Research Paper

« Wilt and/or root rot disease incidence on growth & yield of chickpea (Cicer arietinum L.) affected by residues of some plants »

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Abstract: Field experiments were conducted during winter seasons of 2012/2013 and 2013/2014 at Agricultural Research Farm, Secondary School for girls, Marawi, Northern State, Sudan, to evaluate the efficacy of five organic amendments viz., Neem (Azadirachta indica) leaves, Argel (Solanostemma argel) shoot, Lemongrass(cymbopogon citratus) upper parts of the plant, Spearmint(Mentha spicata) shoots, and Basil (Ocimum gratissimum) shoots and Benomyl (BioneelR) fungicide for the control of wilt and /or root rot disease of chickpea crop caused by Fusarium. oxysporum f. sp.. ciceris, and Fusarium solani f. sp. ciceris. Data on the disease incidence, number of affected plants and yield components were collected and analyzed statistically according to Duncan´s Multiple Range Test (DMRT) for interpretation of the results. The results revealed thatArgel, Neem and Spearmint were found to be effective on both cases of two varieties (Shendi and Burgeig) of chickpea crops tested in the field as compared to check (Control).

Keywords: *Field experiments, Disease incidence, Residues, Chickpea cultivars and Yield.*

Introduction:

Chickpea (Cicer arietinumL.) is the world's third most important pulse crop, after dry beans (Phaseolus vulgaris L.) and dry peas (Pisum sativumL.) (Kumar et al., 2010). This crop is widely attacked by soil-borne diseases resulting in severe yield losses and one of them is fusarium wilt incited by Fusarium oxysporum f. sp. ciceris (Foc, Padwick) which is a serious soil borne disease of chickpea (Hossain et al., 2013; Merkuz et al., 2011). It is a major constraint to chickpea cultivation throughout the world and especially in Indian subcontinent where chickpea is a commonly grown pulse crop, as it can cause up to 100% yield loss annually (Pande et al., 2010; Kumari and Khanna, 2014). This disease can affect the crop at any stage of growth. Characteristic symptoms are sudden drooping of leaves and petioles and black internal discoloration involving xylem and pith (Dubey and Singh, 2004).

Chickpea production is severely curtailed by Fusarium wilt caused by Fusarium oxysporum (Schlechtend.:Fr.) f. sp. ciceris (Padwick) Matuo & K. Sato, in most chickpea growing areas of the world. Although, chickpea is predominantly consumed as a pulse, dry chickpea is also used in preparing a variety of snack foods, sweets and condiments and green fresh chickpeas are commonly consumed as a vegetable. It is a food crop of economic importance to human in Sudan especially in the northern states. However, Chickpea (Cicer arietinumL.) is an annual leguminous, winter crop grows in several types of soils other than alkaline soil with a bad drainage, and sandy soils with good drainage were very suitable for cultivation. Its yields range between 0.83 and 2.8 t/ha, depending on weather conditions. Optimization of crop yields is a necessity to maintain its rank in the existing cropping system. Fungal diseases are known to cause great damages all over the world. Different species of Alternaria, Aspergillus, Ceratobasidium, Cercospora, Cochliobolus, Curvularia, Dreschslera, Fusarium, Gaeumannomyces, Microdochium, Penicillium, Pyricularia, Pythium, Rhizoctonia, Rhizopus, Sclerophthora, Trichoderma and Tricoconella are most common associates of seeds all over the world, causing pre and post-infections and considerable quality losses viz. seed abortion, seed rot, seed necrosis, reduction or elimination of germination capacity, seedling damage and their nutritive value have been reported (Kavitha et al., 2005). Chickpea crop is subjected to many fungal diseases, the most important one is wilt and/or root rot disease complex which is caused by the pathogens; Fusarium oxysporumf.sp. cicero and Fusarium solani and other soil borne pathogens (Kiran et al., 2005). This disease affects the seedlings of the pre and post emergence stages of the crop, leading to the collapse of many plants. Also this disease attacks the zone of shoot-root connection of the crop plant which is weakened and can be easily picked off.

