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ALLELOPATHIC POTENTIAL OF *CAPSICUM ANNUUM* L. AND *CORIANDRUM SATIVUM* L. ON GROWTH OF BEAN CROP

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Abstract: Allelochemical are natural compounds which effects the growth of surrounding plants. The treatment of aqueous powder extracts of *Capsicum annuum* L. and *Coriandrum sativum* L. at 1% showed significant decreased in shoot, root and seedling height, leaves growth and biomass of mung bean (*Vigna radiata*). The inhibitory effect on growth performance was directly related with the increasing concentration of powder extracts of coriander. The seedlings of both legume bean were tested for the determination of toxicity and tolerance to red chilli and coriander powder extract treatment at 0, 1, 2, 3, 4 and 5%. The seedlings of mung bean and cowpea showed lowest percentage of tolerance indices to coriander and red chilli powder extract treatment at 5%. However, on comparison, the seedlings of cowpea showed more tolerance to coriander and red chili powder extract than mung bean.

Keywords: coriander, phytotoxicity, plant extracts, red chili, root growth, seedling growth, tolerance indices.

Introduction

The discharge of phytochemical substances from one plant species altered the growth performances of surrounding plants. Many studies have shown that the release of toxic substances by a plant decreased or promote growth growth of neighboring plants [CHOU & LEE, 1991; KIL & YUN, 1992; REINHARDT & al. 1993; ALLOLI & NARAYANREDDY, 2000; DAIZY & al. 2001; FERGUSON & RATHINASABPATHI, 2003; OUSSAMA, 2003; DONGRE & YADAV, 2005; MISHRA & al. 2014] and termed as allelopathy. The impact of leaf leachates of some woody plant species on agriculture and some desertt plants were reported [MELKANIA, 1984; HEGAZY & al. 1990; PURI & KHARA, 1991]. Seed regeneration failures of *Pinus silvestris* L. by *Empetrum hermaphroditum* Hagerup occurred due to allelopathic interference [ZACKRISSON & NILSSON, 1992].

Allelopathy helps in ecosystems management [ABBASSI & al. 2013] and some work in earlies 1970 was initiated in Pakistan [CHEEMA & al. 2013]. These chemicals products can serve for weed control [BAGHERI & al. 2013; BOJOVIĆ & JAKOVLJEVIĆ, 2015]. The release of allelopathic compounds influence positively and negatively on the growth of plants. *Capsicum annuum* L. belongs to Solanaceae family. *Coriandrum sativum* L. (Apiaceae) is popular medicinal plant and seeds are source of iron, copper, calcium, magnesium and zinc. Both spices production have great economic demands and used in cooking on daily basis in Pakistan and worldwide.

The purpose of the studies was to assess the toxic potential of red chili and coriander aqueous powders extract on the growth of two different bean crops namely, cowpea and mung bean because of economic importance of both leguminous crops are cultivating in the larger agricultural area of the Pakistan.

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Material and methods

The experimental site is located in the Department of Botany at the Karachi University Campus and seedling growth experiment was carried out in pots in green house. 1% solution of red chilli or coriander powder prepared by weighing one g of spice powder then dissolve in 99 ml of distilled water to make up the volume up to 100 ml and subsequent concentrations 1%, 2%, 3%, 4% and 5% were prepared respectively. The fruit of red chilli and seeds of coriander powder was kept in boiling so that convert into solution completely. The certified seeds of cowpea and mung bean were purchased from market and imbibed in water for an hour to break seed dormancy. The beans seeds surface was sterilized with 1N bleach solution for three minutes and rinsed by distilled water to remove any type of fungal contamination. The plastic pots were 7.3 cm in diameter and 9.6 cm in depth and were filled with ratio of one-part manure and three parts garden loam. Dig 1 cm holes of soil from above the surface of pots, at least 5 holes and buried the 2-2 seeds of one type of plant into pot. The pots were water daily and under the influence of sunlight, seeds were able to germinate uniformly in two weeks. One seedling was grown in each pot and ten ml of powder extract of *Capsicum annuum* L. and *Coriandrum sativum* L. were provided into the respective pots. The experiment was completely randomized. The pots were reshuffled weekly to avoid light, shade or any other climatic factors. There were five replicates of each treatment. The seedlings were uprooted from the pots after five weeks and washed with tap water. The root, shoot and seedling length and numbers of leaves were recorded. The removed seedlings were kept in oven at 80 °C for 24 hours for the determination of dry weight. Root, leaf, shoot and total plant fresh and dry weight were recorded. Root / shoot ratio, leaf weight, specific leaf area and leaf area ratio were determined according to REHMAN & IQBAL (2009).

