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Integration between Seed Bio Priming and Potassium Salts Treatments to Control of Root Rot Disease and Improvement Growth and Yield of Green Bean Plants

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ABSTRACT

Seed bio priming and seed soaking in potassium salts alone or in combined treatments as well as seed dressing treatment with commercial fungicide (Rizolex-T) were used to control green bean root rot caused by *Fusarium solani* and *Rhizoctonia solani*. Such treatments gave impressive and promising results, they significantly suppressed green bean root rots compared with control treatment. Seed bio priming combined with seed soaking in potassium salts at 5.0% level was superior than fungicidal seed treatment in controlling root rot diseases of green bean plant under both green house and field conditions. During the two seasons of 2013 and 2014, seed bio priming + potassium sorbet, seed bio priming + potassium benzoate and commercial fungicide treatments had a stimulation effects on bean plant growth characters i.e. plant length, number of leaves and branches per plant as well as fresh and dry weight of leaves and branches compared with individual and control treatments. Moreover, the highest values of the percentages of nitrogen, phosphorus, potassium, protein and dry matter contents in bean pod tissues were recorded in pods of the same treatments. The obtained results reflected that green bean plants could be protected against soil-borne pathogens and improved growth, yields and nutritional values by using bio priming and chemicals persuaded plant resistance inducers which considered as an environmental friendly and used alternatively to fungicides especially under organic farming.

Key words: Green beans, root rot diseases, bio priming, potassium salts, vegetative growth, yield.

Introduction

Green bean (*Phaseulas vulgaris* L.) is one of the important leguminous crops grown in many countries including Egypt. High quality green pods and mature seeds used for fresh and food processing of beans are a favorite commodity for exporting and local consumption. Damping-off and root rot diseases of bean caused by single or combination of soil borne pathogens *Fusarium solani* Mart. Sacc *and Rhizoctonia solani* Kuhn, they can attacks wide range of plant species such as bean causing damping off, hypocotyl rot, root rot and wilt (El-Mougy 1995 and Begum *et al*., 2011). An investigation for controlling green bean root rot diseases is considered important, especially in view of its prevalence in Egypt, particularly under newly reclaimed sandy soils. Fungicides have been used as an essential seed treatment for controlling damping-off and root rot diseases for a long time. However, fungicidal treatments affects human health hazards and increases environmental pollution. Therefore, an alternative fungicidal seed treatments are heavily needed. Biological seed treatments such as seed bio priming and seed soaking in plant resistance inducers chemicals such as potassium salts may provided an alternative to fungicidal control.

Seed priming technique used commercially in many horticultural crops, as a tool to increase rate, capacity and uniformity of seed germination and improve seedlings stand. Seed priming alone or in combination with low dosage of fungicides and/or bio control agents have been used to improve the rate and uniformity emergence of seed and reduced damping off disease (Callan *et al.,* 1991 and Conway *et al.,* 2001). Bio priming a new technique that integrate biological and physiological aspects of disease control was recently used as an alternative method for controlling many seeds and soil borne pathogens (El-Mohamedy *et al.,* 2006; El-Mohamedy and Abd El-Baky, 2008; El-Mougy and Abdel Kader, 2008; Begum *et al*., 2011 and El-Mohamedy and Abd Alla, 2013). Moreover, seed priming has been developed as an indispensable method to produce tolerant plants against adverse environmental conditions which adversely affects the plant growth and productivity (Jisha *et al.,* 2013). Kaya *et al*. (2006) indicated that priming of sunflower seeds with potassium nitrate led to an increase of germination percentage under drought and salinity stresses.

