Reaction of Some Soybean Seed Coat Colors to Rhizoctonia Root Rot and Other Damping – Off Disease Agents, Yield and Yield Components

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ABSTRACT

Laboratory, pot and field experiments using two soybean cultivars had yellow colored seed coats namely Giza 111 and Toano in addition to two promising breeding genotypes had black and brown colored seed coats; naturally mutated from Toano[NMT] (black) and L159 L2 (brown), were carried out during two successive seasons 2014 and 2015 at Etay El-Baroud Agricultural Research Station, El-Beheira Governorate. Data of the laboratory experiment showed that there is a reversible relationship between seed coat extract concentrations, and *Rhizoctonia solani* growth diameter after 4 days, since the reduction was 18.89, 45.22 and 50.78% for the concentrations of 25, 50 and 75%, respectively for the black seed coat extract. In case of the brown seed coat extract concentrations, the same trend cleared where the fungal growth reductions were 22.56, 28.11 and 31.44%, respectively. The least reduction effect was observed with the yellow seed coat extract, where it was 11.44, 19.67 and 25.22% with the same concentrations mentioned above, respectively. Results of pot experiment showed that pre-emergence damping-off caused by *R. solani* was the least with the seedlings of black seed coat (NMT), followed by that of brown seed coat (L159 L2) and finally with that had yellow seed coat (Toano) with averages of 22.00, 23.35 and 26.77%, respectively. Removing seed coats (uncoated seeds) increased pre-emergence damping-off to 46.67, 50.00 and 66.67%, respectively. Also, disease severity showed the same trend with coated and uncoated colored seed coat genotypes. Under field conditions, at the first season the least pre-emergence damping-off was observed with Toano (yellow) followed by L159 L2 (brown), NMT (black) and Giza 111 (yellow) with averages of 15.67, 21.33, 29.00 and 32.00%, respectively. The same trend cleared in case of the post-emergence damping-off, where Toano had the least value followed by L159 L2, NMT and Giza 111 with averages of 4.35, 6.33, 6.61 and 12.68%, respectively. Data of the second season was parallel with that of the first one but with light differences in the arrangement. Soybean seed yield components at the first season showed that Giza 111 had the highest values in case of the number of pods/plant, number of seeds/plant, seed weight/plant (g), 100 seed weight (g), seed yield/plot (kg) and seed yield /feddan (ton) followed by L159 L2 and NMT, respectively. Also, data obtained in the second season were closed with that of the first season.

Key words: Soybean, *Glycine max*, Seed coat colors, Rhizoctonia root rot, Damping-off, *Rhizoctonia solani*

INTRODUCTION

Soybean and soy products represent one of the richest and most economical sources of protein (Codina *et al*., 2003). Soybean are used primarily not only as an oil seed but also serve as a feedstock for livestock and aqua culture, as well as being a good source of protein for the human diet (Masuda and Goldsmith, 2009 and Hartman *et al*., 2011).

Soybean contains 35-40% protein on a dry weight basis (Torres *et al*., 2006 and Liu, 2008) with all of the essential amino acids except for methionine and tryptophan (Zarkadas *et al*., 1993), which makes soy products almost equivalent in the quality of the protein to animal sources but with far less saturated fat and zero cholesterol (Young, 1991). Soybean contains about 30-32% of soluble and insoluble carbohydrates also minor constituents, including phospholipids, vitamins, minerals, trypsin inhibitors, phytic acid, saponins and isoflavones (Yue *et al*., 2010).

Soybean coat or testa is a protective outer covering of the ovule (Moise *et al*., 2005 and Miernyk *et al*., 2011). Soybean seed coats exist in a range of colors from black, brown, green, blue, yellow to mottle. Commercially grown soybean varieties have yellow seeds; however, some soybean varieties accumulate anthocyanins within the epidermal layer of the seed coat leading to the range in colors (Todd and Vodkin, 1993).

Some studies have found that dark-colored seed coats (brown and black) have characteristics of agronomic interest that have not been investigated in soybean seeds with yellow coat. Such contrasting seed coats have greater epidermis thickness, semi-permeability to water, greater resistance to deterioration, and higher concentration of phenolic compounds and lignin, which confer protection against biotic and abiotic factors (Ma *et al.*, 2004; Santos *et al.*, 2007 and Mertz *et al*., 2009).

Biologically active compounds contained in colored soybean seed coats such as isoflavones, saponins, proanthocyanidins and anthocyanins have been shown to prevent and to reduce macular degeneration, obesity cancer, and many other debilitating diseases (Lee *et al*., 2006a; Lee *et al*., 2006b; Messina, 2006 and O᾽Bryan *et al*., 2014). Irina *et al*. (2009) reported that treatment with anthocyanins from black soybean seed coats may be a potential therapeutic strategy to promote wound healing and to prevent inflammation in a persistent inflammatory condition. Also, black soybean seed coat extract is a beneficial food material for the prevention of obesity and diabetes by enhancing energy expenditure and suppressing inflammation (Kanamoto *et al*., 2011). In this respect, Kim *et al*. (2013) reported that anthocyanins might have an anti-inflammatory effect in *Helicobacter pylori* – infected gastric epithelial cells.