The obtained data was statistically analyzed by ANOVA and DMRT (Duncan Multiple Range Test) ($p < 0.05$) using software packages SPSS version 14.0 on personal computer.

Results

The treatment of different concentrations of red chilli and coriander aqueous powder extract showed variable effects on growth performance of cowpea and mung bean (Table 1-4). Red chilli extract treatment at 4% significantly ($p<0.05$) decreased root, shoot, seedling height, leaf area and total fresh weight of cow pea. The significant decline in leaf weight ratio of cow pea was found at 3% red chilli extract treatment. The treatment of red chilli powder extract at 3% was brought a significant decrease in shoot growth, number of leaves and leaves dry weight of mung bean. The treatment of red chilli at all concentration showed nonsignificant effect on root, shoot dry weight and specific leaf area of cow pea, whereas, root fresh weight and root shoot ratio of mung bean. Shoot, root, seedling length, number of leaves and leaf size of cow pea was highly decreased at 5% coriander aqueous powder extract treatment. Coriander extract treatment at 1% treatment produced significantly lower number of leaves in mung bean. The coriander extract treatment at 5% significantly affected root, shoot and total plant dry weight of mung bean. Leaf weight ratio, of mung bean greatly affected by 5% of coriander powder extract treatment.

Table 1. Growth of cowpea in various concentrations of red chilli powder extract.

Seedling growth characteristic	Treatments aqueous powder extract concentration (%)					
	0	1	2	3	4	5
Shoot length (cm)	69.31 f ± 0.070	68.86 e ± 0.017	66.67 d ± 0.017	66.56 c ± 0.015	60.32 b ±0.006	60.00 a ±0.001
Root length (cm)	12.75 f ± 0.020	12.05 e ± 0.020	10.80 d ± 0.011	9.87 c ± 0.004	9.50 b ±0.040	8.27 a ±0.016
Seedling length (cm)	82.05 f ± 0.054	80.91 e ± 0.006	77.47 d ± 0.099	76.43 c ± 0.018	69.82 b ± 0.044	68.27 a ± 0.009
Number of leaves	15.00 ae ± 0.00	13.66 d ± 0.710	12.33 c ± 0.062	12.00 bc ± 0.001	11.00 ab ± 0.010	10.33 a ± 0.023
Leaf area (cm^2)	48.65 d ± 0.037	42.91 d ± 0.007	38.00 c ±0.408	35.33 b ±0.082	35.58 b ± 0.129	30.85 a ± 0.042
Root fresh weight (g)	0.880 d ± 0.020	0.860 d ± 0.006	0.800 c ± 0.004	0.640 b ± 0.004	0.620 b ± 0.018	0.440 a ± 0.008
Shoot fresh weight (g)	1.72 e ± 0.006	1.42 d ± 0.006	1.34 c ± 0.004	1.33 c ± 0.004	1.02 b ± 0.020	0.850 a ± 0.012
Leaves fresh weight (g)	1.15 d ± 0.009	1.01 ± 0.230	0.870 bc ± 0.006	0.640 ab ± 0.012	0.620 ab ± 0.005	0.440a ± 0.008
Total plant fresh weight (g)	3.30 d ± 0.106	2.290 c ± 0.206	2.350 c ± 0.16	2.11 bc ± 0.012	1.890 ab ± 0.092	1.760 ab ± 0.082
Root dry weight (g)	0.180 a ± 0.430	0.190 a ± 0.025	0.310 a ± 0.004	0.170 a ± 0.004	0.120 a ± 0.005	0.100 a ± 0.198
Shoot dry weight (g)	0.850 e ± 0.012	0.720 d ± 0.004	0.660 c ± 0.013	0.680 c ± 0.017	0.520 b ± 0.004	0.310 a ± 0.004
Leaves dry weight (g)	0.280 a ± 0.008	0.260 a ± 0.006	0.250 a ± 0.011	0.240 a ± 0.008	0.185 a ± 0.005	0.100 a ± 0.220
Total plant dry weight (g)	2.180 b ± 0.428	2.020 ab ± 0.220	1.510 a ± 0.070	1.210 a ± 0.039	0.980 a ± 0.041	0.780 a ± 0.020
Root / Shoot ratio	0.297 b ± 0.037	0246 a ± 0.032	0.350 a ± 0.002	0.310 a ± 0.036	0.316 ab ± 0.032	0.320 a ± 0.063
Leaf weight ratio	0.450 ab ± 0.007	0.280 ab ± 0.015	0.220 a ± 0.004	0.230 a ± 0.006	0.310 b ± 0.011	0.340 b ± 0.005
Specific leaf area ($cm^2\ g^{-1}$)	23.260 a ± 0.004	38.930 a ± 0.122	43.270 a ± 0.148	53.190 a ± 0.169	37.540 a ± 0.104	47.160 a ± 0.242
Leaf area ratio ($cm^2\ g^{-1}$)	10.450 c ± 0.107	10.990 c ± 0.330	9.910 a ± 0.042	12.620 b ± 0.036	11.800 d ± 0.057	11.550 e ± 0.102

