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Allelopathic effects of Thymus kotschyanus on seed germination and initial growth of Sanguisorba minor

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ABSTRACT

Allelopathy is a phenomenon of direct or indirect, beneficial or adverse effects of a plant on its own or another plant through the release of chemicals into the environment. The experiment was designed to determine the allelopathic effects of Thymus kotchyanus on seed germination and initial growth characteristic of Sanguisorba minor. Tissues of T. kotchyanus in addition to seeds of S. minor were collected from Bijar rangelands and collected materials of T. kotchyanus were dried and powder. The research was performed at the greenhouse condition. The treatments included 5, 10, 15, 20 and 25 weight percentage of above mentioned powders. The tests were made in a completely randomized blocks with a factorial arrangement with four replications for 4 weeks. Germination seeds were counted and recorded daily. Germination properties included: germination percentage, mean germination time, germination speed and inhibitory percentage. At the end of study period, radicle and stem length were measured. The analysis of their variance was performed with the use of MSTAT-C soft ware, and the Excel soft ware was used to draw the required charts, and the Duncan test was used to compare the data average. The results indicated that allelopathic effect of T. Kotchyanus had negative effects on germination properties of S.minor. It was noted that powder had a considerable inhibitory effect on target plant germination and the effect at 15gr, 20gr and 25gr of powder was found to be significantly higher than that at lower amount powder (5gr and 10gr) and control treatment (without powder). The effect of 5gr powder of T.kotchyanus on germination properties and initial growth of S.minor was almost better than control treatment and effect of 10gr powder of T. Kotchyanus was similar to control treatment. The lowest germination percentage and seedling growth resulted from 25gr powder of T. Kotchyanus.

Keywords: Allelopathy, Germination, *Thymus kotschyanus*, *Sanguisorba minor*.

INTRODUCTION

Allelopathy refers to the beneficial or harmful effects on one plant, both crop and weeds species through the release from plant parts by leaching, root exudation, volatilization, residue decomposition and other processes in both natural and artificial systems (9). Allelopathic plants interfere with nearby dispersing chemicals into the soil that may inhibit neighboring plant growth, nutrient, uptake or germination (1). Plants produce numerous chemical compounds during growth season. These compounds become free in terms of leaching gas from shoots, root discharges, or by decomposing of plants remaining at the environment (16). Allelopathy is an interference mechanism, in which live or dead plant materials release chemical substances, which inhibit or stimulate the associated plant growth (10 and 12). Allelopathy, may also play an eminent role in the intraspecific and interspecific

competition and may determine the type of interspecific association. The plant may exhibit inhibitory or rarely stimulatory effects on germination and growth of other plants in the immediate vicinity. All plants utilize from primary metabolites in other to growth and creating of seed for next lineage. But they are different as regards secondary metabolites. Therefore from the viewpoint of creating allelochemicals are different too. Allelochemicals defines as second plant metabolites, that haven't direct effect on growth of target plant, but act as defensive work (13). Most plant species, including crops, are capable of producing and releasing biologically active compounds (allelochemicals) into the environment to suppress the growth of other plants (2). Allelophatic effect of *T. kotchyanus* on seed germination and initial growth of *Bromus tomentellus* and *Trifolium repens* was tested by (18), They found that aqueous extracts had a considerable inhibitory effect on target plant germination, and the effect at 50%, 75%, and 100% concentration was found to be significantly higher than that at lower concentrations (5% and 25%) and control treatment (distilled water). Seedling length in addition to fresh and dry weights was also reduced significantly over control. The genus Thymus (Lamiaceae) is represented by 14 species in Iran. Among the species grown in Iran, *T. daenensis* and *T. kotschyanus* are widely used as herbal tea, flavoring agents (condiment and spice), carminative, digestive, antispasmodic, antitussive, expectorant, and anti-inflammatory (18). The mentioned uses of *T. kotschyanus* are because of having different chemical compounds especially thymol and carvacrol (17). It is suggested that little plant individuals could be grown around *T. kotschyanus* due to its chemical effects of compounds (allelochemicals) on other plants. Based on this idea, the current research was conducted to test the allelopathic effects of *T. kotschyanus* on *S. minor*, which are valuable species of Bijar grasslands.