In concern of the relationship between seed coat colors and plant diseases, Stasz *et al*. (1980) reported that pea seeds with seed coats colored by anthocyanins were resistant to *Pythium ultimum* seed and seedling diseases, whereas seeds with unpigmented seed coats were susceptible. Similarly, Ginoux and Messiaen (1993) found that black, red buff-colored and mottled beans were more resistant to *P. ultimum* than white one. Also, Morrison *et al*. (1995) mentioned that darkly pigmented cowpea seeds contain more tannins and lignins than unpigmented seeds. Also, Emmons and Peterson (2001); Grassman *et al*. (2002) and Malenčić *et al*. (2008) mentioned that polyphenols play an important role in plant resistance and defense against microbial infections. The gene controlling pigmentation in grain legumes may therefore have effects on seed quality through regulating the rate of imbibition (Powell *et al*., 1984), seed storage potential (Asiedu and Powell, 1998) and also the susceptibility of seeds to infection by soil-borne fungi.

The aim of this study was to investigate the relationship between soybean genotypes with different seed coat colors and the susceptibility or resistance to emergence damping-off under field conditions or artificially infected with *Rhizoctonia solani*.

MATERIALS AND METHODES

Soybean (*Glycine max* L.) cultivars (Giza 111 and Toano) in addition to two genotypes (L 159 L 2 and naturally mutated genotype from Toano "NMT") were obtained from Legume Crops Res. Dept., Field Crops Res. Inst., ARC, Giza, Egypt for this study.

Morphological Characters:

Qualitative traits were visually recorded (Table 1 and Figure 1). These characters including maturity group, pubescence color and type, flower color, seed coat color and hilum color.

Table 1: Morphological characters of the tested soybean genotypes during 2014 and 2015 growing seasons

Genotype	Origin	Pedigree	Maturity group	Pubescence color	Pubescence type	Flower color	Seed coat color	Hilum color
NMT	Egypt	Naturally Mutated from Toano	IV	Tawny	Dense	Purple	Black	Black
L159L2	Egypt	Black x Toano	IV	Gray	Dense	Purple	Brown	Brown
Giza 111	Egypt	Crawford x Selest	IV	Tawny	Dense	Purple	Yellow	Black
Toano	USA	Ware x Essex	V	Gray	Dense	Purple	Yellow	Yellow

Fig. 1: Different soybean seed coat colors from left to right; Naturally Mutated from cultivar Toano (NMT;Black), Toano (Yellow) and L159L2 (Brown)

Isolation and Identification:

Naturally infected soybean plants showing damping-off and root –rot symptoms were collected from Etay El-Baroud Agric. Res. Station Farm. Samples were first washed in running tap water and cut into small pieces, then surface sterilized in 5% sodium hypochlorite solution for three minutes. The sterilized plant parts were rinsed several times in sterilized distilled water and dried between sterilized filter paper and directly placed on PDA medium in Petri dishes which were incubated at 25°C for 4 days. Identification of *Rhizoctonia solani* was confirmed according to Sneh *et al*. (1991).

*** Laboratory Experiment:**

Effect of different concentrations of colored soybean seed coat extracts on *R. solani* diameter growth were studied. Seed coat material for extraction was separated from embryo material by fragmenting dry seeds ~ 10 sec. in a Waring Blendor, removing fine debris with a sieve with 1.3-mm- diameter round holes, and collecting seed coat pieces in a seed blower. Seed coat material was extracted overnight in 30 ml of sterile distilled water/g (Stasz *et al*., 1980). Each extract was filtered under vaccum through 0.2 µm sterile filters (Syborn/Nalgen.Co., Rochester, NY). PDA medium was prepared and autoclaved as usual, then an appropriate amounts of the filtrate were added to the medium before agar solidification with shaking well to obtain the final concentrations of 25, 50 and 75% (v/v). The medium was poured into a series of 9 cm diameter Petri dishes and individually inoculated with 5 mm discs of 6 days old culture of *R. solani*. Plates without a filtrate were used as control. Three plates were used for each concentration of filtrate and incubated at 28C°. The percentage of growth reduction was calculated after 2 and 4 days from inoculation.

*** Pot Experiment:**

Seeds of each cultivar's were divided into two groups: 1- Coated seeds, 2- Uncoated seeds and for this purpose, coats were carefully separated from soaking seeds in sterilized water for one hour using a scalpel (modified method after Bahry *et al*., 2015). Ten seeds of each genotype's were planted in a plastic pot 15 cm in diameter containing 1 kg sterilized soil. Before seeding, each pot was infested with an intact agar layer of 3-day-old culture of *R. solani* isolated on 10 ml of 1.5% water agar in Petri dish 9 cm in diameter (Schmittenner and Hilty, 1962). Pots were watered daily after planting and then lightly each 2 days. After21 days of planting, incidence of pre-emergence damping-off was determined and the seedlings were removed from the soil and their roots washed with water. Seedlings were evaluated for root rot on scales from 1-5, where, 1 = no lesions; 2 = discrete, light or dark brown, superficial necrotic lesions; 3 = adventitious root and / or tap root necrosis and decay; 4 = extensive root rot; and 5 = plant dead (Muyolo *et al*., 1993). Four replicates were used per treatment.

