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Application of Fungicides Alternatives for Controlling Cowpea Root Rot Disease under Greenhouse and Field Conditions

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Potassium sorbate, sodium benzoate and Acetylsalicylic acid (ASA) individually as seed soaking and/or followed by foliar spray were evaluated for their efficacy against cowpea root rot disease under greenhouse and field conditions. *In vitro* assay revealed that complete inhibition of linear growth was obtained with potassium sorbate and sodium benzoate at 6.0% for *R. solani* and 8.0% for *F. solani* while the same effect was observed by ASA at 15.0 & 20.0mM on the growth of the two fungi, respectively. Greenhouse experiments indicated that all treatments have significantly reduced the percentage of cowpea root rot incidence. Moreover, using seed soaking with 9% potassium sorbate, sodium benzoate or 20 mM solutions combined with foliar spray with 1.0 g/l and 7.5 mM of the same components caused significant reduction in root rot incidence caused by both of *F. solani* and *R. solani* comparing with fungicide or untreated (check) treatments in pot experiments. The promising treatments in pot experiments were evaluated under field conditions during two successive growing seasons. Results indicate that all applied treatments could reduce significantly the percentage of root rot incidence. Cowpea seeds soaked in 20 mM ASA solution followed by plant foliar spray with 7.5 mM caused root rot reduction estimated by 40.1 and 40.7% at pre- and post-emergence stages. Meanwhile, the highest concentration of similar treatments of potassium sorbate and sodium benzoate caused reduction in disease incidence calculated as (38.3 & 39.4%) and (39.4 & 39.1%) at pre, and post-emergence stages, respectively. As for cowpea yield, the combined treatment at highest concentrations caused an increase in cowpea yield estimated as 39.3, 31.2 and 28.2%, respectively. This figure was decreased by the decrease of spraying solution concentration to reach its minimum at 2.5 mM, 0.25 and 0.25 g/l of ASA, potassium sorbate and sodium benzoate recording yield increase by 32.0, 19.8 and 15.6%, respectively. The combined treatments between potassium sorbate, sodium benzoate or ASA as seed soaking followed by foliar spray with the same component are considered non harmful control methods which have advantage and limitation. Therefore, such application might be used as an effective and safe technique for controlling soilborne plant pathogens in addition to avoid environmental pollution due to decrease the usage of chemical fungicides.

Key words: **A**cetylsalicylic acid, cowpea, foliar spray, fungicide alternative, potassium sorbate, root rot, seed dressing and sodium benzoate.

Cowpea (*Vigna sinensis* Endl.) is considered as one of the vegetable crops which have an importance for local consumption and exportation purposes in Egypt. Cowpea plants are attacked by soilborne pathogenic fungi causing root diseases which seriously affected plant stand and yield production. Root rot diseases caused by *Fusarium solani* and *Rhizoctonia solani* were reported by many investigators as the most aggressive fungi attacking cowpea plants during growing season (Shihata and Gad El-Hak, 1989 and Satish *et al*., 2000). Root rot disease appears during the growing season at both pre- and post-emergence stages of plant growth (Abdel-Kader and Ashour, 1999). Fungicides could successfully control root rot diseases, however it negatively affect human health and environment (Rauf, 2000). Therefore, recently there are several attempts for using fungicidal alternatives for controlling plant diseases. In this concern, food preservatives as potassium sorbate or sodium benzoate are reported to have antifungal activities against several fungi (Oliver *et al.*, 1999; Al-Zaemey *et al.,* 1993). Using potassium sorbate or sodium benzoate against postharvest diseases of tomato, apple, carrots and potato were reported by Saleh and Huang (1997), Oliver *et al.* (1998) and Ryu and Holt (1993). Moreover, El-Mougy (2002) reported that salicylic acid and acetylsalicylic acid proved antimicrobial effect on some fungal and bacterial plant pathogens and completely inhibited their growth at certain concentrations under *in vitro* conditions. She (2004) added that using salicylic acid (SA) or acetylsalicylic acid (ASA) as seed dressing or soil drench have reduced root rot infection of lupin plants under greenhouse conditions. Furthermore, resistance against plant pathogens can be also induced by salicylic acid or acetylsalicylic acid (Floryszek and Wieczorek, 1993). Dennis and Guest (1995) reported that treatment of tobacco plants with aqueous acetylsalicylic acid (aspirin) and beta-ionone reduced the severity of symptoms caused by *Phytophthora parasitica* var. *nicotianae*, the causal agent of black shank, and tobacco necrosis virus (TNV). Spraying cucumber plants with ASA induced resistance against downy and powdery mildews and increased fruit yield per plant under commercial greenhouse conditions (Abd-El-Kareem, 1998). Abd-El-Kareem *et al.* (2001 and 2002) reported that treated potato plants with aspirin induced resistance against late and early blight diseases and increased tuber yield.