Induction of plant resistance to overcome pathogen infection is a promising approach for controlling plant diseases. This induced resistance to pathogens can be achieved by the application of various abiotic agents (chemical inducers) such as potassium salts (Abdel Monaiem, 2010 and El-Mohamedy *et al.,* 2013). Exogenous

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or endogenous factors may be substantially affected host physiology, led to rapid and coordinated activation of defense-genes in plants normally expressing susceptibility to pathogen infection. On the other hand, application of chemical inducers under field conditions led to an increase of vegetative growth parameters, yield components and quality of fruits in many vegetable plants (El-Mohamedy *et al.,* 2014). Several studies revealed that seed priming significantly improved seed size, vigor and primed crops produced large seeds as compared to non-primed crops (Hussain *et al*., 2014). However, Sarmadi *et al.* (2014) found that primed of common bean seeds before sowing for 10 hours in potassium nitrate at rate of 0.35 moles per liter caused an increase in the active number of root nodules in bean plants. Moreover, Mohammadi (2009) found that among the priming treatments, primed seeds with potassium nitrate showed the highest values for all measured traits compared with control and increased germination percentage, germination rate and seedling dry weight by 28.3, 129.4 and 58.1, respectively. In the same respect, Ahmadvand *et al*. (2012) reported that final germination percentage, radical and plumule length, plant height, plant leaf area and plant dry weight of primed seeds were more significantly than non-primed seeds. The present work was conducted to evaluate different alternatives to fungicidal seed treatment *i.e*. seed bio priming and seed soaking in potassium salts alone or in combined treatments, as well as seed dressing with Rizolex-T (Commercial fungicide) as a comparison treatment to control of green bean root rot diseases as well as the efficiency of such seed treatments on vegetative growth, green pod yield and quality parameters.

Materials and Methods

Source of bean seeds, pathogenic fungi and bio agents used

Bean seeds cv. Giza 3 were obtained from Vegetable Crops Research Dept., Horticultural Institute, Agricultural Research Centre (ARC), Giza, Egypt. *Fusarium solani and Rhizoctonia solani* were isolated from bean plants showed typical root rot disease symptoms. Bio control agent *Trichoderma harzianum* was isolated previously from rhizospher of healthy bean plant and antagonistic ability against most soil borne pathogenic fungi was recorded in previous studies (El-Mohamedy *et al.,* 2013).

Seed treatments

Seed bio priming:

Green bean seeds were initially washed with tap water to remove soluble exudates. Seeds were primed according to methods described by Harman *et al.* (1989) in 1% CMC (Carboxyl methyl cellulous) in Erlenmeyer flask on a rotary shaker set at 150 rpm. CMC 1% or supplemented 1% CMC with spore suspension of *T. harzianum* ($3x10^6$ spore/ml) were subsequently added to seed during priming process for 30 minutes to primed. Bio-primed seeds were shaken at 150 rpm for 12 hour, then dried at room temperature and placed in polyethylene bags for further studies.

Potassium salts seed soaking:

Green bean seeds were soaked in potassium benzoate or potassium sorbet solutions at 2.5 and 5.0% levels for 30 minutes before sowing.

Fungicide seed dressing:

Green bean seeds were dressed with Rizolex-T 50% at the recommended dose (3g/kg of seeds) then sown in infested soil to serve as a comparison treatment.

Control treatment:

Non-treated seeds of green bean were sown in infested soil with pathogenic fungi.

Control of root rot pathogens of green bean under green house conditions.

This experiment was carried out in a green house to evaluate the efficiency of different seed treatments i.e., seed bio priming (applying *T. harzianum* to green bean seeds during priming process) (TH), Green bean seeds soaked in Potassium sorbet or Potassium benzoate at rates of 2.5 and 5% (w/v) for 30 min, Seed bio priming (TH) + potassium sorbet 2.5%, Seed bio priming (TH) + potassium sorbet 5%, Seed bio priming (TH) + potassium benzoate 2.5%, Seed bio priming (TH) + potassium benzoate 5% as well as seed dressing with fungicide (Rizolex-T) as comparison treatment to controlling green bean root rot pathogens under artificially infested soil in addition to control treatment (untreated seeds). Plastic pots 25 and 18 cm upper and lower diameters, respectively, and 21 cm height, were filled with artificially infested soil individually with pathogenic fungus i.e., *F. solani* and *R. solani*.