MATERIALS AND METHODS

The *T. kotchyanus* plant and seeds of *S. minor* were collected from rangelands of Bijar protected region at the end of growing period and seeding time respectively. The allelopathic effect tissues of *T. kotchyanus* as an herbal plant on the germination characteristics of *S. minor* were evaluated in a completely randomized factorial experiment with three replications. CRD statistical method was used because the effect of replication was not significant and was considered the effect of treatment only. The *T. kotchyanus* materials were dried naturally out of reach sunshine and grinded. The experiments were performed in isolated and controlled conditions and there were 6 treatments (5, 10, 15, 20, and 25 gr plant powder from *T.kotchyanus*) with 4 replications in each treatment. Plant powders of T.kotchyanus were mixed with the soil inside the pots and then the seeds of *S.minor* were cultivated into pots and the number of 10 seeds was used in each pot in the uniformity form. Therefore, 24 pots were used. The experiment was lasted for four weeks and the number of germinated saplings was registered every day. Data collecting performed during 4 weeks because of after 4 week, measured characteristic not have any change and germination properties of *S.minor* was fixed after this time. The plants were pulled out, cleaned, stems and roots were separated, and the length of each plant was measured at the end of experiment. Rate of germination was estimated using modified Timpson's index of germination velocity (11). Mean Germination Time (MGT) was calculated to assess the rate of germination (8).

$$MGT = \frac{\sum D.N}{n} \qquad (1)$$

Where N is the number of seeds which in D day grow, n is the total number of seeds grown and D is the number of days from the date of germination and the germination rate index was obtained by reversing MGT at the end of this period, final germination percentage was recorded. Inhibitory percentage (IP) was calculated by this formula:

IP= 100- (FG percentage in *T.kotchyanus* powder / FG percentage in control (without *T.kotchyanus*) *100) (2)

Where FG is final germination percentage. After collecting data experimental data was analyzed by MSTAT-C soft ware. The Excel soft ware was used to draw the required charts and the difference between the means was compared using Duncan's multiple range tests at level of %5 probability.

RESULTS

Germination percentage

The germination percentage was decreased from 73% to 36% for control from 0gr until 25gr weight although the effect of different weights of *T. kotchyanus* on germination percentage *S. minor seed* was different significantly

(P<0.05) except for 20gr (Table 1). The maximum and minimum of germination percentage was related to control treatment and 25gr weight respectively. The germination of *S. minor* was decreased significantly due to increasing of tissues weight of *T. kotchyanus* as it has shown in Table 1. Table 1 represents that while the highest germination percentage was observed in control treatment with 73 %, the lowest was for 25gr weight (36 %).

Mean germination time (MGT)

Mean germination time for S. minor seed was significantly different (P<0.05) at various weight of *T. kotchyanus*. There was not a significant effect for 5gr (Table 1). In comparison of various amounts of herbal plant, the lowest mean germination time was seen for control and 5gr with 15.51day while the highest was seen for 20gr with 17.80 day (Table 1).

Table 1: comparison of mean the allelopathic effect of *T. kotchyanus* in various weight on germination characteristics of *S. minor*

characteristics	treatment		
Germination percentage	**Control treatment**	%73	A
	5gr	%52	B
	10gr	%53	B
	15gr	%58	B
	20gr	%61	AB
	25gr	%36	C
Mean germination Time(day)	**Control treatment**	15.51	B
	5gr	15.51	B
	10gr	17.35	A
	15gr	17.76	A
	20gr	17.80	A
	25gr	16.17	C
Germination rate	**Control treatment**	0.0658	B
	5gr	0.0628	B
	10gr	0.0591	C
	15gr	0.0580	C
	20gr	0.0578	C
	25gr	0.0712	A
Inhibitory percentage	**Control treatment**	-0.0002	C
	5gr	28.74	A
	10gr	26.44	A
	15gr	19.54	AB
	20gr	17.24	AB
	25gr	14.15	BC
length of root (mm)	**Control treatment**	53.75	A
	5gr	43.33	AB
	10gr	41.33	B
	15gr	50.00	AB
	20gr	46.17	AB
	25gr	35.70	C
length of stem (mm)	**Control treatment**	28.75	A
	5gr	26.17	AB
	10gr	25.50	AB
	15gr	29.00	A
	20gr	22.67	B
	25gr	17.11	C

Germination rate

Various weight values (gr) of *T. kotchyanus* have a significant effect on germination speed of S. minor (except for 5gr) moreover; the highest speed of germination was for 25gr with 0.071 and the lowest was for 20gr with 0.057(Table 1).