Number followed by the same letters on the same column are not significantly different ($p<0.05$) according to Duncan's Multiple Range Test. Symbol used: ± = Standard error.

Table 2. Growth of mung bean in various concentrations of red chilli powder extract.

Seedling growth characteristic	Treatments aqueous powder extract concentration (%)					
	0	1	2	3	4	5
Shoot length (cm)	48.210 a ± 0.048	44.130 e ± 0.041	43.00 d ± 0.025	42.810 c ± 0.020	42.330 b ±0.213	40.230 b ±0.052
Root length (cm)	12.43 a ± 0.094	10.96 e ± 0.251	11.370 c ± 0.094	11.000 d ± 0.001	8.060 d ±0.043	6.900 b ±0.231
Seedling length (cm)	60.640 b ± 0.140	55.090 a ± 0.029	54.370 b ± 0.071	53.810 b ±11.767	50.390 b ± 0.172	47.130 b ± 0.273
Number of leaves	10.00 a ± 0.001	8.660 c ± 0.249	8.000 b ± 0.002	7.870 ab ± 0.462	7.510 a ± 0.427	7.120 a ± 0.241
Leaf area (cm^2)	22.800 a ± 0.218	21.450 e ± 0.114	20.450 d ±0.085	20.300 c ±0.091	18.000 c ± 0.001	17.000 b ± 0.002
Root fresh weight (g)	0.390 a ± 0.009	0.360 a ± 0.004	0.230 a ± 0.013	0.210 a ± 0.006	0.100 a ± 0.223	0.090 a ± 0.004
Shoot fresh weight (g)	1.630 a ± 0.165	1.410 e ± 0.006	1.400 d ± 0.005	1.210 d ± 0.013	1.150 c ± 0.004	1.010 b ± 0.006
Leaves fresh weight (g)	1.280 b ± 0.021	0.520 e ± 0.006	0.720 a ± 0.002	0.690 d ± 0.004	0.640 c ± 0.004	0.620 b ± 0.005
Total plant fresh weight (g)	3.300 a ± 0.019	2.290 c ± 0.011	2.350 b ± 0.11	2.110 b ± 0.017	1.890 b ± 0.229	1.720ab ± 0.006
Root dry weight (g)	0.170 a ± 0.004	0.150 bc ± 0.004	0.190 b ± 0.004	0.160 c ± 0.004	0.040 b ± 0.006	0.020 a ± 0.017
Shoot dry weight (g)	1.030 a ± 0.004	1.010 e ± 0.006	0.640 f ± 0.004	0.410 d ± 0.004	0.350 c ± 0.008	0.210 b ± 0.002
Leaves dry weight (g)	0.980 a ± 0.004	0.860 f ± 0.004	0.680 e ± 0.004	0.590 c ± 0.008	0.550 b ± 0.004	0.780 b ± 0.220
Total plant dry weight (g)	2.180 b ± 0.428	2.020 ab ± 0.220	1.510 a ± 0.070	1.210 a ± 0.039	0.980 a ± 0.041	0.780 a ± 0.020
Root / Shoot ratio	0.297 a ± 0.004	0.291 a ± 0.043	0.304 a ± 0.002	0.296 a ± 0.020	0.216 a ± 0.028	0.192 a ± 0.006
Leaf weight ratio	0.450 a ± 0.001	0.425 a ± 0.011	0.450 a ± 0.001	0.450 ab ± 0.004	0.602 a ± 0.051	0.705 b ± 0.014
Specific leaf area ($cm^2\ g^{-1}$)	23.260 a ± 0.242	24.900 b ± 0.095	30.070 c ± 0.052	31.710 d ± 0.100	30.500 c ± 0.097	30.900 c ± 0.176
Leaf area ratio ($cm^2\ g^{-1}$)	10.450 a ± 0.069	10.610 a ± 0.112	13.540 b ± 0.070	16.770 c ± 0.155	18.360 d ± 0.184	21.790 e ± 0.154