Therefore, the impact of this disease is reflected negatively on productivity. At national level the yield losses encountered due to wilt disease may vary between five to ten per cent. Fusarium wilt of chickpea is a monocyclic disease in which development is driven by the pathogen's primary inoculum. Therefore, management of the disease should be targeted to exclusion of the pathogen as well as by reducing the amount and/or efficiency of the initial inoculum (Jiménez-Díaz, 2015). Soil amendments are one of the viable an eco-friendly propositions available in modern agriculture which can considerably minimize the disease incidence if applied at least 30-40 days before transplanting and allowed to decompose (Prasad, 2010). Amending the soil with plant material, such as fresh broccoli or grass, before polyethylene mulching can also suppress soil-borne fungal inoculum under conditions of sub-lethal heating of soil. This heating releases biocidal products after microbial degradation of the plant material incorporated into soil, which together with the anaerobic and strongly reducing soil conditions that develop are effective against fungal propagules (Kirkegaard, 2009). Synthetic chemicals have been used to control post - harvest rot of many root and tuber crops. The continuous use of these chemicals develop resistance in the pathogens and cause a number of environmental and health problem. The use of the plant extracts in control of plant disease is now universally accepted. These plant extracts have been reported to be safe, non-toxic and effective against plant pathogens (Kumar, et al., 2007).

Objectives: Food legumes will undoubtedly assume a more important role in providing a larger share of the protein requirements of the inhabitant of many developed countries, including the Sudan. So there should be an effective, manageable, applicable control with low-cost treatment for wilt and/or root rot disease to achieve the objectives of this study were: to determine the effects of proposed research which is represented by the plants residues and extracts supposed to be the alternatives of chemical fungicides that have become expensive and hazardous to human and animals environment.

Materials and methods:

The experiment was carried out during winter seasons of 2012/2013 and 2013/2014 at Agricultural Research Farm, Secondary School for girls (Merowe, Northern State), Sudan, designed in the field measuring 12 m x 42 m naturally and artificially infested with the pathogens. It was laid out in a randomized complete block design (RCBD) (3.0 m x 4 m) with three replicates. Five organic amendments viz., Neem (Azadirachta indica) dried green leaves, Argel (Solanostemma argel) shoot, Lemongrass (cymbopogon citratus) upper parts of the plant, Spearmint (Mentha spicata) shoots, and Basil (Ocimum gratissimum) shoots were added to the naturally and artificially infested soil, one week before sowing at the rate of one kilogram (chopped 2-3 cm in length) of each dried residues per sub-plot (3.0mx4.0m). 4 ridges in each subplot were sown. Before sowing, the soil was well pulverized 3 – 4 times to have an even mixing of the residues. Although recommended fungicide Benomyl (BioneelR) (50gm/100L) and untreated check were applied for comparison of the result. The sowing was conducted on 15th November for the two consecutive seasons. Chickpea seeds (160seed/sub-plot) 40 and 50gm in weight of Shendi and Burgeig cultivars were respectively; sown in each sub-plot in the experimental field and other recommended routine practices were done.For the inoculation of spore suspension of causal agents (F. oxysporum f. sp.ciceris, and Fusarium solani f. sp. ciceris) grown on solid medium, two petri plates culture were used from each. The spores' suspension was prepared by removing the mycelial mat from the surface of the media after mixing with sterilized distilled water. The material was homogenized in a mixer. The spores' suspension of the inoculums was then injected at the partially wet underground growing roots zone (5 – 8 cm under the soil surface) at the emergence stage of the seedling plants. Data on the disease incidence, number of affected plants and yield components were collected and analyzed statistically according to Duncan´s Multiple Range Test (DMRT) for interpretation of the results.

Results and Discussion:

Effects of residues from certain medicinal and aromatic plants on disease incidence of chickpea plants.

Generally, the residues incorporated into the soil, at the season conducted on 15th of November 2012, reduced the disease incidence in both of the chickpea cultivars (Shendi and Burgeig).There was an appreciable reduction in disease incidence, when the soil was amended with Neem and Argel residues in both cultivars, and the maximum reduction of incidence was obtained when the bioneelR (benomyl) fungicide applied to the soil, throughout the three readings (Table 1-a). As will be seen from table 1-b the residues showed better antifungal activity on the second crop sown about one year after the addition of amendments to the soil than the first crop sown immediately after addition to the soil especially in case of V1:(Shendi). Neem and Argel gave the same response of fungicide applied to the soil. These were followed by the effect of the other remaining residues as compared to the control (Table 1-b). Similarly, A. indica has revealed the efficacy against F. solani, C. lunata and R. bataticola on brinjal and sunflower (Joseph et al., 2008). In general, almost similar results were obtained for both Chickpea cultivars (V1 and V2) used here in two consecutive seasons, of course with slight variation.