Five seeds of green bean were sown in each pot and ten pots were used as a replicate for each treatment. The percentage of damping-off and root rot incidence during 45 days from sowing date was calculated.

Control of root rot disease of green bean under field conditions

Field experiments were carried out during seasons of 2013 and 2014 at the Experimental Research Station of National Research Centre at El-Noubaria region, Behera Governorate, Egypt. The highly effective treatments that mentioned above in controlling root rot pathogens under greenhouse conditions were evaluated under field conditions. The field trail conducted in naturally heavily infested soil with root rot pathogens with 28 plots. The evaluated treatments were applied as follows: (A) Single treatments 1- Bio priming (TH). 2- Potassium sorbet 5.0%. 3- Potassium benzoate 5.0%. (B) Combined treatments. 4- Bio priming (TH) + Potassium sorbet 5.0%. 5- Bio priming (TH) + Potassium benzoate 5.0%. 6- Fungicide (Rizolex-T 50% at rate of 3g/Kg seeds as seed dressing). 7- Control (untreated seeds). All treatments applied in a complete randomized block design with four replicates (plots) for each treatment. Green bean seeds were sown at rate of 3 seeds per hill and 30 cm distance between hills on one side of ridge with 70 cm width and 4 m length. Each experimental plot included 3 ridges with 8.4 m^2.

Disease assessment

The percentage of root rot incidence at pre-emergence stage was calculated as the number of absent emerged seedlings in relative to the total number of sown seeds after 20 days from sowing date. Meanwhile, the percentage of post-emergence root rot was calculated as the number of bean plants showed disease symptoms in relative to the total number of bean plants, periodically every 10 days starting from 20 up to 60 days after sowing date. In the same time the effect of different seed treatments on vegetative growth and yield quality as well as total green pods yield were investigated.

Plant growth measurements

A sample of 10 plants was randomly taken at flowering stage (45 days after sowing date), from each experimental plot for determining growth characters of green bean plant, as follows: Plant height from soil surface to the highest point of the plant, number of leaves and branches per plant, leaf area plant cm^2 as well as fresh and dry weight of leaves and branches.

Green pod yield and quality parameters

At harvesting stage (65 days after seed sowing), total green pods from each plot were harvested along the harvesting season (40 days). The following data were recorded: average number of pods per plant, pods weight (g), total yield of green pods/m^2 (kg) and total green pods (ton/fed.) were also calculated.

Also a random sample of 25 green pods from each experiment plot at the second harvest was taken and the following parameters were recorded: average pod weight (g), average number of pods per plant and weight of pods per plant (g).

Nutritive value of green pods

A random sample of 25 green pods from the second harvest were taken and the following data were recorded: N percentage in pod was determined according to the method of Pregl (1945). In addition, protein percentages in pod was calculated by multiplying nitrogen content by 6.25. Potassium was assayed using flame photometer according to Allen *et al.* (1984). Phosphorous was extracted and measured spectrophotometerically according to Jackson (1965). As well as dry matter percentage was determined according to the method of Dubois *et al.* (1960).

Statistical Analysis

All data obtained were subjected to statistical analysis according to the procedures reported by Snedecor and Cochran (1982).

