Scholars Journal of Agriculture and Veterinary Sciences **e-ISSN 2348–1854**
Sch J Agric Vet Sci 2014; 1(3):115-120 **p-ISSN 2348–8883**
©Scholars Academic and Scientific Publishers (SAS Publishers)
(An International Publisher for Academic and Scientific Resources)

Effect of tobacco (*Nicotianatobaccum* L.) residue on seedling emergence and physiological characteristics of same cereals in rotation

Yazdani Mohammad
Ph.D. Student, Department of Agronomy, Tabriz Branch, Islamic Azad University, Tabriz, Iran

***Corresponding Author**
Name: Yazdani Mohammad
Email: Yazdanisavadkoohi@yahoo.com

Abstract: Among different crops, tobacco (*Nicotionatobaccum* L.) is considered as an index crop because it contains allelochimicals or alkaloid components such as nicotine, anabazine, nor nicotine and nicotrin. These products may be release in soil under crop rotation and affect crop growth and development. The aim of this experiment was evaluation of inhibitory rate of two different types of tobacco residues on seedling emergence and physiological characteristics of same cereals (corn, wheat and barley) that likely planted after tobacco. A factorial experiment based on completely randomized design with three replications was conducted at greenhouse in Sari Agricultural Sciences and Natural Resources University during 2012. Root and shoot residues of Virginia and Basma and corn (cv. SC704), wheat (Shanghai) and barley (Sahra) were the experimental factors. Tobacco residues in soil significantly decreased emergence time, emergence rate, chlorophyll content and seedling vigor index of corn, wheat and barley. Among cereals, corn and barley had the greatest and lowest damage, respectively. Seedling emergence of corn and wheat significantly decreased by Virginia root and shoot residue compared to control. Based on the results, barley had optimum growth in comparison with corn and wheat in tobacco rotation system.
Keywords: Alkaloid, Cereals, Rotation, Tobacco, Seedling emergence.

INTRODUCTION

The phenomenon of allelopathy has recently received greater attention from researchers and farmers worldwide. Allelopathy deals with problems of chemical interference between crops and weeds, crops and crops, toxicity of crops and weeds residues, and/or crop and weeds exudates on the growth of other crops [1-3]. The releases of allelochemicals in the soil are discussed herein. Examples of allelopathic crops, the allelochemicals produced and their uses in cropping systems are also presented along with current research trends regarding allelopathy[4-5]. The occurrence of natural allelopathic activity in crops has important positive and negative implications for cropping systems. This objective is of great importance in the design of organic farming in traditional practices. Several crops are known to have allelopathic effects on other crops [6-9]. For example, reported that phenyl acetic acid and other compounds produced during decomposition of corn and rye residues in soil were highly inhibitory to the growth of lettuce [10-12].

Allelochemicals can be present in several parts of plants including roots, rhizomes, leaves, stems, pollen, seeds and flowers [5, 13-14]. These secondary metabolites are released into the environment by root exudation, leaching from aboveground parts and volatilisation and/or by decomposition of plant material [13, 15-16]. These materials found in many plant tissues that inhibit the growth of competing plant species in different ways, such as prohibiting photosynthesis, stunting root growth, or inhibiting seed germination [17-19]. The production of allelochemicals in crop plants and their release into the soil could influence the germination and growth of plant species [20-21]. The most frequent reported gross morphological effect on plants isinhibited or retarded seed germination, effects on coleoptiles elongation and on radicle, shoot and root development and seedling emergence [22, 23, 12]. These effects are selective, depending upon the concentrations and residue type, either inhibitory or stimulatory to the growth of companion or subsequent crops or weeds [22-26]. Furthermore, reported that allelopathic compounds released from residues of barley apparently inhibit the emergence of yellow foxtail (*Setariaglauca*) whereas eastern black nightshade (*Solanumptycanthum*) was apparently only affected by the physical suppression of barley straws [22, 27]. Moreover, understanding plant interactions is important to be able to reduce the dependency on herbicides in future cropping systems.

Tobacco (*Nicotionatobaccum* L.) contains allelochemicals (nicotine, anabazine, nornicotine and nicotrin) that can either inhibit or promote the growth and development of subsequent crops in certain cropping systems [28]. In addition, collections of compounds released from tobacco roots and shoot through exudates traps can be used to provide a test solution which is biological meaningful since it contains allelochemicals actually released from the plants. The tobacco residue is used in this study because in last year's experiment it proved from farmers that to be a very effective seed germination inhibitor of same cereals such as corn and wheat. Therefore to test the hypothesis, the objective of the present studywas to investigation the allelopathic effect of tobacco residue on seedling emergence and physiological characteristic of same cereals in rotation.