Number followed by the same letters on the same column are not significantly different ($p<0.05$) according to Duncan's Multiple Range Test. Symbol used: ± = Standard error.

Table 3. Growth of cowpea in various concentrations of coriander powder extract.

Seedling growth characteristic	Treatments aqueous powder extract concentration (%)					
	0	1	2	3	4	5
Shoot length (cm)	69.30 f ± 0.040	65.87 d ± 0.067	64.56 c ± 0.157	68.92 e ± 0.195	62.18 b ±0.008	57.00 a ±0.278
Root length (cm)	12.75 c ± 0.016	10.80 b ± 0.040	15.05 e ± 0.012	12.80 c ± 0.173	13.65 d ±0.167	8.60 a ±0.040
Seedling length (cm)	82.05 f ± 0.022	76.67 c ± 0.154	79.61d ± 0.030	81.72 e ± 0.150	75.83 b ± 0.011	65.60 a ± 0.086
Number of leaves	15.00 e ± 0.00	10.30 b ± 0.230	10.23 b ± 0.020	12.66 d ± 0.230	11.00 c ± 0.010	9.00 a ± 0.001
Leaf area (cm^2)	48.65 d ± 0.037	40.38 c ± 0.033	46.00 d ±0.040	40.41 c ±0.004	30.33 b ± 0.008	22.16 a ± 2.736
Root fresh weight (g)	0.88 b ± 0.004	0.930 c ± 0.004	0.820 a ± 0.004	1.00 d ± 0.002	0.950 e ± 0.004	0.810 a ± 0.004
Shoot fresh weight (g)	1.72 d ± 0.013	1.73 d ± 0.008	1.44 c ± 0.008	1.41 c ± 0.004	1.28 b ± 0.020	1.140 a ± 0.008
Leaves fresh weight (g)	1.15 d ± 0.009	0.970 ab ± 0.212	0.950 bc ± 0.008	0.850 ab ± 0.144	0.720 ab ± 0.004	0.610 a ± 0.008
Total plant fresh weight (g)	3.30 c ± 0.115	3.39 bc ± 0.206	3.70 bc ± 0.122	3.30 bc ± 0.017	3.53 b ± 0.149	2.96 a ± 0.038
Root dry weight (g)	0.220 a ± 0.400	0.210 a ± 0.004	0.300 a ± 0.005	0.240 a ± 0.008	0.200 a ± 0.004	0.180 a ± 0.010
Shoot dry weight (g)	0.210 d ± 0.012	0.130 b ± 0.007	0.200 d ± 0.018	0.150 a ± 0.015	0.130 c ± 0.008	0.160 a ± 0.004
Root / Shoot ratio	0.180 a ± 0.005	0.230 c ± 0.001	0.220 bc ± 0.003	0.200 ab ± 0.009	0.300 d ± 0.010	0.270 c ± 0.008
Leaf weight ratio	0.850 d ± 0.004	0.880 d ± 0.004	0.740 c ± 0.005	0.610 b ± 0.012	0.800d d ± 0.034	0.590 a ± 0.007
Specific leaf area ($cm^2\ g^{-1}$)	0.280 d ± 0.002	0.170 b ± 0.002	0.250 c ± 0.010	0.180 b ± 0.004	0.170 ab ± 0.002	0.170 a ± 0.004
Leaf area ratio ($cm^2\ g^{-1}$)	2.180 c ± 0.007	2.30 c ± 0.244	2.400 c ± 0.020	1.98 b ± 0.027	1.94 b ± 0.023	1.510 a ± 0.012