The present study aimed to evaluate the efficacy of potassium sorbate, sodium benzoate and acetylsalicylic acid as seed soaking and/or foliar application for controlling cowpea root rot diseases under greenhouse and field conditions.

Materials and Methods

Root rot pathogens:

An isolate of each of *Fusarium solani* and *Rhizoctonia solani*, obtained from Plant Pathol. Dept., National Res. Centre, Egypt, were used in the present study. These isolates proved to be aggressive for inducing root rot of cowpea, bean, faba bean and lupin in previous studies.

In vitro assay:

The inhibitory effect of potassium sorbate, sodium benzoate and acetylsalicylic acid (ASA) on the linear growth of *Fusarium solani* and *Rhizoctonia solani*, the cowpea root rot pathogens, was evaluated. Five concentrations of potassium sorbate

and sodium benzoate, *i.e.* 2, 4, 6 and 8 g/100ml as well as four concentrations of ASA, *i.e.* 5, 10, 15 and 20 mM, were tested. Tested solutions were added to conical flasks containing sterilized PDA medium before solidifying to obtain the proposed concentrations and shaked gently, then dispensed into sterilized Petri dishes (10-cm-diameter). Petri dishes were individually inoculated with equal disks (6-mm-diam.), taken from 10-day-old cultures of tested fungi, and incubated at 25±1^{0}C for 7 days, then examined. The average linear growth of tested fungi and its reduction percentages were calculated.

Greenhouse experiments:

The efficacy of potassium sorbate, sodium benzoate and acetylsalicylic acid as seed soaking and/or foliar spraying on root rot disease of cowpea was evaluated under greenhouse conditions. Different concentrations of these materials were evaluated as seed soaking only. Furthermore, the most efficient tested dose was evaluated again for seed soaking in combination with foliar spray.

Loamy soil was artificially infested individually with the inoculum of *Fusarium solani* or *Rhizoctonia solani* (at the rate of 5% w/w), previously grown for two weeks on sand barley medium (1: 1, w/w and 40% water) at 25±2ºC. A set of each infested soil was placed in plastic pots (20-cm-diam.) and sown with disinfected cowpea seeds, as relevant to each treatment as follows:

(a) Seed dressing only:

Cowpea seeds were individually soaked for one hour in each solution of either;

1- Potassium sorbate solution at concentrations of 3, 6 or 9% or;
2- Sodium benzoate solution at concentration of 3, 6 or 9% or;
3- ASA solution at concentration of 10, 15 and 20 mM.

(b) Seed dressing followed by foliar spray:

Cowpea seeds were individually soaked for one hour in each solution of the highest concentration of tested chemicals followed by foliar application with the same used chemical as;

1- Potassium sorbate at 9% as seed soaking and 0.25, 0.50 and 1.0 g/l foliar spray or;
2- Sodium benzoate at 9% as seed soaking and 0.25, 0.50 and 1.0 g/l foliar spray or;
3- ASA at 20 mM as seed soaking and 2.5, 5 and 7.5 mM foliar spray.

(c) Foliar spray only:

1- Potassium sorbate at 0.25, 0.50 and 1.0 g/l or;
2- Sodium benzoate at 0.25, 0.50 and 1.0 g/l or;
3- ASA at 2.5, 5.0 and 7.5 mM.

The previous treatments carried out in consideration that the foliar spray was applied at the emergence time of the first true leaf (10 days after sowing). The fungicide Rizolex-T was applied for comparison treatment as seed dressing in artificially infested soils at the recommended dose (3 g/kg seeds). A set of disinfected cowpea seeds were sown in artificially infested soils, and served as general check treatment. Five cowpea seeds (cv. Dokki 331) were sown in each pot and five pots were used as replicates for each particular treatment. Percentage of root rot disease incidence was calculated at both pre- and post–emergence stages after 20 and 40 days of sowing date.