MATERIALS AND METHODS

In order to investigate the effect of different tobacco cultivars residue on seeding growth of same cereal in rotation of tobacco an experiment was conducted at glasshouse in Sari Agricultural Sciences and Natural Resources University during 2012 as a factorial based on completely randomized design with three replications. Residue of root and shoot from two different types of tobacco (Virginia and Basma) were the treatments. Alkaloids were measured according to the Coresta [15] recommended method N^{O} 35 determination of total alkaloids (as nicotine) in tobacco by continuous flow analysis (table 1). Results of the soil manure analysis are summarized in Table 2. Seeds of corn (cv. SC704), wheat (Shanghai) and barely (Sahra) were sterilized in 2% sodium hypochlorite for 30 min and finally washed several times with distilled water. In each pot ten seeds were placed and the plants were grown in a greenhouse, under natural light conditions. The temperaturein the greenhouse was 25±3ºCin days and 18±3 ºCin nights.All pots were monitored daily to record cumulative seedling emergence. Once seedlings began to emerge, emergence was measured daily. Mean emergence time (MET) was estimated according to the following equation:

$$\mathrm{MTE} = \sum \frac{(\mathrm{ni} * \mathrm{di})}{\mathrm{N}} \qquad [1]$$

Where *ni* is the number of emerged seedlings at day *i*, *di* the incubation period in days and N the total number of emerged seedlings in the treatment. Seedling vigor index was calculated using the number of seedlings that had emerged by 5, 7, 9, 11 and 13 days after sowing as follows [29].

$$\text{Seedling vigour index} = \frac{\dfrac{\text{number of seedlings emerged}}{\text{number of days of first count}} + \text{number of seedlings emerged}}{\text{number of days of second count} + \cdots + \dfrac{\text{number of seedlings emerged}}{\text{number of days of the last count}}}$$

Emergence speed was calculated using following equation-

$$\text{Emergence rate} = \frac{\text{number of seedling emerged 5 days after sowing}}{\text{number of seedling emerged 13 days after sowing}} \times 100$$

Chlorophyll content measured by chlorophyll meter SPAD 502 which isdesigned and produced by Minolta, Japan. One month after sowing the plants were removed from the pots and the roots gently washed with water. Plants samples were oven dried at 70 0C for 48 h. Total seedling biomass was taken as the sum of root and shoot biomass.Residue of tobacco wastested for allelopathy on seedlingemergence and early growth of seeds of corn, wheat and barley in greenhouse. Data were subjected to ANOVA using the SAS statistical software package [30] and means were compared by LSD test (P<%5).

Table 1. Residue properties of two different types of tobacco

Tobacco residue		Virginia			Basma	
		Root	Shoot		Root	Shoot
Alkaloid (Nicotine) %		0.29	0.16		0.43	0.36

Table 2. Soil chemical properties, and soil particle distribution of the top soil layer (0-30 cm)

Type	PH	OM (%)	N (mg 100 g^{-1})	P (mg 100 g^{-1})	K (mg 100 g^{-1})	Soil particle size (mm)		
						2.0 – 0.2	0.2 – 0.02	<0.02
Silty loam	7. 6	1. 92	169	14.3	186.2	44.3	46.1	9.6

RESULTS AND DISCUSSION

All studied traits including mean emergence time, emergence rate, chlorophyll content andseedling vigor index were significantly affected by different tobacco root and shoot residue(Table 3).Among cereals, corn and barley had the greatest and lowest damage, respectively.Virginia root and Basma shoot residue had the highest and the lowest effect in terms of mentioned traits, respectively.Residues from several crop species have been examined for their potential to reduce cropgrowth [20, 31]. Kayode and Ayeni reported that the extracts of sorghum stem and rice husks considerably inhibits in the germination of maize seeds and the growth of radical and plumule [32].

Table 3: Effect of different tobacco cultivars residue on seeding growth of same cereal

Treatments	df	Mean emergence time	Emergence rate	Chlorophyll content	seedling weight	Seedling vigor index
Tobacco residue (A)	4	0.26 **	4.20 *	35.56 **	0.41 **	0.008 **
Crop in rotation (B)	3	0.02 **	0.75 NS	9.42 NS	0.02 **	0.0007 NS
A * B	6	0.02 **	0.69 NS	12.31 NS	0.02 **	0.001 NS
Total error	30	0.001	1.40	6.22	0.0001	0.001
CV %	--	10.82	8.74	8.17	10.82	21.82
***, ** Significant at 5% and 1%, respectively, NS: not significant**						

Seedling emergence was significantly affected by different tobacco root and shoot residue. Seedling emergence of corn and wheat significantly decreased by Virginia root and shoot residue compared to control (Figure 1). A rate of seedling emergence and leaf appearance is important in developing cereals crops with earlier canopy closure and better seasonal light interception [33]. Moreover, emergence rate is an important index of seedling vigor, and it is always targeted for enhancing the overall seed and seedling performance of some important plants by physical, chemical and biological priming approaches. Inhibitory effects on germination and establishments of crops caused by residues of either crop have ledto investigation of the release of toxic compounds from such residues. For example, the allelopathic interference of both living plant and of plant residues of the highly aggressive tobacco, soybean, has been strongly indicated [11]. Khan et al observed that residues from mature harvested crops of sorghum(*Sorghum bicolor*),wheat (*Triticumaestivum*) and rice (*Oryza sativa*) had phytotoxic effects ongermination and dry matter production of *Physalis minima* [7].