Resistance response classifications:

Genotypes were grouped according to disease severity as; resistance (R) if the mean disease score ranged between 1 and 2; moderately resistance (MR) if the mean disease score was 2.1- 3.0; moderately susceptible (MS) if the mean disease score was 3.1- 4.0; and susceptible (S) if the mean disease score was 4.1- 5.0 (Muyolo *et al*., 1993).

*** Field Experiments:**

The experiments were carried out in naturally infested soil at Etay El-Baroud Agric. Res. Station Farm, El-Behiera Governorate during two successive seasons; 2014 and 2015. Two cultivars; Giza 111 and Toano had yellow seed coats and two promising genotypes named; NMT (naturally mutated from Toano) and L159L2 had black and brown seed coats, respectively were used in this work. Seeds were sown in the first of June 2014 and 2015, in 4 m long rows and 0.60 m apart and four rows represented a replicate. Seeds were inoculated with Okadeen (*Rhizobium japonicum*) and sown in hills 20 cm apart on one side of each ridge at a rate of 3 seeds per hill. All treatments were replicated three times and arranged in a completely randomized block design. Pre- and post-emergence damping-off as well as survival plants recorded 25, 50 and 90 days after sowing. At harvest, five guarded plants were taken at random on which the following characters were recorded as follows: shoot length (cm), number of branches / plant, number of pods / plant, number of seeds / plant, seed weight / plant (g), 100 seed weight (g), seed weight / plot (9.6m^2) kg and seed yield / feddan (ton).

Data obtained were statistically analyzed according to Snedecor and Gochran (1981).

RESULTS AND DISCUSSION

Laboratory Experiment:

Data presented in Table (2) show the effect of 25, 50 and 75% of the extracts of three colored soybean seed coats on the growth of *Rhizoctonia solani* after 2 and 4 days from inoculation *in vitro*. Generally there is a reversible relationship between seed coat extract concentrations and fungal growth except in case of the concentration of 50% after 2 days from inoculation for the brown seed coat extract (BrSCE) which had the highest reduction with an average of 49.46% compared to the all other treatments, followed by black seed coat extract (BlSCE) and (BrSCE) at 75% with averages of 48.73 and 43.24%, respectively. On the other hand, yellow seed coat extract (YSCE) had light growth reduction with averages of 1.80, 9.49 and 25.64% for the concentrations of 25, 50 and 75%, respectively. From the previous data it is clear that, the brown seed coat extract at the concentration of

75% had less fungal growth reduction (43.24%) compared to the concentration of 50% which had the highest reduction (49.46%). Researches in this area are very limited but Halloin (1983) mentioned that nutrients, such as carbohydrates and amino acids, diffuse when seeds imbibe and they contribute to the proliferation of pathogenic fungi. Also, Wang and Grusak (2005) reported that seed coats could synthesize nutrients for the developing embryo. So, the stimulation effect of the highest concentration of the brown seed coat extract (75%) on the growth diameter of *R. solani* after 2 days may be due to the fact that soybean genotypes differ in their seed coat chemical compositions (Bahry *et al*., 2015) which leak from the seed coats during extraction and promote *R. solani* growth. The same trend cleared after 4 days from inoculation but (BlSCE) had the higher reduction effect on the fungal growth more than the other treatments, where the growth reduction was 45.22 and 50.78% for the concentrations of 50 and 75%, respectively (Table 2 and Figure 2).

Table 2: Effect of different concentrations of colored soybean seed coat extracts on growth diameter of *Rhizoctonia solani* after 2 and 4 days from inoculation (*in vitro*)

		Growth diameter (cm)			
Genotype	**Conc.%**	**2 days**	**Reduction %**	**4 days**	**Reduction %**
	0	5.13	-	9.00	-
NMT	25	4.03	21.44	7.30	18.89
(Black)	50	3.30	35.67	4.93	45.22
	75	2.63	48.73	4.43	50.78
	$\bar{X}$		35.28		38.30
	0	3.70	-	9.00	-
L159L2	25	3.00	18.92	6.97	22.56
(Brown)	50	1.87	49.46	6.47	28.11
	75	2.10	43.24	6.17	31.44
	$\bar{X}$		37.21		27.37
	0	3.90	-	9.00	-
Toano	25	3.83	1.80	7.97	11.44
(Yellow)	50	3.53	9.49	7.23	19.67
	75	2.90	25.64	6.73	25.22
	$\bar{X}$		12.31		18.78
	A	B	C AB	AC	BC ABC
L.S.D 0.05	0.03	0.04	0.02 0.11	0.05	0.07 0.22
L.S.D 0.01	0.04	0.05	0.03 0.14	0.07	0.10 0.29