Field experiments:

These experiments were carried out in the experimental farm of National Res. Centre at El-Qanater El-Khairiya, Qalubiya governorate during two successive growing seasons, *i.e.* the Nili season 2003/2004 and the early summer cultivation season, 2004 in naturally heavily infested field with cowpea root rot pathogenic fungi. The promising and successful applied treatments in pot experiment were evaluated on root rot incidence of cowpea under field conditions.

Potassium sorbate and sodium benzoate solutions at the dosage of 9.0% as seed soaking singly or combined individually with the same chemicals as foliar spray at concentrations of 0.25, 0.50 and 1.0 g/l as well as seed soaking followed by foliar application with ASA at concentrations of 20.0 and 2.5, 5.0 & 7.5 mM, respectively. Seed dressing with the fungicide Rizolex-T at 3 g/kg seeds was applied as comparison treatment, in addition to untreated cowpea seeds for general check.

A field experiment consisted of plots (7 x 6 m) each comprised of 12 rows and 60 pits / holes / row, which were conducted in randomly complete block design with three replicates (plots) for each particular treatment as well as the control (check). Cowpea seeds (cv. Dokki 331) were sown in all treatments at the rate of 3 seeds/pit. All plots were sown on the first of each October, 2003 and March, 2004 for the Nili and early summer cultivation seasons. The cultivated plots received the traditional agricultural practices. Percentage of root rot incidence at pre- and post-emergence growth stages of cowpea plants was recorded after 25 and 45 days of sowing date. Obtained cowpea yield was determined as fresh pods for each particular treatment at the end of growing seasons and the average of the accumulated yield kg/plot was calculated.

Statistical analysis:

Tukey test for multiple comparisons among means was utilized after (Neler *et al*., 1985).

Results and Discussion

In vitro assay:

Four concentrations of each of potassium sorbate, sodium benzoate, *i.e.* 2, 4, 6 & 8 g/100 ml and ASA, *i.e.* 5, 10, 15 & 20 mM were evaluated under *in vitro* condition for their inhibitory effect against the growth of *Fusarium solani* and *Rhizoctonia solani* the cowpea root rot pathogens.

Results in Table (1) indicate that all treatments significantly reduced the linear growth of both tested fungi. The fungal growth affected negatively with the increasing concentrations of the tested chemicals. Complete inhibition of linear growth of *F. solani* was observed when potassium sorbate and sodium benzoate added to the growth medium at concentration of 8% as well as ASA at 20 mM. In this regard, *R. solani* showed more sensitivity towards these chemical as its growth was completely inhibited at 6% of each of potassium sorbate and sodium benzoate and 15 mM of ASA as well. This observation was true for tested chemicals at all used concentrations. Similar results were reported by many investigators. In this

Table 1. Reduction in the growth of *F. solani* and *R. solani* in response of different concentrations of potassium sorbate, sodium benzoate and ASA

Tested chemical	Concentration	*F. solani*		*R. solani*	
		Linear growth (mm)	Reduction (%)	Linear growth (mm)	Reduction (%)
Sodium benzoate	2%	56.7 b*	37.0	52.1 b	42.1
	4%	44.7 c	50.3	35.4 c	60.7
	6%	21.4 e	76.2	0.0 e	100
	8%	0.0 f	100	0.0 e	100
Potassium sorbate	2%	50.1 c	44.3	45.2 b	49.8
	4%	40.5 c	55.0	38.1 c	57.7
	6%	18.4 e	79.6	0.0 e	100
	8%	0.0 f	100	0.0 e	100
ASA	5.0 mM	55.4 b	38.4	41.2 c	54.2
	10.0 mM	33.7 d	62.6	18.6 d	79.3
	15.0 mM	21.1 e	76.6	0.0 e	100
	20.0 mM	0.0 f	100	0.0 e	100
Check	0.0	9.00 a	----	9.00 a	--

* Figures with the same letter are not significantly different (P= 0.05).