Results and Discussion

Control of root rot disease of green bean under greenhouse

The efficacy of seed bio priming alone or in combined with seed soaking in potassium benzoate or sorbet at level of 2.5 and 5.0% (w/v) for 30 min as well as seed dressing with fungicide as a comparative treatment in controlling of *Rhizoctonia solani and Fusarium solani*, the main pathogens of green bean root rot disease was evaluated under artificially infested soil under green house conditions. Seed bio priming and seed soaking in potassium salts alone or in combined treatments as well as seed dressing with fungicide (Rizolex-T) significantly suppress green bean root rot caused by *F. solani* and *R. solani* at pre-emergence damping off stage (20 days after sowing) as well as at post-emergence after 20 to 60 days after sowing date compared with control treatment (untreated seeds) as shown in Tables (1 and 2). Data presented in Table (1) showed that all seed treatments significantly reduced *Fusarium* root rot at both pre and post emergence stages if compared with untreated seeds (control treatment). However, the integration between seed bio priming and potassium salts soaking treatments caused a highly significant reduction in *Fusarium* root rot incidence if compared with single treatment and control. The most effective seed treatments were seed bio priming combined with potassium sorbet or benzoate at 5.0% level followed by fungicide seed treatment (Rizolex-T), such treatments led to a reduction of *Fusarium* root rot by 72.0, 70.0, 70.8% and 70.2, 67.0, 68.2% at pre and post emergence, respectively.

Table 1: Effect of seed bio priming and potassium salts treatments on root rot disease incidence of green bean plants artificially infected with *Fusarium solani* under greenhouse conditions.

Seed treatments	Pre-emergence damping off after 20 days		Root rot incidence% after 45 day		Plants survival %
	Infection	Reduction %	Infection	Reduction %	
Bio priming TH	9.5e	68.4	16.6d	60.4	73.9e
Potassium sorbet 2.5%	20.1b	44.0	22.4b	42.0	55.5c
Potassium sorbet 5%	14.3d	52.2	19.7c	52.8	66.0d
Potassium benzoate 2.5%	18.0c	40.0	25.9b	38.0	36.6b
Potassium benzoate 5%	14.5d	51.8	20.7c	50.4	64.8d
Seed bio priming TH + Potassium sorbet 2.5%	8.9e	70.4	14.6d	65.0	76.5e
Seed bio priming TH + Potassium sorbet 5%	8.4e	72.0	12.4e	70.2	79.2e
Seed bio priming TH + Potassium benzoate 2.5%	9.5e	68.4	16.1d	61.4	74.4e
Seed bio priming TH + Potassium benzoate 5%	9.0e	70.0	13.7e	67.0	77.3e
Fungicide (Rhizolex-T 3g/kg seeds)	8.8e	70.8	13.2e	68.2	78.0e
Control	30.0a	0.0	41.8a	0.0	28.2a

Means within each column followed by the same letter are not significantly different according to Duncan's multiple range test at 5% level of probability.

Table 2: Effect of seed bio priming and potassium salts treatments on damping off and root rot diseases incidence of green bean plants artificially infected with *Rhizoctonia solani* under greenhouse conditions.

Seed treatments	Pre-emergence damping off after 20 days		Root rot incidence % after 45 day		Plant Survival %
	Infection	Reduction %	Infection	Reduction %	
Bio priming TH	6.6c	70.7	14.4d	62.0	79.0c
Potassium sorbate 2.5%	11.6b	48.6	20.9b	44.8	67.5b
Potassium sorbet 5%	7.5c	66.6	17.6c	55.2	75.5c
Potassium benzoate 2.5%	13.1b	42.0	22.7b	40.2	64.2b
Potassium benzoate 5%	9.3c	59.0	18.6c	51.0	72.1c
Seed bio priming TH + Potassium sorbet 2.5%	6.5d	71.0	12.7d	66.4	80.0c
Seed bio priming TH + Potassium sorbet 5%	4.4e	80.4	10.6e	72.0	85.0d
Seed bio priming TH +Potassium benzoate 2.5%	7.1c	68.4	13.0d	65.8	79.9c
Seed bio priming TH + Potassium benzoate 5%	5.1e	77.4	11.2e	70.4	83.7d
Fungicide (Rhizolex-T 3g/kg seeds)	4.8e	78.8	14.4d	70.0	80.8d
Control	22.6a	0.0	38.0a	0.0	39.4a

Means within each column followed by the same letter are not significantly different according to Duncan's multiple range test at 5% level of probability.