Number followed by the same letters on the same column are not significantly different ($p<0.05$) according to Duncan's Multiple Range Test. Symbol used: ± = Standard error.

Table 4. Growth of mung bean in various concentrations of coriander powder extract.

Seedling growth characteristic	Treatments aqueous powder extract concentration (%)					
	0	1	2	3	4	5
Shoot length (cm)	48.21 e ± 0.008	45.31 b ± 0.004	45.42 c ± 0.029	46.13 d ± 0.010	46.22 d ±0.027	40.23 a ±0.016
Root length (cm)	12.43 d ± 0.020	13.37 de ± 0.010	11.90 a ± 0.040	12.30 c ± 0.062	12.33 c ±0.009	6.90 b ±0.016
Seedling length (cm)	60.64 e ± 0.014	56.68 d ± 0.014	57.32 b ± 0.056	58.43 c ± 0.057	58.55 c ± 0.030	47.13 a ± 0.029
Number of leaves	10.00 b ± 0.00	8.35 a ± 0.781	9.00 b ± 0.00	10.12 b ± 0.409	9.66 b ± 0.034	7.22 b ± 0.001
Leaf area (cm^2)	22.80 a ± 0.080	22.97 ab ± 0.040	23.80 b ±0.080	25.00 c ±0.062	22.90 a ± 0.022	17.00 c ± 0.81

Root fresh weight (g)	0.390 a ± 0.007	0.650 b ± 0.010	0.980 d ± 0.047	0.610 b ± 0.004	0.780 c ± 0.006	0.090 b ± 0.004
Shoot fresh weight (g)	1.630 c ± 0.004	1.650 c ± 0.004	1.770 d ± 0.017	1.720 e ± 0.006	1.540 b ± 0.004	1.010 a ± 0.011
Leaves fresh weight (g)	1.280 f ± 0.004	1.090 d ± 0.010	1.090 d ± 0.010	0.950 a ± 0.019	1.210 e ± 0.004	0.620 c ± 0.006
Total plant fresh weight (g)	3.30 b ± 0.125	3.390 c ± 0.017	3.700 e ± 0.048	3.300 b ± 0.008	3.530 d ± 0.004	1.720 a ± 0.006
Root dry weight (g)	0.170 b ± 0.005	0.250 d ± 0.004	0.480 e ± 0.008	0.210 c ± 0.004	0.190 b ± 0.004	0.070 a ± 0.008
Shoot dry weight (g)	1.030 b ± 0.004	1.250 d ± 0.004	1.370 f ± 0.004	1.300 e ± 0.004	1.140 c ± 0.004	0.910 a ± 0.004
Leaves dry weight (g)	0.980 a ± 0.217	0.590 a ± 0.008	0.550 a ± 0.097	0.470 a ± 0.004	0.610 a ± 0.005	0.530 ab ± 0.019
Total plant dry weight (g)	2.180 b ± 0.210	2.090 b ± 0.010	2.400 c ± 0.012	1.980 b ± 0.010	1.940 b ± 0.008	1.510 a ± 0.021
Leaf weight ratio	0.450 e ± 0.007	0.280 c ± 0.150	0.220 c ± 0.004	0.230 b ± 0.006	0.310 d ± 0.001	0.340 d ± 0.005
Specific leaf area ($cm^2\ g^{-1}$)	23.260 a ± 0.094	38.390 c ± 0.123	43.270 d ± 0.146	53.190 f ± 0.159	37.540 b ± 0.104	47.160 e ± 0.242
Leaf area ratio ($cm^2\ g^{-1}$)	10.450 b ± 0.107	10.990 c ± 0.033	9.910 a ± 0.042	12.620 d ± 0.036	11.800 d ± 0.067	16.550 e ± 0.103