concern, the food preservatives, *i.e.* potassium sorbate and sodium benzoate, were reported to have antifungal activities against postharvest decaying fungi (Oliver *et al.*, 1999 and Al-Zaemey *et al.*, 1993). Abd-El-Kareem (2002) reported that potassium sorbate and sodium benzoate at 2.0 and 2.5 %, respectively, caused complete inhibition in the *in vitro* linear growth and spore germination of *Penicillium digitatum* and *P. italicum.* On the other hand, the efficacy of ASA as an antifungal substance against various plant pathogenic fungi has been discussed by many investigations. Srinivas *et al.* (1997) indicated that acetylsalicylic acid (ASA) was highly effective in inhibiting the *in vitro* mycelial growth of *Alternaria solani*. Moreover, El-Mougy (2002) recorded that the mycelial linear growth of pathogenic fungi was decreased significantly by increasing the concentrations of SA and ASA. *Fusarium solani* f.sp. *pisi, Rhizoctonia solani* (AG-4) and *Sclerotium rolfsii* showed high sensitivity to the used chemicals where their growth was completely inhibited at 20 mM of SA, ASA.

Greenhouse experiments:

Different concentrations of potassium sorbate, sodium benzoate or ASA were applied as seed soaking to evaluate their efficacy on cowpea root rot incidence at the pre-emergence stage of cowpea plants growth under greenhouse conditions. Data in Table (2) indicate that all treatments have reduced significantly the percentage of cowpea root rot incidence at pre-emergence stage caused by *F. solani* or *R. solani.* It is interesting to note that the percentage of disease incidence was reduced as the concentrations of all tested chemicals were increased to reach its minimum at the highest dosage used of each of potassium sorbate, sodium benzoate and ASA. Data

Table 2. Percentage of root rot incidence of cowpea in response to potassium sorbate, sodium benzoate and ASA as seed dressing application under greenhouse conditions

Treatment		Fusarium root rot (Pre- & Post-emergence)				Rhizoctonia root rot (Pre- & Post-emergence)			
Seed dressing	Concent-ration	Pre-	Reduction (%)	Post-	Reduction (%)	Pre-	Reduction (%)	Post-	Reduction (%)
Sodium benzoate	٣%	٤٢,٤ c	٢٢,٢	45.8 c	27.7	٣٨,٤ c	٣٨,٢	41.3 c	39.7
	٦%	٢١,٧ e	٦٠,١	26.2 e	58.6	١٧,٥ e	٧١,٩	15.8 e	76.9
	9%	٦,٠ f	٨٨,٩	7.6 f	88.0	٤,٠ f	٩٣,٥	3.8 f	94.4
Potassium sorbate	3%	٥٠,٤ b	٧,٥	52.6 b	17.0	٤٢,١ b	٣٢,٣	44.5 b	34.9
	6%	١٨,٦ e	٦٥,٨	19.3 e	69.5	١٤,٢ e	٧٧,١	16.2 e	76.3
	٩%	٦,٣ f	٨٨,٤	7.2 f	88.6	٥,١ f	٩١,٨	6.2 f	90.9
ASA	١٠,٠mM	٣٥,٤ d	٣٥,٠	39.7 d	37.3	٢٨,٤ d	٥٤,٣	31.3 d	68.4
	١٥,٠ mM	٢١,٠ e	٦١,٤	24.4 e	61.5	١٤,٥ e	٧٦,٦	15.7 e	77.0
	٢٠,٠ mM	٨,٠ f	٨٥,٣	9.6 f	84.8	٦,٥ f	٨٩,٥	6.9 f	89.9
Rizolex-T (٣g/kg seeds)		٢٨,٨ e	٤٧,١	31.9 e	49.6	٢٤,٦ e	٦٠,٤	26.1 e	61.8
Check (untreated)		٥٤,٥ a	----	63.4 a	----	٦٢,٢ a	----	68.4 a	----

* Figures with the same letter are not significantly different (P= 0.05).

also show that the most effective treatments were potassium sorbate, sodium benzoate at concentration of 9% and ASA at 20 mM. They reduced the Fusarium root rot by 88.9, 88.4 and 85.3%, respectively. Meanwhile, Rhizoctonia root rot incidence was reduced by 93.5, 91.8 and 89.5%, in respective order with the same concentrations of tested chemicals. Moreover, the tested chemicals showed superior effect on disease incidence comparing with fungicidal treatment. Moderate reduction in disease incidence was observed when cowpea seeds were treated with the fungicide Rizolex-T, which reduced Fusarium and Rhizoctonia root rot by 47.1 and 60.4%, respectively.

