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Response of Wheat Yield Under Combined Use of Fungicides and Bio-fertilizer

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ABSTRACT

This study was conducted to evaluate the outcomes of fungicides on indigenous as well as inoculated microorganisms provided in bio-fertilizer under field conditions. Different physiological, growth and yield traits of wheat were studied in the presence of Alert Plus (Mancozeb + Fosetyl Aluminium), Benlate (Benomyl), Darosal (Benzimidazole) and Mancozeb {Penncozeb (ethylenebisdithiocarbamate)}. The seeds were treated with fungicides and pelleted with bio-fertilizer before sowing. Data revealed that Alert Plus, Mancozeb and Darosal have significant negative effect and Benlate has positive effect as compared to bio-fertilizer treated positive control but effect is non-significant as compared to negative control. It was concluded that suggested field concentration of fungicides do have negative effects on inoculated microorganisms and their activities but in rare cases they may be stimulatory.

Key words: Fungicides; Microbial inoculants; Bio-fertilizer; Wheat; Plant Growth Promoting Rhizobacteria

INTRODUCTION

Low fertility of agricultural soils and increasing incidence of pests on crops is a real and immediate threat to food security and to the lives and livelihood of millions of people. For good crop productivity, modern agriculture technologies based on balanced fertilization, irrigation, pest management and mechanization are required. The use of expensive chemical fertilizers and pesticides is a limiting factor for the low-income farmers and increases the cost of crop production. Bio-fertilizers are eco-friendly and have been proved to be effective and economical alternate of chemical fertilizers with lesser in put of capital and energy (Hafeez *et al.*, 2002).

Among different pesticides, fungicides comprise 3% of the total pesticide consumption in the country (Husain, 2004). Fungicide seed treatment is used to control attack by the fungi, seed borne and root pathogens (Phipps, 1984; Sinclair & Backman, 1984). The wide spread use of pesticides over the past 50 years has resulted in problems in natural ecosystem due to the interaction of pesticides with natural biological system (Ayansina & Oso, 2006). Problem gets more serious when microbial inoculants are used in conjunction with fungicides that affect the nodulation or growth hormone production in rhizosphere (Catroux & Arnaud, 1991). Bio-chemical and microbiological techniques carried out under laboratory conditions do not reflect real field conditions.

The present study was conducted to evaluate the effect of the combine use of fungicides and bio-fertilizer on wheat yield and yield influencing traits.

MATERIALS AND METHODS

Bacterial inoculant. A multistrain (serologically distinct) inoculum with trade name *Bio-power* obtained from bio-fertilizer division, NIBGE was used in the experiment. The inoculum was composed of growth promoting strains of *Azospirillum*, *Pseudomonas*, and *Agrobacterium*.

Test fungicides. Test fungicides were Alert Plus (Mancozeb + Fosetyl Aluminium), Benlate (Benomyl), Darosal (Benzimidazole) and Mancozeb {Penncozeb (ethylenebisdithiocarbamate)} @ 2 g kg^{-1} seeds.

Wheat variety. Wheat variety Inqlab 91 was used in the field trial.

Experimental layout. The trial was conducted during 2003 - 2004, NIBGE, Faisalabad, in randomized complete block design (RCBD). The experiment was planted with ten treatments each with four replicates (with uninoculated & inoculated controls) in the presence and absence of fungicides. Before sowing, wheat seeds were treated with test fungicides at the rate of 2 g kg^{-1} seeds. After drying, seeds were inoculated with bio-fertilizer according to the standard procedure. Nitrogen and Phosphorus were used half (36 kg $acre^{-1}$) and full (34 kg $acre^{-1}$), respectively as recommended to the farmers by Agriculture Department, Government of Punjab, Lahore.