Number followed by the same letters on the same column are not significantly different ($p<0.05$) according to Duncan's Multiple Range Test. Symbol used: ± = Standard error.

The seedlings of cowpea were tested to the tolerance to different concentrations of red chilli and coriander powder extract. Red chili extract treatment at 1, 2, 3, 4 and 5% gradually decreased tolerance indices by 94.50, 84.70, 77.41, 74.50 and 65.79% in seedlings of cowpea. The treatment of coriander extract treatment at 5% showed the lowest tolerance (67.45%) indices. However, on comparison, the seedlings of cowpea showed more tolerance to coriander powder extract than red chili extract at 5%. Red chilli extract treatment at 4 and 5% showed tolerance indices by 64.84 and 55.51% in seedlings of mung bean. Coriander extract treatment at all concentrations showed better tolerance in seedlings of mung bean as compared to red chilli extract at similar concentrations.

Discussion

The studies on interactions and competition for resources among plants was carried out and suggested for the use in modifying the pattern of crop cultivation and for the increase in yields [MAJEED & al. 2017]. The treatment of red chili and coriander aqueous powder extract influenced on seedling growth performances of cowpea and mung bean. The agrochemical groups are naturally occurred in plant [KUTI & al. 1990] and produced favorable and toxic impact on the growth of surrounding plants. It was found that the release of chemical compounds from both home spices in the given substrate affected growth performance of both beans. The different response in seedling growth parameters of bean seems attributable to the level of red chili and coriander powder extract treatments. Allelopathic compounds from plants residues called allelochemicals and may work as inhibitor or beneficial for growth of subsequent plants [RICE, 1984]. The maximum

inhibitory allelopathic effect of bindweed (*Convolvulus arvensis* L.) vegetative part at 10% on seed vigor index for millet and basil plants was observed [FATEH & al. 2012]. The inhibitory substances from *C. annuum* and *C. sativum* released in the soil which apparently showed allelopathic potential and might be cause for significant decline in growth characteristics of cowpea and agreed with the findings of ELLS & MCSAY (1991) on cucumber seedlings by alfalfa plant residues. Capsaicin have a powerful allelopathic effect on growth of plant [CHO & al. 1992] and growth of weed [GONZALEZ & al. 1997]. The treatment of both spices at 2% level further decreased root and shoot growth of cowpea. MOOSAVI & al. (2011) also found significantly decreased in shoot and root growth of *Vigna radiata* L. with aqueous extract of leaf, stem and root of sorghum. The treatment of ccoriander powder extract showed beneficial and harmful effects on the seedling characteristics of cowpea. The low concentration of coriander powder at 1% slightly increased and a higher concentration decreased the seedling dry weight of cowpea. The presence of phenols and tannins from *Jatropha curcas* (5-20%) as allelochemicals showed inhibitory effect on green chilli and stimulatory on sesame [REJILA & VIJAYAKUMAR, 2011].

Conclusions

It was concluded that aqueous powder extract of red chili and coriander at 5% influenced on seedling growth and tolerance index of cowpea and mung bean. The availability of toxic allelochemicals compounds from both spices in substrate showed strong allelopathic potential activity for seedling of cowpea and mung bean.

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