A: Seed coat colors B: Extract concentrations C: Days after inoculation

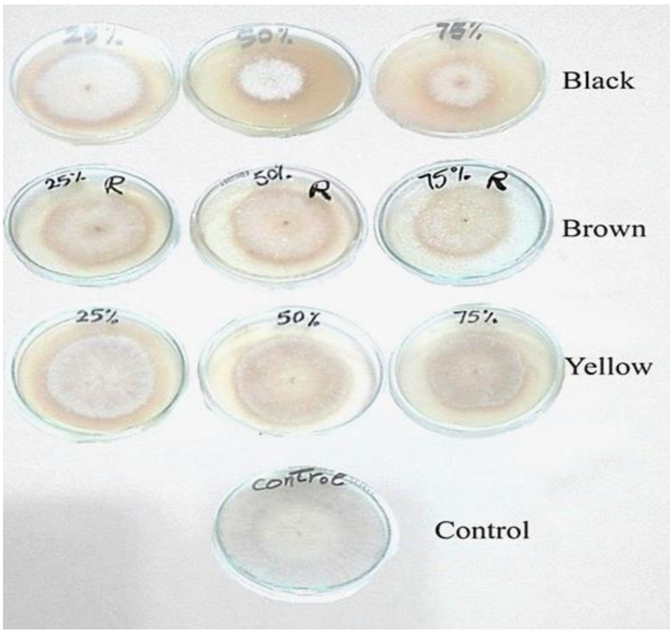

Fig. 2: Effect of different concentrations of soybean seed coat color extracts on *Rhizoctonia solani* growth diameter after 4 days from inoculation (*in vitro*

The mean averages of the fungal growth reduction due to seed coat extract concentrations after 2 days were 37.21, 35.28 and 12.31% for (BrSCE), (BlSCE) and (YSCE), respectively. But after 4 days the mean reduction was 38.30, 27.37 and 18.78%, for (BlSCE), (BrSCE) and (YSCE), respectively. The high reduction effectiveness of dark soybean seed coat extracts may be due to the presence of phenolic compounds, antioxidant potential, anthocyanins and carotenoids at higher concentrations in black coated genotypes than in yellow coated genotypes (Malenčić *et al*., 2012 and Bahry *et al*., 2015). The statistical analysis was highly significant between seed coat colors, extract concentrations, days after inoculation and the interaction between them (p = 0.01).

Pot Experiment:

Soybean genotypes which varied in its coat colors; black, brown or yellow expressed a range of pre-emergence damping-off due to *Rhizoctonia solani* infection. When coated seeds were sown in infested soil, the pre-emergence damping-off for black, brown and yellow seed coats showed 20.00, 23.35 and 26.67%, respectively, but differences among black and brown genotypes were not significant. Furthermore, removing seed coats from colored seeds greatly increased pre-emergence damping-off with averages of 46.67, 50.00 and 66.67% for the genotypes mentioned above, respectively. Also, removing seed coats increased the infection with *Rhizoctonia solani* especially in case of the yellow seed coat Toano genotype (Table 3 and Figures 3 and 4). These results are in agreement with the findings of Aveling and Powell (2005), who reported that the percentages of pre-emergence damping-off of black and tan cowpea (*Vigna unguiculata*) seeds planted in soil inoculated with *P. ultimum* or *F. solani* significantly were lower than those of the white varieties.

Also, Stasz *et al*. (1980) reported that removing seed coats from colored seeds greatly reduced resistance to *P. ultimum.* Morrison *et al.* (1995) concluded that the resistance expressed by the pigmented cowpea seeds may be attributable to the presence of phenols, tannins and /or lignins in the seed coat. In this respect, disease severity expressed the same trend as pre-emergence where black, brown and yellow coated soybean seeds showed disease severity with averages of 1.89, 2.56 and 2.67%, respectively (Table 3 and Fig.3). Colored soybean genotypes showed resistance (R) and moderately resistance (MR) responses for the infection by *R. solani* (Table 3).

Table 3: Relationship between soybean seed coat color, the incidence of pre-emergence damping – off caused by *Rhizoctonia solani,* and disease severity % 21 days after seeding (pot experiment)

Genotype	Pre-emergence damping-off %		Disease severity %	
	Coated seeds	Uncoated seeds	Coated seeds	Uncoated seeds
NMT (Black)	20.00	46 67	1.89 (R)	4.22 (S)
L159L2 (Brown	23.35	50.00	2.56 (MR)	4.29 (S)
Toano (Yellow)	26.67	66.67	2.67 (MR)	5.15 (S)
L.S.D.	0.05	0.01	0.05	0.01
A	3.78	N.S	0.14	0.20
B	2.53	3.60	0.10	0.14
AB	N.S	N.S	N.S	N.S