Although, the percentage of root rot incidence caused by *R. solani* showed lower disease readings than that recorded by *F. solani* at all treatments, while untreated (check) seeds showed the opposite trend as no significant differences were observed between these treatments at the same concentration of tested chemicals. This observation confirm the recorded results in the present study that the high sensitivity of *R. solani* comparing with *F. solani* against different concentrations of potassium sorbate, sodium benzoate and ASA *in vitro*. These observations were also confirmed with the presented data in Table (3).

Potassium sorbate, sodium benzoate solutions at 9.0% as well as ASA at 20.0 mM as cowpea seed soaking singly or combined with foliar spray with the same tested materials at 0.25, 0.50, 1.0 g/l and 2.5, 5.0, 7.5 mM, in respective order, in addition to single treatment as foliar spray only were evaluated against root rot incidence of cowpea plants.

Table 3. Percentage of cowpea root rot incidence in response to potassium sorbate, sodium benzoate and ASA as seed dressing and/or foliar application under greenhouse conditions

Treatment		Fusarium root rot (Pre- & Post-emergence)				Rhizoctonia root rot (Pre- & Post-emergence)			
Seed dressing	Foliar spray	Pre-*	Reduction (%)	Post-	Reduction (%)	Pre-	Reduction (%)	Post-	Reduction (%)
Sodium benzoate (0%)	0.25 g/l	30.2 b	35.8	49.0 b	21.0	36.4 b	37.8	49.5 b	27.6
	0.50 g/l	27.5 b	41.6	48.2 b	22.7	33.8 b	42.3	45.5 b	33.4
	1.0 g/l	25.3 b	46.2	46.2 b	25.9	29.6 b	49.4	44.3 b	35.2
Sodium benzoate (9%)	0.0 g/l	13.2 cd	71.9	16.8 cd	73.0	12.7 cd	78.3	15.5 cd	77.3
	0.25 g/l	12.6 de	73.2	14.0 de	77.6	10.8 de	81.5	14.5 de	78.8
	0.50 g/l	9.4 e	80.0	10.0 e	83.9	7.3 e	87.5	8.0 e	88.3
	1.0 g/l	7.7 e	83.6	8.6 e	86.2	6.9 e	89.7	8.0 e	88.3
Potassium sorbate (0%)	0.25 g/l	38.3 b	18.6	50.1 b	19.7	32.6 b	44.3	52.5 b	23.2
	0.50 g/l	34.1 b	27.6	46.3 b	25.8	30.4 b	48.1	46.4 b	32.2
	1.0 g/l	32.9 b	30.1	45.4 b	27.1	29.8 b	49.1	44.5 b	34.9
Potassium sorbate (9%)	0.0 g/l	11.9 c	74.7	22.2 c	64.4	19.4 d	66.8	19.4 d	71.6
	0.25 g/l	11.6 cd	75.3	21.0 cd	66.3	16.4 d	72.0	18.4 d	73.0
	0.50 g/l	10.8 ed	77.0	12.0 ed	80.8	9.4 ed	83.9	11.0 ed	83.9
	1.0 g/l	6.9 e	85.3	8.0 e	87.2	6.8 e	88.3	7.5 e	89.1
ASA (0 mM)	2.5 mM	37.2 b	21.0	45.2 b	27.6	30.4 c	48.1	34.1 c	50.1
	5.0 mM	34.6 b	26.5	43.4 b	30.4	29.6 c	49.4	32.4 c	52.6
	7.5 mM	31.4 b	33.3	41.6 b	33.3	27.8 c	52.5	32.4 c	52.6
ASA (20 mM)	0.0 mM	10.2 de	78.3	12.7 de	79.6	9.7 de	83.4	11.5 de	83.1
	2.5 mM	9.2 e	80.4	10.0 e	83.9	8.7 e	85.1	9.4 e	86.3
	5.0 mM	7.1 e	84.9	8.0 e	87.2	6.6 e	88.7	8.0 e	88.3
	7.5 mM	6.0 e	87.2	7.5 e	87.9	6.0 e	89.7	8.0 e	88.3
Rizolex-T (3g/kg seeds)		34.5 b	26.7	43.8 b	29.8	30.2 b	48.4	41.5 b	39.3
Check (untreated)		47.1 a	----	62.4 a	----	58.6 a	----	68.4 a	----

* Figures with the same letter are not significantly different (P= 0.05).

