), respectively in 2000-2001. Bion also yielded significantly higher grain over control in the same year. In 2001-2002 Bion @ 25 mg p L^{-1} (T_3) also resulted statistically higher grain yield (0.46 kg m^{-2}) which was

53.33 % increased over untreated control. Hossain (2002) reported that Bion sprayed at tillering stage and ear initiation stage increased grain yield of rice by 25.87 and 12.83%, respectively over control. Sultana (2003) studied the effect of seed treatment with Bion, Amistar and Vitavax-200 on tikka disease of peanut var. Dhaka-1 and Jhinga badam. Seed treatment with Bion increased pod yield/plant and kernel yield/plant of peanut var.Dhaka-1 up to 27.06 and 32.33%, respectively over untreated control. The findings of the present study are also supported by Jonczyk and Smagacz (1999). Firoz and Hossain (2000) carried out an experiment on induction of resistance to rice against some major diseases with increasing grain yield and they found Bion either alone or in combination with Amistar and Tilt to be very effective in inducing resistance to rice against brown spot, narrow brown leaf spot, sheath rot and sheath blight. They also reported that Bion alone increased grain yield of rice cultivars BR 11 and BRRI Dhan 32 by 40.46 and 9.55%, respectively over control.

CONCLUSION

Bion, Tilt and Amistar either alone and in combinations reduced leaf spot (*Bipolaris sorokiniana*) reaction of wheat in the laboratory but their induction effect against the disease in the field was not consistent to that of laboratory experiment. Seed treatment with Bion and Amistar increased 53.33 and 53.00% grain yield, respectively of wheat over untreated control.

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