A: Coated seeds B: Uncoated seeds

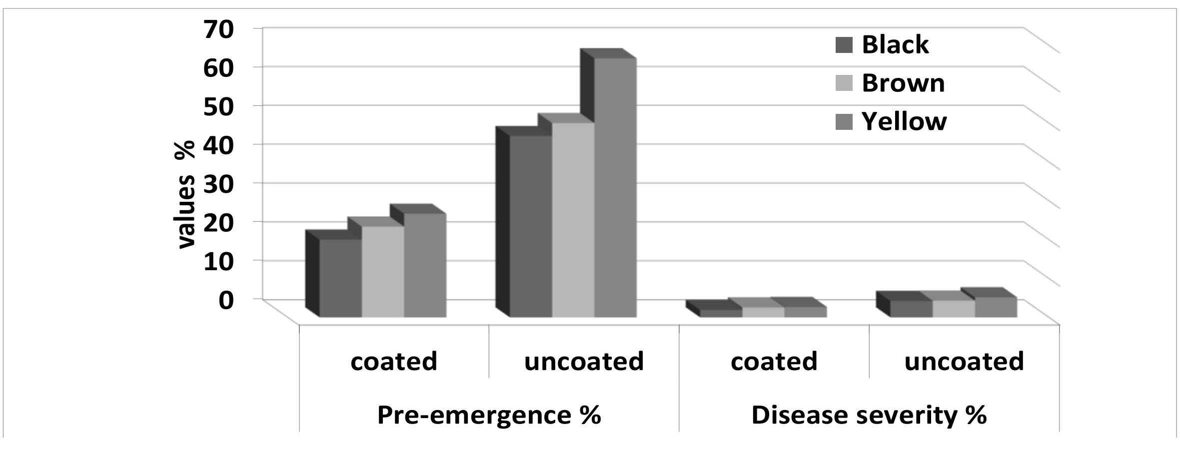

Fig. 3: Relationship between soybean seed coat colors and the incidence of pre- emergence damping-off caused by *Rhizoctonia solani* and its disease severity% 21 days after seeding (pot experiment)

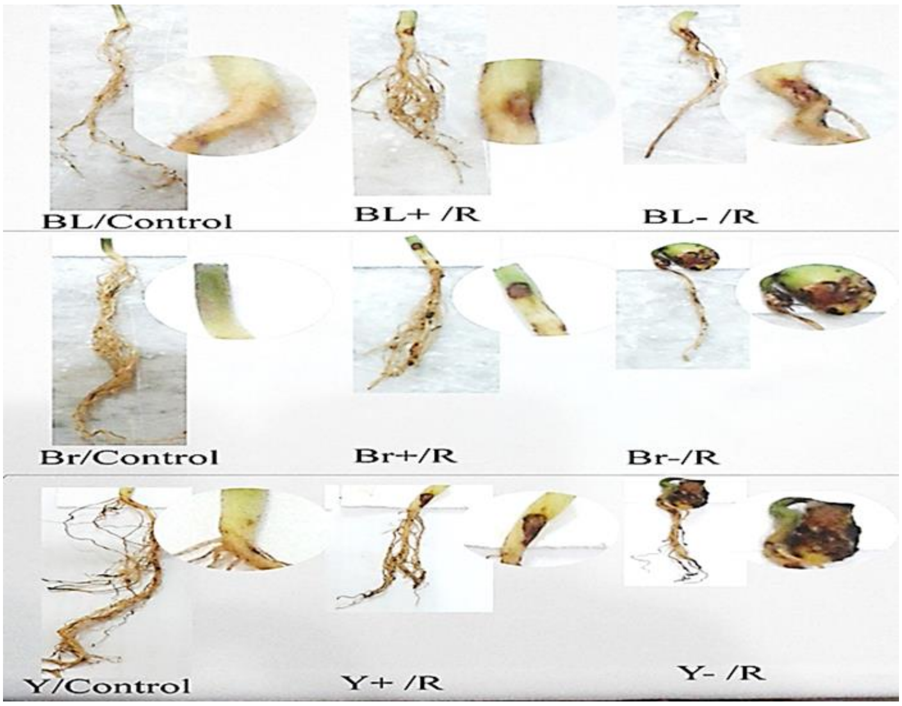

Fig. 4: Effect of removing seed coats from black, brown and yellow soybean seeds on disease severity caused by *R.solani* after 21 days from inoculation (Bl+ = Black seed coat, Bl ─ = removed black seed coat, Br+ = Brown seed coat, Br─= removed brown seed coat, Y+ = Yellow seed coat and Y─ = removed yellow seed coat).

Removing coats from black, brown and yellow seeds increased disease severity to 4.22, 4.29 and 5.15%, respectively and thus, resistance response classification changed to susceptible (S) for all treatments. Differences among black and brown genotypes were statistically not significant.