Field sampling and data collection. Data on various morphological and yield traits, i.e., Total Biomass, Grain Weight, Shoot length, Root area, Length and Width was recorded at different growth stages, i.e., 20, 40, 60 and 80 days after planting and also at maturity. For estimation of root parameters, the un-disturbed samples were washed

using gently running tap water to ensure that the roots were recovered intact. At maturity (130 days after planting), 5 plants were randomly hand-harvested from 1 m^2 area of un-sampled center rows of each plot, to estimate the plant height total biomass/plant and grain yield/plant. Seeds were carefully taken from each plant, cleaned and weighed. Yield was calculated on a per-hectare basis. The following treatment comparisons were made:

T1= Alert Plus, T2= Benlate, T3= Mancozeb, T4= Darosal, T5= Alert Plus + Bio-fertilizer, T6= Benlate + Bio-fertilizer, T7= Mancozeb + Bio-fertilizer, T8= Darosal + Bio-fertilizer, T9= Seeds without fungicide + Bio-fertilizer, T10= Seeds without fungicide + without Bio-fertilizer.

Statistical analysis. The data were subjected to standard analysis of variance technique as proposed by Steel and Torrie (1964). Duncan's new multiple range test was performed to compare the means of different treatments by using the computer software CoStat and MStatC. All the results and confidence limits are given at 0.5% level of significance.

RESULTS AND DISCUSSION

Results indicated that there was no significant difference in shoot length, root area, root length and root width in the plant with and without different fungicide treatments and also with indigenous population after 20 and 40 days (Table I) of germination. It indicated that root rhizosphere bacterial population is established slowly after inoculation to initialize the effect on plant. These results are supported by the electron microscopic findings of Arif (2004), reporting the presence of bacterial cells in different parts of wheat roots studied at different time intervals of bacterial inoculation. After 60 days of germination, highest vegetative growth (Table II) i.e. shoot length was recorded for plant emerged from the seeds treated with Darosal followed by the seeds treated with Alert Plus. Root growth was recorded highest in plants emerged from the seeds treated with bio-fertilizer, followed by the plants emerged from Benlate treated seeds. After 80 days of growth, shoot length was recorded highest in the Mancozeb treated plants while root parameter were maximum in bio-fertilizer treated plants followed by Benlate treatment (Table III). Several fungicides containing strobiluren and kresoxin-methyl as active ingredient are reported to induce physiological changes in wheat plants and also affect crop yield. In combination, these fungicides seem to enable plants for better adaptation to environment. In most cases, average yield increases up to 5 - 10% (Habermyer *et al.*, 1998). The data at maturity indicated (Table IV) that maximum shoot length was recorded for the plants with fungicide Alert plus followed by the plants treated with Darosal. These results are supported by the results of Udaiyan *et al.* (1995) during study of bio-static effect of pesticide drenches on endomycorrhizal- *Rhizobium*- legume tripartite association under field conditions. They reported that the pesticide treatment had no marked effect on plant growth but accumulation of nutrients in pesticide treated plants was lower than those in untreated plants. However, some studies have shown that a large majority of the rhizobia, applied to seed via conventional seed inoculation, killed before seeding or shortly after placement in the soil due to exposure to seed treatment chemicals, seed-coat toxins, dehydration, or excessive heat (Brockwell *et al.*, 1980; Roughley *et al.*, 1993).

Maximum biomass and grain yield (Table IV) was obtained from the bio-fertilizer treated plots as compared to control. Fungicide Mancozeb showed non significant

Table I. Analysis of variance for different morphological traits due to the effect of fungicides and bio-fertilizer at different time intervals

First Sample		Mean Square							
		After 20 days of growth				After 40 days of growth			
Source of variation	df	Shoot Length	Root Area	Root Length	Root Width	Shoot Length	Root Area	Root Length	Root Width
Treatments	9	2.87	0.104	23.39	0.000	5.91	2.25	127.31	0.00
Replication	3	1.73	0.213	22.15	0.000	6.51	5.19	510.84	0.001
Error	27	3.00	0.030	18.82	0.000	2.69	1.61	110.26	0.00

Table II. Pair wise Comparison of different treatments for various morphological traits to study the effect of fungicides and bio-fertilizer in Wheat variety Inqlab-91