Effects of residues on the number of affected plants of the two chickpea cultivars in the field:

Table (2-a) illustrated that maximum numbers of affected plants were infected in control plots, and low disease incidence showing less number of infected plants was observed when fungicide, Argel, Neem, Spearmint and Basil were used as residues amendments in both cultivars (Shendi and Burgeig). These were followed by Lemongrass as compare to control in the first season. In the second season, the results revealed that all treatments exhibited highly significant response in reducing the number of affected plant per plot

.BioneelR (benomyl) fungicide, Neem, Argel and Spearmint were used as soil residues showed significant reduction in the number of affected plant of both chickpea cultivars (V1 and V2), followed by the Basil and Lemongrass as compare to control (Table 2-b). Neem, Argel and Spearmint appear to have the potential to be used for managing the wilt and/ or root rot disease in the field, this supports the findings of Shah-Z; Faheem-A, (2000). Although the varietal response in relation to disease was slightly variable but in general, a similar trend was observed.

Effects of residues on grain yield:

The amended residues in soil of the experimental farm slightly increased the grain yield per plot (3.0m x 4m) in both chickpea cultivars grown in the first season. The greatest increase in grain yield of (V1) was obtained in soil amended with the fungicide Benomyl, Neem, Basil, Argel, and Spearmint residues, and these were followed by the effect of lemongrass residues as compare to the control where they gave (2.087, 1.844, 1.627, 1.607, 1.553 and 1.31 kg. per plot respectively), while in the case of (V2) the response was insignificantly different (Table 3-a). In the second season, the results revealed that all treatments gave the highest rate of grain yield in both cultivars and the response was almost the same especially in the case of (V1). As compared to the control, the maximum yield of 2.7 kg/plot was obtained when Argel residue was used (Table 3-b).

These results indicate that Neem, Argel, Spearmint and Basil residues (amendments) can be used as a bio-fertilizer to boost the yield of chickpea crop. The investigations indicate that it is possible to significantly increase the yield of chickpea crop through the application of different plants residues to the infested field. These findings agreed with that reported by Merkuz, et al., (2011) and the expressed by Shah-Z; and Faheem-A, (2000) which seemed to have a tremendous impact on the agricultural production of the Sudan in particular and of the world in general.

Conclusion and recommendations:

According to the above mentioned data:

- There was an appreciable reduction in disease incidence, less number of infected plants was observed when Argel, Neem, Spearmint and Basil were used as residues in both cultivars (Shendi and Burgeig).

- The amended residues showed better antifungal activity on the second crop sown about one year after the addition of amendments to the soil than the first crop sown immediately after addition to the soil especially in case of Shendi cultivar. Neem and Argel gave the same response of fungicide applied to the soil.

- The amended residues in soil of the experimental farm slightly increased the grain yield in both chickpea cultivars grown in the first season. The greatest increase in grain yield of Shendi cultivar was obtained in soil amended with the fungicide Benomyl, Neem, Basil, Argel.

- All treatments gave the highest rate of grain yield in both cultivars in the second season and the response was almost the same especially in the case of Shendi cultivar.

- Maximum yield was obtained from Argel residues treated plots.

- Neem, Argel, Spearmint and Basil residues (amendments) can be used as a bio- fertilizer to boost the yield of chickpea crop.

Table (1-a): Effect of residues from certain medicinal and aromatic plants on disease incidence of wilt/and or root-rot of two chickpea cultivars in the field (First season).