Also the same mentioned treatments gave the highest values of survival healthy plants of green bean 79.2, 77.3 and 78.0% compared with 28.2% of control treatment (untreated seeds). Meanwhile, single treatment i.e. seed bio priming, potassium sorbet at 5.0 and potassium benzoate at 5.0% levels reduced *Fusarium* root rot by 68.4, 52.2, 51.8% and 60.4, 52.8, 50.4% at pre and post emergence damping-off, respectively.

Data in Table (2) clearly indicated that the obtained results followed the same trend of results in Table (1), as the combined treatments of seed bio priming plus seed soaking in potassium salts caused an effective reduction in *Rhizoctonia* root rot compared with using seed bio priming or potassium salts seed soaked treatments alone. The most effective seed treatments were seed bio priming combined with potassium sorbet or benzoate at 5.0% level followed by fungicide seed treatment (Rizolex-T), these treatments strongly decreased *Rhizoctonia* root rot at both pre and post emergence by 80.4, 78.8, 77.4% and 72.0, 70.4, 70.0%, respectively. Moreover, the highest values of the percentage of survival healthy plants were also recorded with such treatments since they gave 85.0, 83.7 and 81.5% compared with 39.4% of control treatment (untreated seeds).

Meanwhile, single treatments i.e. seed bio priming, potassium sorbet and potassium benzoate at 5.0% level clearly reduced *Rhizoctonia* root rot by 70.7, 66.6, 59.0% and 62.0, 55.2, 51.0% at pre and post emergence damping-off, respectively. Seed bio priming combined with seed soaking in potassium salts at 5.0% level was superior than fungicidal seed treatment in controlling of *Fusarium* root rot of green bean plant.

The observed decrements in *Fusarium* and *Rhizoctonia* root rot due to seed bio priming of green bean may be due to that priming induced quantitative changes in biochemical content of the seeds and improved membrane integrity (Callan *et al.,* 1991). This may be also due to the proliferation of the bio agent in the primed medium (El-Mohamedy *et al.,* 2006; El-Mougy and Abdel-Kader, 2008; Akram and Anjum, 2011).

The same trends were observed at 20 and 45 days after sowing date when seed bio priming treatments were applied. Seed bio priming treatments caused a highly significant control of root rot disease as shown in Table (3).

Table 3: Effect of seed bio priming and potassium salts treatments on damping off and root rot diseases incidence of green bean plant under field conditions (average of two seasons 2013 and 2014).

Seed treatments	Pre-emergence damping off after 15 days		Root rot incidence % after 40 days		Root rot incidence % after 60 days		Plant survival %
	Infection	Reduction %	Infection	Reduction %	Infection	Reduction %	
Bio priming TH	3.6	72.8	6.6	63.0	4.5	70.2	85.3
Potassium sorbate 5%	4.8	64.0	7.5	58.0	6.0	60.0	81.7
Potassium benzoate 5%	5.2	60.8	8.2	53.8	6.7	55.0	79.4
Seed bio priming TH + potassium sorbate 5%	1.9	85.5	3.9	78.2	1.8	88.2	92.4
Seed bio priming TH + potassium benzoate 5%	3.1	77.2	5.1	71.4	4.1	72.8	87.7
Fungicide (Rhizolex-T 3g/kg seed)	4.0	70.0	4.9	72.2	3.9	74.0	87.2
Control	13.4	0.0	17.8	0.0	15.0	0.0	53.8

Means within each column followed by the same letter are not significantly different according to Duncan's multiple range test at 5% level of probability.