Data presented in Table (3) indicate that all treatments have significantly reduced root rot incidence. The highest reduction was obtained at treatment of ASA 20.0 mM as seed soaking followed by foliar spray at 2.5, 5.0 and 7.5 mM. They reduced the disease incidence caused by *F. solani* between (80.4-87.2%) and (83.9-87.9%) at pre- and post-emergence stages, respectively. As for Rhizoctonia root rot the same treatments have reduced disease incidence by 85.1-89.7% and 86.3-88.3% at successive plant growth periods pre- and post-emergence stages, respectively. Data also show that the moderate reduction in disease incidence was observed in treatments of potassium sorbate and sodium benzoate as 9.0% seed soaking singly or combined with foliar spray at 0.25, 0.50 and 1.0 g/l. They reduced Fusarium root rot by 71.9-85.3% and 64.4-87.2%, while Rhizoctonia root rot was decreased by 66.8-89.7% and 71.6-89.1% at pre- and post-emergence stages, respectively. The presented results in Table (3) indicate that combination treatments between seed and foliar application showed significant superior effect on root rot incidence comparing with each treatment alone as well as the fungicide Rizolex-T.

Field experiments:

The promising treatments in pot experiments in addition to Rizolex-T at 3 g/kg seeds were applied during two successive growing seasons to evaluate their efficacy against root rot incidence and produced yield of cowpea plants under field conditions. The applied treatments in the two successive cultivated seasons showed similar trend for reducing the incidence of cowpea root rot disease. The averages of the obtained results were presented in Tables 4 and 5.

Data presented in Table (4) indicate that all applied treatments could reduce significantly the percentage of root rot incidence at both pre- and post-emergence stages. The highest reduction was observed with ASA treatments followed by potassium sorbate and sodium benzoate in a respective order. Cowpea seeds soaked in 20 mM ASA solution followed by plant foliar spray with 7.5 mM caused root rot reduction estimated by 40.1 and 40.7% at pre- and post-emergence stages.

Table 4. Effect of seed soaking and/or foliar spray with Potassium sorbate, Sodium benzoate or ASA on root rot incidence of cowpea plants under field conditions

Treatment		Root rot incidence (%) (Average records of 2003/2004 and 2004 seasons)			
Seed soaking	Foliar spray	Pre-emergence	Reduction (%)	Post-emergence	Reduction (%)
Sodium benzoate (9.0 %)	0.0 g/l	18.4 b*	35.2	22.1 b	29.6
	0.25 g/l	17.8 b	37.3	20.4 c	35.0
	0.50 g/l	17.4 c	38.7	19.7 c	37.2
	1.0 g/l	17.2 c	39.4	19.1 b	39.1
Potassium sorbate (9.0%)	0.0 g/l	20.4 b	28.1	21.5 b	31.5
	0.25 g/l	18.7 b	34.1	20.0 c	36.3
	0.50 g/l	18.3 c	35.5	19.6 c	37.5
	1.0 g/l	17.5 c	38.3	19.0 b	39.4
ASA (20.0 mM)	0.0 mM	20.8 b	26.7	20.4 b	35.0
	2.5 mM	18.4 c	35.2	19.5 c	37.8
	5.0 mM	18.2 c	35.9	19.0 c	39.4
	7.5 mM	17.0 c	40.1	18.6 c	40.7
Rizolex- T (3g /kg seeds)		23.5 b	17.2	24.6 b	21.6
Check (untreated)		28.4 a	----	31.4 a	----

*Figures with the same letter are not significantly different (P= 0.05).

Meanwhile, the highest concentration of similar treatments of potassium sorbate and sodium benzoate caused reduction in disease incidence reached 38.3 & 39.4% and 39.4 & 39.1% at pre- and post-emergence stages, respectively.

Data also show that no significant differences were observed between all tested treatments as seed soaking and fungicide seed dressing application, however they were significantly efficient in reducing root rot incidence when comparing with untreated check treatment.