		Disease incidence (means)* of two chickpea cultivars					
		V1(Shendi)			V2(Burgeig)		
Tr. No.	Treatments (residues)	1st count	2nd count	3rd count	1st count	2nd count	3rd count
1	Neem(Leaves)	0.0 c	15 a	33.3 b	0.7 bc	4.67 c	25.7 bc
2	Argel(shoots)	2.3 bc	17 a	38.7 b	0.0 c	11 bc	25.3 bc
3	Spearmint (shoots)	4.0 bc	16 a	39.7 b	6.7 ab	18 ab	33 b
4	Basil (shoots)	2.7 bc	22.6 a	42.7 b	1.7 bc	8.67 bc	32.7 b
5	Lemongrass (Leaves)	7.0 b	26.3 a	71.3 a	2.3 abc	17.3 ab	37.7 b
6	Bioneel(Benomyl)	2.0 c	18 a	24.3 b	0.0 c	7.3 bc	17.7 c
7	Control	14.7 a	26 a	84.3 a	8.3 a	26.3 a	53.3 a
	±SE	1.58	4.2	7.18	2.07	3.64	4.67
	LSD	4.869	13.03	22.11	6.393	11.21	14.40

* Figures indicate the average number of lesions per plot.

* Mean based on ten observations.

* Means followed by the same letter (s) in each column are not significantly different at (5%) level according to DMR.

Table (1-b): Effect of residues from certain medicinal and aromatic plants on disease incidence of wilt/and or root-rot of two chickpea cultivars in the field (Second season).

Disease incidence (means)* of two chickpea cultivars							
		V1(Shendi)			V2(Burgeig)		
Tr. No	Treatments(residues)	1st count	2nd count	3rd count	1st count	2nd count	3rd count
1	Neem (Leaves)	2.0 b	6.0 c	28.3 c	0.0 b	6.3 b	21.3 cd
2	Argel (shoots)	2.7 b	9.7 bc	33.0 c	0.0 b	2.0 b	22.7 cd
3	Spearmint (shoots)	7.3 ab	17 ab	35.0 bc	1.0 b	5.3 b	29.7 bc
4	Basil (shoots)	5.7 ab	13 abc	39.7 bc	3.7 ab	10.3 ab	26.7 bcd
5	Lemongrass (Leaves)	5.3ab	14.3 abc	47.7 b	4.7 ab	8.7 ab	37.0 ab
6	Bioneel (Benomyl)	2.0 b	6.0 c	14.0 d	0.0 b	5.0 b	15.3 d
7	Control	10.3 a	21.3 a	67.0 a	8.7 a	16.7 a	46.3 a
	±SE	1.75	2.97	4.47	1.87	3.27	4.53
	LSD	5.4	9.16	13.77	5.8	10.06	13.96

* Legend as in table **1-a**

Table (2-a): Effect of residues from certain medicinal and aromatic plants on disease incidence (Number of affected plants) in two chickpea cultivars in the field (First season).

		No. of affected plants / plot of each chickpea cultivar (means)*					
		V1(Shendi)			V2(Burgeig)		
Tr. No.	Treatments(residues)	1st count	2nd count	3rd count	1st count	2nd count	3rd count
1	Neem (Leaves)	0.0 c	2.7 c	4.7 d	0.33 bc	2.0 bc	2.3 c
2	Argel (shoots)	1.7 bc	2.7 c	4.0 d	0.0 c	1.3 c	2.7 c
3	Spearmint (shoots)	2.0 ab	3.7 bc	6.0 bc	0.67 ab	3.0 b	5.3 ab
4	Basil (shoots)	1.0 bc	3.7 bc	6.3 b	0.33 bc	2.3 bc	3.3 bc
5	Lemongrass (Leaves)	2.0 ab	5.3 ab	7.0 ab	0.0 c	2.7 bc	5.3 ab
6	Bioneel (Benomyl)	1.0 bc	2.0 c	5.0 cd	0.33 bc	1.7 bc	2.3 c
7	Control	3.7 a	7.0 a	7.7 a	1.0 a	4.7 a	6.0 a
	±SE	0.60	0.568	0.364	0.21	0.527	0.79
	LSD	1.85	1.75	1.121	0.637	1.624	2.44

* Average based on thirty observations (Ten / each replicate).