These results are in harmony with the findings of Flor *et al.* (2004) and Capeleti *et al.* (2005) who mentioned that seed coat plays an important protective function in a physiologically mature soybean seeds, also seed coat may have different levels of resistance to mechanical damage. Soybean seed coats contain large amount of secondary metabolites, including phenolic acid derivatives(flavonoids/isoflavonoids/ anthocyanidins/proanthocyanidin), alkaloids, terpenoids, and steroids (Kovinich *et al.*, 2011) which play an important role in plant resistance and defense against microbial infections (Emmons and Peterson, 2001; Grassman *et al.*, 2002 and Malenčić *et al*., 2008).

In this respect, Ma *et al.* (2004), Santos *et al*. (2007) and Mertz *et al.* (2009) mentioned that dark-colored seed coat (brown and black) have greater epidermis thickness, semi-permeability to water, greater resistance to deterioration, and higher concentration of phenolic compounds and lignin, which confer protection against biotic and abiotic factors.

Data presented in Table (4) indicated that root length was more in case of yellow coated seeds, followed by black and brown. In case of root fresh and dry weight, black coated seeds had the first grade, followed by brown coated seeds (second grade). Removing seed coats showed the same trend, where black uncoated seeds had the highest values of root length (cm) and root fresh weight (g). The statistical analysis was significant or highly significant between seed coat color, seed coat existence and the interaction between them except in case of the seedlings root fresh weight of colored seeds and the interaction between seed coat colors and its existence. The differences of soybean seedlings growth parameters between coated and uncoated seeds may be due to the important role of seed coat in the life cycle of soybean by controlling embryo development and determining seed dormancy and germination as mentioned by Kim *et al.* (2010).

Field Experiments:

Data presented in Table(5) realized the relationship between soybean coat colors and the incidence of pre- and post-emergence damping-off and plant survival after 25, 50 and 90 days from seeding for 2014 and 2015 seasons. In addition the table showed that, in the first season genotype Toano(Yellow) had the least pre-emergence damping-off followed by L159L2 (Brown), NMT (Black) and Giza 111 (Yellow) with averages of 15.67, 21.33, 29.00 and 32.00%, respectively. At the same time, post-emergence damping-off had the same arrangement with averages of 4.35, 6.33, 6.61 and 12.68%, respectively.

Table 4: Effect of soybean seed coat colors on some growth parameters of infected soybean with *Rhizoctonia solani* after 21 days (pot experiment).

Genotype	Root length (cm)		Root fresh weight (g)		Root dry weight (g)	
	coated	uncoated	coated	uncoated	coated	uncoated
NMT (Black)	12.33	3.83	0.427	0.203	0.041	0.016
L159L2 (Brown)	8.67	3.23	0.360	0.153	0.028	0.008
Toano (Yellow)	13.40	3.67	0.323	0.197	0.028	0.019
L.S.D	0.05	0.01	0.05	0.01	0.05	0.01
A	0.66	N.S	N.S	N.S	0.002	0.003
B	0.44	0.80	0.018	0.025	0.001	0.002
AB	1.33	N.S	N.S	N.S	0.004	0.005

A: Seed coat colors B: Seed coat existence

Also the same arrangement cleared in case of the survival plants. Data of the second season are similar as the first one with light differences, where Toano had the first grade followed by L159L2 for all parameters mentioned before, but NMT and G 111 had light differences for the three parameters. The statistical analysis was highly significant except in case of the pre-emergence damping-off for the first season. Although genotype Toano had the best values for pre-, post- emergence damping-off and survival plants, genotypes L159L2 and NMT showed considerable values because they belongs to the genotype Toano and these results corroborate the findings by other authors who observed a greater amount of lignin in dark soybean seed coats, contributing to greater resistance of these seed coats to mechanical damage (Souza and Marcos-Filho, 2001) and protecting the cell wall against the attacks by microorganisms (Santos *et al*., 2007). In this respect, Aveling and Powell (2005) mentioned that pre-emergence damping-off values of black and tan cowpea seeds planted in soil inoculated with *P. ultimum* or *F. solani* were significantly lower than those of white varieties.

Data presented in Table (6) showed the yield and its components as affected by seed colors and infection at the end of the first and second seasons (2014 and 2015). At the first season, Giza 111 genotype had the best values, where it had the highest values of number of pods/plant, number of seeds/plant, seed weight/plant (g), 100 seed weight (g), seed yield/plot (kg) and seed yield/feddan (ton) with averages of 202.27, 409.90, 52.93 (g), 18.16 (g), 4.41 (kg) and 1.745 (ton), respectively. In this concern, L159L2 had the first grade in case of shoot length and number of branches/plant with averages of 82.73 (cm) and 4.73, respectively and the second grade after Giza 111 for number of pods/plant, number of seeds/plant, seed weight/plant (g), seed yield/plot (kg) and seed yield/fed (ton) with averages of 182.80, 355.00, 46.59, 3.53 (kg) and 1.393 (ton), respectively. NMT had the third grade after G 111 and L159L2. Differences among the four tested genotypes were statistically highly significant.