Furthermore, all different tobacco cultivars residue exhibited inhibitory effects on the seedling weight of corn. Virginia root had the highest inhibitory in terms of seedling weight, while the lowest amount was related to Basma shoot (Figure 1). Several studies have shown that allelopathic crops reduce growth and development of other crops growing simultaneously or subsequently in the fields [6,10, 23, 34]. Albuquerque et al reported that variation in the allelopathic response of different plant parts depends upon the distribution and accumulation of allelochmicals in different plant parts [5]. One possibility is that the allelochemicals may partially block the biosynthetic pathway of chlorophyll, or stimulate the degradative pathway of chlorophyll, or both, leading to a reduction of chlorophyll accumulation, in turn causing a reduction of photosynthesis and finally diminished total plant growth [35].

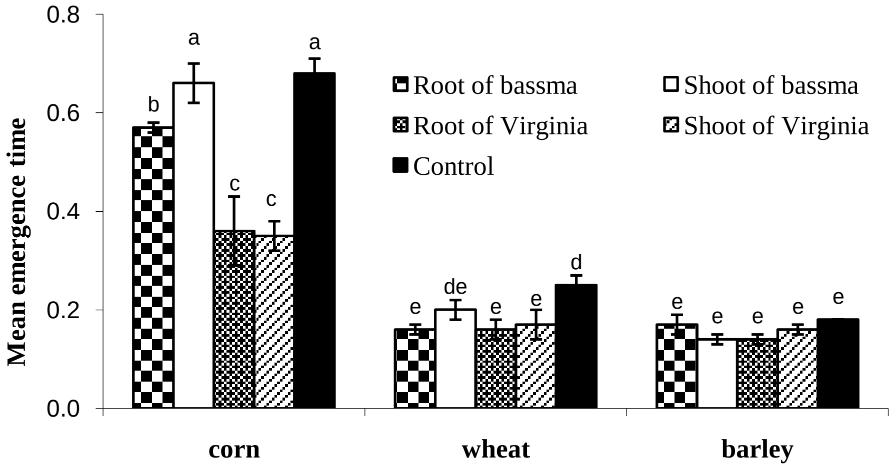

Fig- 1: Effect of tobacco residue on mean emergence time of corn, wheat and barley

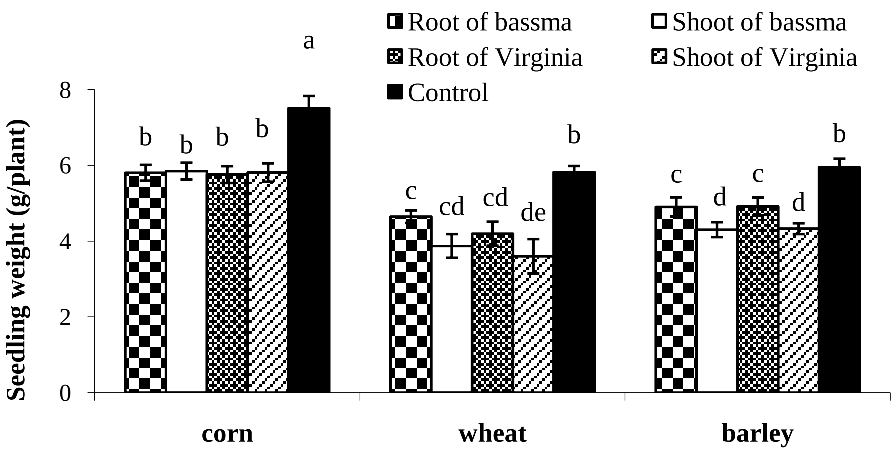

Fig-2: Effect of tobacco residue on seedling weight of corn, wheat and barley

Virginia residue had the highest inhibitory in term of chlorophyll content of corn, while this treatment was not affected on barley. Allelopathically, alkaloids are known for a variety of effects such as damaging DNA reproduction in different plants by attacking the RNA translation process. By attacking DNA replication, plants affected by the alkaloid are unable to grow. Moreover, It reported that, allelochemicals from decomposed mung bean in soil reduced the seed germination and plant height of subsequent crops especially in soybean (*Glycine max*) and lettuce (*Lactuca sativa*).