Moreover, the highest values of plant survival percentage were recorded by application of such treatments. Seed bio primed and seed coated with either *T. hazianum* as well as seed dressed with fungicide treatment were the most effective treatments in controlling root rots caused by *R. solani, F. solani and F. oxysporum* after 45 days from sowing date. These treatments let to a considerable decrease of root rot disease caused by such pathogens by about 76.0, 76.0, 70.8%; 73.6, 71.2, 67.4% and 71.2, 68.8, 50.6%, respectively. Seed bio primed (application *T. harzianum* to green bean seeds during priming) alone or in combined with seed soaking in potassium sorbet or benzoate at 5.0% level resulted in evident reduction in root rots caused by *F. solani* and *R. solani*. These treatments were superior than seed dressed with fungicide (Rizolex-T) in controlling of root rot diseases under artificially infection under green house conditions. Based on this results, these promising treatments were chosen to apply under open field conditions to control root rot diseases of green bean plants.

Control of root rot diseases of green bean under field conditions

Since greenhouse pot experiments provided promising results, the same treatments were applied under field conditions to review the control of green bean root rot diseases in practical environment. The effects of promising seed treatments, i.e. seed bio priming (TH); fungicide treatment and combined treatments of seed bio priming + potassium sorbet or benzoate at 5.0% level on control of root rot diseases of green bean under field conditions were studied during both seasons of 2013 and 2014. Moreover, the beneficial effect of these treatments on vegetative growth and yield quality parameters of green bean were also recorded.

Influence of seed bio priming and potassium salts treatments on control of green bean root rot diseases

Seed bio priming treatment alone or combined with seed soaking in potassium sorbet or benzoate at 5.0% level strongly reduced root rot incidence at pre and post emergence stages of green bean plants, which led to a higher plant survival percentage (Table 3). The most effective treatments under field conditions were seed bio primed combined with seed soaking in potassium sorbet or benzoate at 5.0% level, these treatments reduced root rots at pre emergence damping-off by 85.5, 77.2% and root rot diseases after 40 and 60 days of seed sowing by 78.2, 71.4% and 88.2, 72.8%, respectively. Whereas, single seed treatments i.e., coated primed green bean seeds with *T. harzainum*, potassium sorbet or potassium at 5.0% level strongly reduced pre emergence damping off by 72.8, 64.8, 60.8% and root rot incidence after 40 and 60 days of sowing by 63.8, 58.0, 53.8% and 70.2, 60.0, 55.0%, respectively. Meanwhile, dressed green bean seeds with Rizolex-T decreased pre emergence and root rot incidence by 70.0% and 72.2, 74.0% after 40 and 60 days of seed sowing, respectively.

Many researchers have been demonstrated the potential of *Trichoderma* spp in controlling damping off and root rot diseases of crop plants caused by *Rhizoctonia solani* and *Fusarium* spp. Seed bio priming in which specific biological control agents are incorporated into the seed priming process, can be very effective in suppressing many disease caused by seed and soil borne pathogens. Moreover, bio priming has a great promise for enhancing the efficacy, shelf life and consistent performance of biological control agents.

Application of chemical resistance inducers such as potassium salts alone or combined with seed bio priming treatments significantly reduced *Rhizoctonia* and *Fusarium* root rots on green bean plants. In this respect, many workers have been conducted on chemical resistance inducers used for controlling root rot and wilt diseases under greenhouse and field conditions (Abdel-Kareem, 1998; Amel *et al.,* 2010 and Aheda and Juber, 2013).

It should be mentioned that some chemical inducers may also have a direct antimicrobial effect and consequently involved in cross linking in cell walls, induction of gene expression, phytoalexin production and induction of systemic resistance (Abdel-Monaim *et al.,* 2011). The applied chemical inducers might be stimulated some defense mechanisms such as phenolic compounds, oxidative enzymes and other metabolites (Abdel-Monaim *et al*., 2011; Amel *et al.,* 2010 and El-Mohamedy *et al*., 2013).