The length of root

There was no significant effect of between weight values (5, 15 and 20gr) and control on length of root properties (Table 1).but for 10 and 25gr was significant. With increasing weight value of *T. kotchyanus* from 0gr (control) to 25gr, the length of root decreased in *S. minor*. Therefore the lowest root length observed in 25gr value with 35.70 and the highest root length was in control of *T. kotchyanus* powder (Table 1).

The length of stem

Length of stem properties for *S. minor* seed was significantly different (P<0.05) at various weight of *T. kotchyanus*(for 20 and 25gr). There was not a significant effect for 5, 10 and 15gr (Table 1). With increasing weight value of *T. kotchyanus* from 0gr (control) to 25gr, the length of stem decreased in *S. minor* (except for 15gr). Table 1 represents that the shortest length of stem and root was for 25gr *T. kotchyanus* powder, in another words, the most powerful preventive effect resulted from 25gr *T. kotchyanus* powder.

Results obtained from the allelopathic effect of *T. kotchyanus* on germination characteristics of *S. minor* species (Table 2) show that these effects have a significant difference at level of %5 probability.

Table 2: Variance effect analysis of *T. kotchyanus* on germination characteristics of *S. minor* species

Source of Changes	Degree of freedom	Germination percentage	Mean germination time	Germination rate	Inhibitory percentage	root	stem
replication	3	35.093	3.445	0.003	179.684	84.819	40.566
treatment	5	1088.078**	49.835**	0.00043799**	5206.745**	646.742**	202.167**
Test error	15	24.432	0.465	0.00001332	103.582	43.986	7.389

*** Significant level, refer to 0.5%*

DISCUSSION AND CONCLUSION

Decreased and delayed seed germination by an allelopathic extract could be confounded with osmotic effects on rate of inhibition, delayed initiation of germination, and especially cell elongation (5); the main factor that affects root growth before and after the tip penetrates the seed coat (6). (4) stated that allelopathy influenced seed germination and seedling development by preventing cell division and inhibiting cell elongation. (3) reported that fenolic compounds, as main parts of allelochemicals, prevented root cell division. From studies using aqueous alfalfa leaf extract by (7), they concluded that delayed seed germination and, especially, reduced root elongation were due mainly to toxic factors of the leaf extract.

Allelochemicals are toxic (e.g., phenolics, terpenoids and alkaloids and their derivatives) and may inhibit shoot/root growth, nutrient uptake, or may attack a naturally occurring symbiotic relationship thereby destroying the plant's usable source of a nutrient(2). These results agree with (15) that pointed out the effects of some allelochemicals compounds on germination and growth of plants may occur through a variety of mechanisms including reduced mitotic activity in roots and hypocotyls, suppressed hormone activity, alter cell division, elongation and ultra structure, reduced rate of ion uptake, inhibited photosynthesis and respiration, inhibited protein formation and nucleic acid, influence of membrance permeability or chlorophyll content, decreased permeability of cell membrance and/or inhibition of enzyme action.

The results indicated that allelopathic effect of *T. Kotchyanus* had negative effects on germination properties of *S.mibor*. It was noted that powder had a considerable inhibitory effect on target plant germination and the effect at 15gr, 20gr and 25gr of powder was found to be significantly higher than that at lower amount powder (5gr and 10gr) and control treatment (without powder). The effect of 5gr powder of *T.kotchyanus* on germination properties and initial growth of *S.minor* was almost better than control treatment and effect of 10gr powder of *T. Kotchyanus* was similar to control treatment.

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