Reduction in disease incidence means increasing in plant stand which reflected on the obtained yield. Data in Table (5) indicate that the applied combined treatments of cowpea seed soaking followed by foliar spray with the highest concentrations of ASA, potassium sorbate and sodium benzoate caused an increase in cowpea yield estimated as 39.3, 31.2 and 28.2 %, respectively. This figure was decreased by the decrease of spraying solution concentration to reach its minimum at 2.5 mM, 0.25 and 0.25 g/l of ASA, potassium sorbate and sodium benzoate recording yield increase by 32.0, 19.8 and 15.6 %, respectively. Furthermore, no significant difference was observed in the obtained yield between seed treatment only with ASA, potassium sorbate, sodium benzoate and Rizolex-T as well as untreated check treatments. They increased the produced yield over check treatment as much as 13.7, 11.4, 9.9 and 8.0%, respectively. Similar results were also recorded by many investigators.

Table 5. Cowpea yield in response to seed soaking and/or foliar spray with Potassium sorbate, Sodium benzoate or ASA under field conditions

Treatment		Average accumulated cowpea yield as fresh pod (Average records of 2003/2004 and 2004 seasons)	
Seed dressing	Foliar spray	Yield (kg / plot)	Increase (%)
Sodium benzoate (9.0%)	0.0 g/l	28.8 a	9.9
	0.25 g/l	30.3 b	15.6
	0.50 g/l	31.4 b	19.8
	1.0 g/l	33.6 b	28.2
Potassium sorbate (9.0%)	0.0 g/l	29.2 a	11.4
	0.25 g/l	31.4 b	19.8
	0.50 g/l	33.6 b	28.2
	1.0 g/l	34.4 b	31.2
ASA (20.0 mM)	0.0 mM	29.8 a	13.7
	2.5 mM	34.6 b	32.0
	5.0 mM	35.7 b	36.2
	7.5 mM	36.5 b	39.3
Rizolex- T (3g /kg seeds)		28.3 a	8.0
Check (untreated)		26.2 a	----

* Figures with the same letter are not significantly different (P= 0.05).

In this regard, El-Gamal *et al*. (2003) found that bean seed dressing with chitosan or ASA followed by foliar spray with the same components at different concentrations caused yield increase ranging between 44.3-62.8% and 29.5-63.2%, respectively.

In the present study, seed soaking only with ASA, potassium sorbate and sodium benzoate or combined with foliar spray with the same chemicals proved to be effective treatments for controlling root rot incidence of cowpea under greenhouse and field conditions.

Many investigators evaluated these chemicals as anti-microbial inhibitors and for plant diseases suppression. In this concern, the food preservatives potassium sorbate or sodium benzoate were reported to have antifungal activities against several fungi as well as post harvest decaying fungi (Oliver *et al.*, 1999 and Al-Zaemey *et al.*, 1993). They were also used against postharvest diseases of apple, carrots, citrus, tomato, and potato (Ryu and Holt, 1993; Saleh and Huang, 1997 and Abd-Alla, 2003). Similar results were also reported against plant diseases using acetylsalicylic acid as seed dressing and or foliar spray. Dennis and Guest (1995) reported that treated tobacco plants with ASA reduced severity of necrosis virus (TNV). Also, Voget and Buchenauer (1997) stated that ASA could reduce powdery mildew incidence in cucumber when applied as seed treatment, soil drench and foliar spray. Furthermore, spraying cucumber plants with ASA induced resistance against downy and powdery mildews and increased fruit yield per plant was also reported by Abd-El-Kareem (1998).

Salicylic acid and/or acetylsalicylic acid (ASA) were also reported to induce resistance in many host–pathogen systems (Okuno *et al*., 1991 and Walters *et al*., 1993). It was postulated that ASA may act as transmissible signal for induction of resistance (Metraux *et al*., 1990 and Verooij *et al*., 1994). It was found that ASA plays its role in induction of resistance by stimulating the biosynthesis of different families of P-R-proteins (Raskin, 1992) and increasing the activities of chitinase and ß-1,3-glucanase (Schneider and Ullrich, 1994). Moreover, Abd-El-Kareem *et al*. (2001 and 2002) reported that treated potato plants with acetylsalicylic induced resistance against late and early blight diseases and increased tuber yield under field conditions.

The obtained results in the present study indicate that fungicide treatment was effective against cowpea root rot, however it had high risk for environmental pollution and residual effects. The combined treatments between potassium sorbate, sodium benzoate or ASA as seed soaking following by foliar spray with the same component are considered non harmful control methods which have advantage and limitation. Therefore, such application could be used as an effective and safe technique for controlling soilborne plant pathogens in addition to avoid environmental pollution due to decrease the usage of chemical fungicides. The integration of such fungicide alternatives with biological and cultural methods may improve the control of soilborne diseases and should be considered for further investigations.