In the second season, the same trend was noticed where Giza 111 genotype had the highest values as it shown in the first season except in case of seed weight/plant (g). In this respect, NMT had the third grade as it cleared in the first season. Also, the same trend cleared with L159L2 genotype except in case of seed weight/plant (g). The statistical analysis was highly significant (p=0.01) with all parameters except with shoot length (cm), number of branches/plant, seed yield/plant (kg) and seed yield/feddan (ton). In this respect, El-Garhy *et al*. (2013) evaluated six soybean genotypes differed in their coats color morphologically and for their yield and they reported that the highest seed yield/feddan (ton) was obtained from genotype L159L2 followed by the black seed genotype.

Table 5: Relationship between soybean seed coat colors and the incidence of pre-, post-emergence damping-off and survival plants after 25, 50 and 90 days from seeding under natural infection conditions at 2014 and 2015 growing seasons (field experiment)

Genotype	Color	1st season			2nd season		
		Pre-emergence damping-off	Post-emergence damping-off	Survival plants	Pre-emergence damping-off	Post-emergence damping-off	Survival plants
NMT	Black	29.00	6.61	64.37	27.79	8.88	63.33
L159L2	Brown	21.33	6.33	72.34	19.71	6.45	73.83
Giza 111	Yellow	32.00	12.68	55.32	23.27	12.73	64.00
Toano	Yellow	15.67	4.35	79.99	15.92	5.61	78.47
L.S.D	0.05	4.46	1.72	4.37	3.09	1.32	3.58
L.S.D	0.01	N.S	2.43	6.16	4.69	1.99	5.43

Table 6: Relationship between soybean seed coat color and some plant morphological characters and yield and its components during two seasons 2014 and 2015 (field experiment).

Genotype	Shoot length (cm)	No.branches per plant	No.pods per plant	No.seeds per plant	Seed weight per plant (g)	100 seed weight (g)	Seed yield per plot (kg)	Seed yield per feddan (ton)
First season	2014	2014	2014	2014	2014	2014	2014	2104
Second season	2015	2015	2015	2015	2015	2015	2015	2015
NMT	72.9	3.20	123.80	251.47	44.01	17.89	3.22	1.273
Black	73.87	3.20	95.73	239.39	30.76	17.09	3.16	1.250
L159L2	82.73	4.73	182.80	355.00	46.59	15.67	3.54	1.393
Brown	81.77	3.00	159.43	345.78	24.61	14.77	3.30	1.308
Toano	67.23	3.93	84.07	179.10	28.15	16.52	2.74	1.084
Yellow	68.30	3.40	102.87	221.95	36.20	17.46	2.86	1.131
Giza 111	79.10	2.60	202.27	409.90	52.93	18.16	4.41	1.745
Yellow	81.67	2.40	210.53	373.07	32.39	18.10	3.66	1.450
L.S.D 0.05	3.42	0.25	14.97	20.53	4.12	0.46	0.30	0.126
L.S.D 0.01	5.19	0.37	22.68	39.31	6.25	0.70	0.45	0.191
L.S.D 0.05	3.17	0.23	10.95	17.62	1.19	0.55	0.25	0.094
L.S.D 0.01	N.S	N.S	5.47	24.89	1.68	0.78	N.S	N.S

Table 7: Summarized arrangement of the four genotypes for their morphological characters and seed yield components for the two seasons; 2014 and 2015

Genotype	Shoot length (cm)	No.branches per plant	No.pods per plant	No.seeds per plant	Seed weight per plant (g)	100 seed weight (g)	Seed yield per plot (kg)	Seed yield per feddan (ton)
First season	2014	2014	2014	2014	2014	2014	2014	2014
Second season	2015	2015	2015	2015	2015	2015	2015	2015
NMT	3	3	3	3	3	2	3	3
Black	3	2	4	3	3	3	3	3
L159L2	1	1	2	2	2	4	2	2
Brown	1	3	2	2	4	4	2	2
Toano	4	2	4	4	4	3	4	4
Yellow	4	1	3	4	1	2	4	4
Giza 111	2	4	1	1	1	1	1	1
Yellow	2	4	1	1	2	1	1	1

Also they mentioned that Toano was the shortest and latest one in flowering and maturity. Table (7) showed summarized arrangement of the tested four genotypes for their morphological characters and seed yield components for both seasons. Alvarez *et al*. (1994) reported that the differences in 100 seed weight could be related to the differences of assimilates translocations to seeds among genotypes. The wide variation among the studied genotypes in all studied traits may be attributed mainly to differences in maturity group among the studied genotypes, therefore, the response of each genotype to environmental conditions prevailed during growing season were governed by genetic factors and this clearly reflected on the growth characters, consequently yield components (Attallah, 2001 and Hufsteler *et al*., 2007).