Influence of seed bio priming and potassium salts treatments on green bean growth characters

Data presented in Table (4) showed that the effect of seed bio priming and potassium salts soaking on vegetative growth characters of bean plants (average of two seasons, 2013 and 2014). It was evidently clear that most of the seed bio priming and potassium salts treatments greatly improved all measured growth characters of bean plants with various significant level compared with those of control in both seasons. However, seed bio priming plus potassium sorbet, seed bio priming plus potassium benzoate and Fungicide had the highest stimulation effect on bean plant growth characters i.e. (plant length, number of leaves and branches as well as fresh and dry weight of leaves and branches) compared with individual treatments and control. In addition**,** total leaf area/plant recorded no significant differences among treatments applied and when compared to control treatment. The positive effect of seed bio priming and potassium salts treatments have been repeatedly reported on many vegetable crops, for instance, it significantly increased vegetative growth parameters of soybean Ahmadvand *et al.* (2012) they reported that seed priming with KNO_3 caused a significant increase in germination and emergence percentage, radical and plumule length, seedling dry weight, plant height, plant leaf area and plant dry weight. In the same respect, Singh and Rao (1993) reported that under stress conditions, potassium nitrate effectively improved germination, seedling growth and seedling vigor index of the seeds of sunflower. Seed priming is a practical method with economic benefit for producers. In priming, seeds are soaked in different solutions with high osmotic potential, this prevents the seeds from absorbing enough water for radical protrusion, thus suspending the seeds in the lag phase (Taylor *et al*., 1998).

Table 4: Effect of seed bio priming and potassium salts treatments on vegetative growth of green bean plants (average of two seasons of 2013 and 2014).

Seed treatments	Plant length (cm)	Number of		Fresh weight (g)		Dry weight (g)		Leaf area/plant (cm^2)
		Leaves	Branches	Leaves	Branches	Leaves	Branches	
Bio priming TH	41.64	8.72	6.00	13.67	11.22	5.00	5.83	144.45
Potassium sorbate 5%	41.52	8.20	6.17	13.33	10.67	5.00	5.67	143.69
Potassium benzoate 5%	38.44	8.13	5.67	13.18	10.40	5.05	5.50	143.59
Seed bio priming TH + Potassium sorbate 5%	49.77	10.96	7.58	16.99	17.38	6.65	7.50	144.29
Seed bio priming TH + Potassium benzoate 5%	49.25	10.84	7.49	16.74	17.03	6.50	7.47	145.15
Fungicide (Rhizolex-T 3g/kg seeds)	44.15	9.90	7.07	15.83	15.84	5.83	7.00	144.63
Control	35.59	8.00	5.00	11.45	9.23	4.30	4.81	144.33
LSD at 5% level	6.20	1.21	1.72	3.59	1.92	0.94	1.15	N.S.

During priming process, this is the physical up take of water into seeds. It is usually very rapid because water potential difference between dry seeds and water is usually high. DNA and mitochondria repaired and protein is synthesized using existing messenger RNA. Few metabolic activities occur. However, little uptake of water thus there is little change in fresh weight of seeds. Also, considerable metabolic activities occur along with new physiological activities associated with germination including the synthesis of mitochondria and proteins relying on the translation of new mRNA. This is the time in which seed converts stored food reserves such as protein, fats and lipids into compounds needed for germination. Hence, both phases represent the process of germination and are the foundation of successful seed priming where the seed is brought to a moisture content that is just start of radical protrusion. The superiority effect of potassium salts treatments (Table 4) may be stimulated plant growth by the assimilation of major and minor elements, enzyme activation and/or inhabitation, changes in membrane permeability, protein synthesis and finally the activation of biomass production (El-Bassiony *et al.* 2010). These results are in line with that obtained by Abdel-Razzak and El-Sharkawy (2013) and Shafeek *et al*. (2013).