* Means followed by the same letter (s) in each column are not significantly different at (5%) level according to DMRT

		No. of affected plants / plot of each chickpea cultivar (means)*					
		V1(Shandi)			V2(Burgeig)		
Tr. No.	Treatments(residues)	1st count	2nd count	3rd count	1st count	2nd count	3rd count
1	Neem (Leaves)	0.7 b	1.3 d	3.3 bc	0.0 c	1.0 bc	2.3 c
2	Argel (shoots)	1.0 b	2.0 cd	4.0 b	0.0 c	0.3 c	2.7 bc
3	Spearmint (shoots)	3.0 a	3.7 b	3.7 b	0.3 bc	0.7 bc	4.0 b
4	Basil (shoots)	2.3 ab	3.3 bc	4.7 b	0.7 bc	1.7 b	3.3 bc
5	Lemongrass (Leaves)	2.0 ab	3.3 bc	4.0 b	1.0 b	1.3 bc	4.0 b
6	Bioneel (Benomyl)	1.0 b	1.3 d	2.0 c	0.0 c	1.0 bc	2.0 c
7	Control	3.7 a	6.0 a	7.7 a	2.7 a	3.7 a	5.7 a
	±SE	0.57	0.49	0.54	0.32	0.402	0.50
	LSD	1.75	1.52	1.67	0.98	1.24	1.54

Table (2-b): Effect of residues from certain medicinal and aromatic plants on disease incidence (Number of affected plants) in two chickpea cultivars in the field (Second season).

* Legend as in table **2-a**

Table (3-a): Effects of

Residues of some medicinal and aromatic plants on yield

V1 (Shendi Cultivar)		
Tr. NO)	Treatments (residues)	*No. of pods/ plant
1	Neem	43
2	Argel	33
3	Spear mint	32
4	Basil	38
5	Lemongrass	29
6	Bioneel	45
7	Control	46
SE± 0.16		
LSD 0.49		

*Based on average of ten observations per subplot.

**Based on average of number

seeds / twenty pods/ subplot.

				V2(Burgeig cultivar)				
**No. of seeds/ pod	***Weight Of 100 Seeds/ subplot (g)	***Seed yield / subplot (kg)	Seed yield (Ton/ha)	*No. of pods/ plant	**No. of seeds/ pod	***Weight Of 100 Seeds/ subplot (g)	***Seed yield / subplot (kg)	Seed yield (Ton/ha)
1.6	21	1.844	1.537 ab	35	1.4	25	1.672	1.394 ab
1.7	23	1.607	1.339 ab	39	1.4	26	1.758	1.465 a
1.8	21	1.533	1.294 ab	48	1.2	24	1.640	1.367 ab
1.7	20	1.627	1.356 ab	40	1.3	25	1.610	1.342 ab
1.6	19	1.310	1.092 b	39	1.3	24	1.448	1.207 ab
1.6	23	2.088	1.740 a	42	1.2	26	1.749	1.458 a
1.2	18	1.269	1.057 b	36	1.0	22	1.180	0.983 b
								0.15
								0.45

Table (3 –b) : Effects of residues of some

V1 (Shendi Cultivar)	
Tr. N0)	Treatments (residues)
1	Neem
2	Argel
3	Spear.mint
4	Basil
5	Lemongrass
6	Bioneel
7	Control
	SE± 0.104
LSD 0.323	

*Based on average of ten observations per subplot.

**Based on average of number

seeds / twenty pods/

					V2(Burgeig cultivar)				
*No. of pods/ plant	**No. of seeds/ pod	***Weight Of 100 Seeds/ subplot (g)	***Seed yield / subplot (kg)	Seed yield (Ton/ha)	*No. of pods/ plant	**No. of seeds/ pod	***Weight Of 100 Seeds/ subplot (g)	***Seed yield / subplot (kg)	Seed yield (Ton/ha)
49	1.6	19	1.972	1.643 ab	39	1.5	24	1.794	1.495 a
50	1.7	19	2.077	1.731 a	38	1.5	25	1.878	1.565 a
47	1.5	18	1.558	1.299 c	43	1.4	21	1.558	1.297 a
55	1.5	17	1.814	1.512 abc	44	1.3	23	1.676	1.383 a
61	1.3	17	1.687	1.406 bc	48	1.3	20	1.570	1.308 a
47	1.7	20	2.118	1.765 a	35	1.6	26	1.906	1.588 a
62	1.0	15	1.158	0.965 d	45	1.1	18	1.130	0.941 b
					0.109				
					0.338				

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