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استخدام بعض بدائل المبيدات في مكافحة عفن جذور اللوبيا تحت ظروف الصوبة والحقل

نهـــال ســـامي المـــوجي و فريـــد عبـــد الكـــريم
و نادية جميل الجمال و يحي عمر فتوح
قسم أمراض النبات - المركز القومي للبحوث - جيزة- مصر.

تم إجراء تقييم لمكافحة مرض عفن ا لجذور في اللوبيا باســتخدام حمــض الاسيتيل ساليسيلك و سوربيت البوتاسيوم و بنزوات الصوديوم كمعاملة منفــردة للبذور أو متبوعا برش المجموع الخضري بنفس المركبات وذلك تحت ظروف الصوبة والحقل.

أظهرت الاختبارات المعملية على الفطريات المسببة لعفن جــذور اللوبيــا حدوث تثبيط كامل لنمو الفطر رايزوكتونيا سولانى عند إضافة كل من سوربيت البوتاسيوم وبنزوات الصوديوم إلى بيئة النمو بتركيز ٦% وعند زيادة التركيــز إلى ٨% لوحظ التثبيط الكامل لنمو الفطر فيوزاريوم اوكسيسبوريوم ، كما لوحظ نفس التأثير عند استخدام حمض الاسيتيل ساليسيلك بتركيزا ت ١٥ ، ٢٠ ملليموز على التوالي.

في تجارب الأصص وجد أن غمر بذور اللوبيــا فــي محلــول ســوربيت البوتاسيوم وبنزوات الصوديوم بتركيز ٩% أو حمض الاسيتيل ساليسيلك بتركيز ٢٠ ملليموز متبوعا برش المجموع الخضري بنفس المركبات بتركيز ١ جم/لتر و ٥ر٧ملليموز كانت أفضل المعاملا ت في تقليل نسبة إصــابة اللوبيــا بعفــن الجذور معنويا وذلك مقارنة بمعاملات البذور فقط بالمبيد الفطري ريزولكس-ت.

تم تأكيد هذه النتائج وذلك عند إجراء تطبيق لهذه المعاملات تحت ظــروف الحقل حيث أوضحت النتائج حدوث نقص في نسبة إصابة اللوبيا بمرض عفــن الجذور يقدر بحوالي ٤٠% بالنسبة إلى معاملة المقارنة وذلــك عنــد اســتخدام حمض الاسيتيل ساليسيلك كمعاملة بذور ثم الرش للمجموع الخضري بتركيز ٢٠ ، ٥ر٧ ملليموز على التوالي ، بينما كانت معاملة البذور بسوربيت البوتاسيوم أو بنزوات الصوديوم بتركيزات ٩% ، ١ جم/لتر كمعاملات للبذور ثم الرش أن لها القدرة على إحداث نقص في نسبة حدوث عفن الجذور قبــل أو بعــد ظهــور البادرات فوق ســطح التربــة بنــسبة تتــراوح مــابين (٣ر٣٨ - ٤ر٣٩%) و (٤ر٣٩ - ١ر٣٩%) على التوالي.

لوحظ تأثير المعاملات السابقة على زيادة في محصول نباتات اللوبيا وذلك بالنسبة لمعاملة المقارنة ، وقد وجد أن أعلى زيادة في المحصول (٣ر٣٩%) تم تسجيلها بالنسبة للنباتات المعاملة بحمض الاسيتيل ساليسيلك متبوعا بمعــاملات سوربيت البوتاسيوم ثم بنزوات الصوديوم واللاتي أدت إلى زيادة في المحصول قدرت بحوالي ٣ر٣١ ، ٢ر٢٨% على التوالي.

تشير نتائج هذه الدراسة إلى أن اســتخدام حمــض الاســيتيل ساليــسيلك ، سوربيت البوتاسيوم ، بنزوات الصوديوم كمعاملة للبذور متبوعا بالرش للمجموع الخضري يعتبر من الطرق الحديثة الآمنة ذات الكفاءة العالية والتي يمكن تطبيقها تحت ظروف الحقل لمكافحة مسببات أمراض النبــات الكامنــة فــي التربــة ، بالإضافة إلى أنها تعتبر بديلا لاستخدام المبيدات التي تدخل ضمن مسببات تلوث البيئة.