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الملخص العربى

رد فعل بعض أصناف وسلالات فول الصويا المختلفه فى لون القصره لأمراض عفن الجذور الريزوكتونى وأعفان ماقبل وما بعد الظهور والمحصول ومكوناته

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أجريت تجارب معمليه وأصص وحقليه بإستخدام صنفين من فول الصويا ذات القصره صفراء اللون هما Toano و Giza 111 بالإضافه إلى سلالتين مبشرتين أحدهما ذات قصره سوداء اللون وهى طفره طبيعيه من الصنف Toano وتم الرمز لها NMT والأخرى ذات قصره بنية اللون ناتجه من التهجين بين Toano X NMT وتم الرمز لها L159L2 لدراسة العلاقه بين تركيز مستخلص القصره للألوان الثلاثه وبين نمو فطر ريزوكتونيا سولانى معمليا وكذلك العلاقه بين لون القصره وحساسية أو مقاومة فول الصويا لعفن ماقبل الظهور وعفن الجذور الناتج عن الإصابه بفطر ريزوكتونيا سولانى تحت ظروف الصوبه وكذلك الإصابه بأعفان ماقبل ومابعد الظهور تحت ظروف العدوى الطبيعيه فى الحقل وذلك فى مزرعة محطة البحوث الزراعيه بإيتاى البارود– محافظة البحيره خلال موسمى ٢٠١٤ و٢٠١٥.

أظهرت نتائج التجربه المعمليه أن هناك علاقه عكسيه بين تركيز مستخلص قصرة بذور فول الصويا بألوانها الثلاثه وبين النمو القطرى لفطر ريزوكتونيا سولانى حيث بلغت نسبة الخفض ١٨,٩٨, ٤٥,٢٢, ٥٠,٧٨٪ للتركيزات ٢٥، ٥٠، ٧٥٪ على التوالى لمستخلص القصره السوداء وذلك بعد أربعة أيام من تلقيح أطباق بترى. أما فى حالة مستخلص القصره بنية اللون فكانت نسبة الخفض ٢٢,٥٦، ٢٨,١١، ٣١,٤٤٪ لنفس التركيزات السابقه على التوالى وأقل نسبة خفض كانت مع مستخلص القصره صفراء اللون بنسبة ١١,٤٤، ١٩,٦٧، ٢٥,٢٢٪ على التوالى.

أظهرت نتائج تجربة الأصص أن نسبة الإصابه بعفن ما قبل الظهور الناتج عن الإصابه بفطر ريزوكتونيا سولانى كانت الأقل فى حالة البادرات الناتجه من البذور ذات القصره سوداء اللون NMT تليها البادرات الناتجه من البذور ذات القصره بنية اللون L159L2 وأخيرا تلك الناتجه من البذور ذات القصره صفراء اللون Toano بنسبة ٢٢,٠٠، ٢٣,٣٥، ٢٦,٧٧٪ على التوالى. وفى نفس الوقت عند زراعة البذور بعد إزالة القصره فى التربه السابق عدواها بهذا الفطر إرتفعت نسبة الإصابه بعفن ماقبل الظهور معنويا إلى ٤٦,٦٧، ٥٠,٠٠، ٦٦,٦٧٪ لنفس الألوان الثلاثه المذكوره سابقا على التوالى. كذلك أظهرت شده إصابة الجذور بهذا الفطر نفس الإتجاه كما فى نسبة الإصابه بعفن ماقبل الظهور سواء للبذور ذات القصره أو تلك منزوعة القصره.

أظهرت نتائج التجارب الحقليه فى الموسم الأول(٢٠١٤) أن أقل نسبة إصابه بأعفان ما قبل الظهور سجلت للصنف Toano (قصره صفراء اللون) يليه L159L2 (قصره بنية اللون)، NMT (قصره سوداء اللون) ثم Giza 111 (قصره صفراء اللون) بمتوسطات ١٥,٦٧، ٢١,٣٣، ٢٩,٠٠، ٣٢,٠٠٪ على التوالى. نفس الإتجاه كان واضحا مع الإصابه بأعفان مابعد الظهور بنسبة ٤,٣٥، ٦,٣٣، ٦,٦١، ١٢,٦٨٪ على التوالى.

أظهرت نتائج الموسم الثانى (٢٠١٥) نفس الإتجاه كما فى الموسم الأول مع إختلاف طفيف فى الترتيب بين L159L2, Giza 111 فقط فى الإصابه بأعفان ما قبل الظهور٠ أظهرت القياسات المورفولوجيه والمحصوليه فى نهاية الموسم الأول أن الصنف Giza 111 (قصره صفراء اللون) أظهر تفوقا معنويا فى قيم عدد القرون/نبات, عدد البذور/نبات، وزن البذور/نبات(جم), وزن ١٠٠ بذره(جم), وزن البذور/قطعه تجريبيه(كجم)، وزن البذور/فدان (طن) يليه السلالتين L159L2 (قصره بنية اللون) ثم NMT (قصره سوداء اللون) على التوالى٠ كذلك أظهرت النتائج المحصوليه المتحصل عليها فى الموسم الثانى تقاربا واضحا مع تلك المسجله فى الموسم الأول٠