Treatments	60 Days after planting			
	Shoot Length	Root Area	Root Length	Root Width
T1 – Fungicide Alert Plus	66.50 b	4.05e	26.94 d	0.158 bc
T2 – Fungicide Benlate	63.13 e	4.00 e	30.89 bc	0.193 b
T3 – Fungicide Mancozeb	59.00 f	6.14 bc	25.32 d	0.170 bc
T4 – Fungicide Darosal	65.75 bc	2.25 f	25.46 d	0.167 bc
T5 – Fungicide Alert Plus + Bio-fertilizer	65.63 bcd	4.88 de	27.34 d	0.139 c
T6 – Fungicide Benlate+ Bio-fertilizer	64.50 bcde	5.89 bc	31.11 b	0.145 bc
T7 – Fungicide Mancozeb+ Bio-fertilizer	64.00 cde	5.31 cd	28.05 bcd	0.247 a
T8 – Fungicide Darosal+ Bio-fertilizer	68.72 a	6.33 b	28.46 bcd	0.155 bc
T9- Seeds without fungicide + Bio-fertilizer	55.13 g	7.52 a	39.13 a	0.245 a
T10- Seeds without fungicide + without Bio-fertilizer	63.63 de	6.08 bc	27.82 cd	0.184 bc

Table III. Pair wise Comparison of different treatments for various morphological traits to study the effect of fungicides and Bio-fertilizer in Wheat variety Inqlab-91

Treatments	80 Days after planting			
	Shoot Length	Root Area	Root Length	Root Width
T1 – Fungicide Alert Plus	66.75 c	3.83 ef	22.19 f	0.170 b
T2 – Fungicide Benlate	68.50 c	3.35 fg	27.92 cd	0.146bcd
T3 – Fungicide Mancozeb	78.50 a	5.00 ab	26.59 de	0.142bcd
T4 – Fungicide Darosal	75.50 ab	2.51 h	22.97 ef	0.105e
T5 – Fungicide Alert Plus + Bio-fertilizer	68.00 c	2.85 gh	24.31 def	0.133cde
T6 – Fungicide Benlate+ Bio-fertilizer	69.25 c	3.91de	30.83 bc	0.135 cd
T7 – Fungicide Mancozeb+ Bio-fertilizer	73.88 b	4.66bc	26.07def	0.118 de
T8 – Fungicide Darosal+ Bio-fertilizer	74.75 ab	4.41cd	25.01def	0.147bcd
T9- Seeds without fungicide + Bio-fertilizer	75.25 ab	5.29 a	38.74 a	0.242 a
T10- Seeds without fungicide + without Bio-fertilizer	77.25ab	3.22 g	32.56 b	0.157 bc

Table IV. Pair wise Comparison of different treatments for yield and yield influencing traits study the effect of fungicides and Bio-fertilizer in Wheat variety Inqlab-91

Treatments	Maturity		
	Plant Height	Biomass g/plant	Grain yield/plant
T1 – Fungicide Alert Plus	74.80 d	28.30 cd	10.17 c
T2 – Fungicide Benlate	77.30 abcd	31.20 bc	12.78 b
T3 – Fungicide Mancozeb	78.10 abc	27.95 cd	13.09 b
T4 – Fungicide Darosal	79.30 ab	26.90 d	12.45 b
T5 – Fungicide Alert Plus + Bio-fertilizer	79.84 a	26.63 d	13.66 b
T6 – Fungicide Benlate+ Bio-fertilizer	78.80 abc	32.20 b	12.53 b
T7 – Fungicide Mancozeb+ Bio-fertilizer	75.80 cd	31.20 bc	14.47 b
T8 – Fungicide Darosal+ Bio-fertilizer	79.72 a	25.45 d	12.73 b
T9- Seeds without fungicide + Bio-fertilizer	76.30 bcd	37.95 a	17.84 a
T10- Seeds without fungicide + without Bio-fertilizer	74.25 d	33.95 b	12.71 b

difference as compared to other fungicides in case of grain yield. These results are in agreement with the results of Castro *et al.* (1997), who reported that Mancozeb decrease the growth of pure *Rhizobium* culture up to 50% but no difference was found in peanut yield under field conditions. They suggested that the soil environment could reduce the probability of the direct harmful effect of Mancozeb on bacterial growth.

CONCLUSION

It was concluded that pesticides when used at recommended field rates do not significantly reduce indigenous microbial activities and in some cases like in Benlate, they are stimulatory.

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