Influence of seed bio priming and potassium salts treatments on green bean total yield and its components

Total green pods yield as kg/fed. recorded the heaviest values (3666.33 kg/fed.) with green bean seed bio priming plus potassium sorbate at 5% level treatment compared with control treatment which recorded the lowest value for green pod yield (3453.00 kg/fed.). In descending order, seeds priming plus potassium benzoate recorded (3660 kg\fed.). In the same respect, using fungicide treatment recorded (3613.33 kg\fed.). The statistical analysis of the obtained results showed that significant differences were detected among treatments except with application of seed bio priming, potassium sorbet and potassium benzoate individually. However, number of pods/plant, weight of pods/plant, average of pod weight (g) and total yield of green pods/m^2 (kg) followed the same pattern of significance as shown in Table (5). It could be concluded that the best values of yield physical properties, which resulted by bean seed bio priming with potassium salts may be attributed to the best vigor of plant growth characters Table (4).

There is no doubt that, potassium as a nutritional element plays an important part in regulation of many physical criteria in plant, which in turn effect on the resulted total yield. The trend of obtained results are in good accordance with previous investigators (Ruan *et al.,* 2002; Hussain *et al*., 2014 and Sarmadi *et al.,* 2014).

Table 5: Effect of seed bio priming and potassium salts treatments on total yield of pods of green bean plants (average of two seasons of 2013 and 2014).

Seed treatments	Number of pods/plant	Weight of pods/plant (g)	Average of pod weight (g)	Total yield of green pods/ m^2 (kg)	Total yield of green pods/ fed. (kg)
Bio priming TH	17.33	42.81	1.86	8.68	3535.00
Potassium sorbate 5%	17.17	42.91	1.85	8.73	3519.67
Potassium benzoate 5%	17.02	42.60	1.86	8.66	3508.33
Seed bio priming TH + potassium sorbate 5%	20.50	48.18	1.95	9.83	3666.33
Seed bio priming TH + potassium benzoate 5%	20.33	46.56	1.93	9.74	3660.00
Fungicide (Rhizolex-T 3g/kg seed)	20.09	44.93	1.89	9.62	3613.33
Control	15.31	40.67	1.76	8.42	3453.00
LSD at 5%	2.81	4.23	0.16	0.94	136.12

Influence of seed bio priming and potassium salts treatments on green bean nutrition values

Data in Table (6) showed that seed bio priming plus potassium salts treatments gave the highest significant values of the percentage of nitrogen, phosphorus, potassium, protein and dry matter contents in bean pods tissues. Whereas, no significant differences were realized among application of seed bio priming or potassium salts soak as individual treatment.

Similar results were obtained by Ahmadvand *et al*. (2012), Hussain *et al*. (2014) and Sarmadi *et al.* (2014).

Table 6: Effect of seed priming and potassium salts treatments on chemical quality of pods of green bean plants (average of two seasons of 2013 and 2014).

Seed treatments	Chemical quality of pods of green bean				
	N%	Protein%	P%	K%	Dry matter %
Bio priming TH	3.13	19.56	0.345	2.12	6.72
Potassum sorbate 5%	3.11	19.46	0.344	2.12	6.56
Potassum benzoate 5%	3.09	19.33	0.344	2.11	6.35
Seed bio priming TH + potassum sorbate 5%	3.16	19.73	0.348	2.16	7.11
Seed bio priming TH + potassum benzoate 5%	3.15	19.67	0.348	2.16	7.11
Fungicide (Rhizolex-T 3g/kg seeds)	3.15	19.67	0.347	2.14	6.98
Control	3.04	18.98	0.339	2.10	6.55
LSD at 5% level	0.10	0.62	0.008	2.16	0.52

Conclusion

Controlling of soil-borne pathogens is difficult since they produce resting structures such as chlamydo spores and sclerotia resistant to adverse environmental conditions. The misuse of chemicals to control these pathogens caused enormous problems to ecosystem and human's health as well as has led to development of resistant races of pathogens. This research paper aimed to protect green bean plants against soil-borne pathogens (*F. solani* and *R. solani*) and improve growth, yields and nutritional values by using seed bio priming treatments as an environmental friendly alternative to fungicides. Results obtained showed that using seed bio priming plus potassium salts soak treatments induced a high reduction in root rots disease incidence as well as promoted plant growth, total pods yield and its nutritional values under greenhouse and field conditions.

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