In addition, Oussama found that durum wheat leaf extracts significantly affected germination of wheat [6]. Kong et al founds that wheat growth could be significantly inhibited in *Ambrosia trifida* infested or residue amended soil**s** [36]. Anaya reported that even though a reduction of photosynthesis has been widely observed in the allelochemical targeted plants, the component of photosynthesis which is directly or indirectly affected by the allelochemicals is still unknown[10].

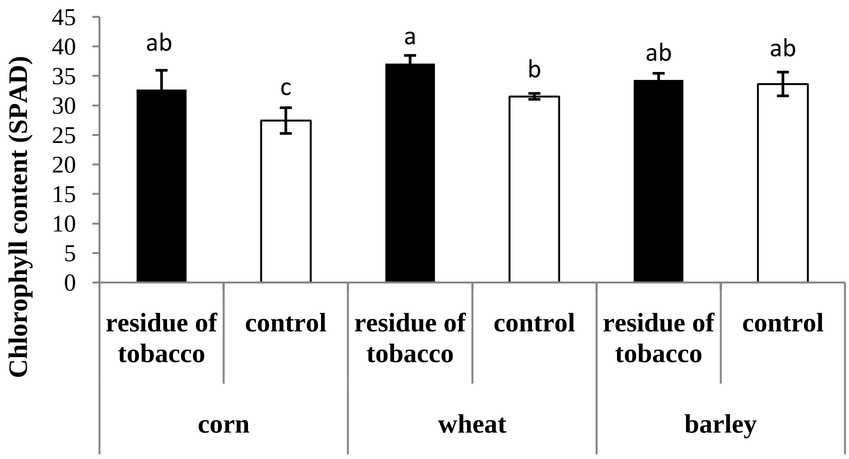

Fig- 3: Effect of tobacco residue on chlorophyll content of corn, wheat and barley

CONCLUSION

Results of the experiment indicated that when corn and wheat seed grown with tobacco cultivar, their seedling vigor, seedling emergence and seedling weight significantly decreases. Leaf area, seedling emergence and vigor and chlorophyll contents were significantly affected by different tobacco root and shoot extracts. Moreover, root of Virginia residue, decreased corn and wheat growth more than Basma stem residue. Different tobacco root and shoot residue significantly decreased germination percentage and rate, shoot and root length in soybean. Virginia root and Basma shoot extracts had the highest and the lowest effect in terms of mentioned traits, respectively. The study of the chemical interactions among plants could be a useful approach for the development of new classes of environmentally safe herbicide. Therefore it seems that use of allelopathy tobacco considered as a potential and environmentally friendly approach for weed control in crop production.

REFERENCES

1. Khanh TD, Chung MI; Crop allelopathy in sustainable agricultural production. Agronomy Journal, 1997; 3: 172-18.
2. Monica F, Josefina A. Sillero C, Rubiales D;.Intercropping with cereals reduces infection by *Orobanchecrenata* in legumes. Crop Protection, 2007; 26: 1166-1173.
3. Siddique AB, Ismail BS; Allelopathic Effects of *Fimbristylismiliaceae*on Rice Plants. Proceedings of "The 16th Asian Agricultural Symposium and 1st International Symposium on Agriculture Technology (ISAT)" Bangkok, Thailand, on 25-27 August. 2010; 72-75.
4. Inderjit C, Weiner J; Plant allelochemical interference or soil chemical ecology? Perspectives in plant ecology. Evolution and Systematics, 2001; 4: 3-12.
5. Albuquerque MB, Santos RC, Lima LM, MeloFilho PA, Nogueira RJM, Camara CAG, Ramos AR; Allelopathy, an alternative tool to improve cropping systems. Agronomy Sustainable Development, 2001;31: 379-395.
6. Oussama O; Allelopathy in two durum wheat (*Triticum durum* L.) varieties. Agriculture Ecosystems and Environment, 2003; 96: 161-163.
7. Khanh TD, Chung MI, Xuan TD,Tawata S; The exploitation of crop allelopathy in sustainable agricultural production. Agronomy and Crop Science, 2005;191: 172-184.
8. Amar M, Abdul K, Muhammad F, Zahid AC; Quantification of Allelopathic potential of different crop residues for the purple nut sedge suppression. Pakistan Journal Weed Science Research, 2010; 16 (1): 1-12.
9. Yazdani M, Bagheri H; Allelopathic effect of tobacco (*Nicotiona tobaccum* L.) on germination and earlygrowth of Soybean (*Glycine max* L.). Australian Journal of Basic and Applied Sciences, 2011 ;5(11): 1178-1181.
10. Anaya AL; Allelopathy as a tool in the management of biotic resources in agroecosystems. Plant Sciences, 1999; 18: 697-739.
11. Schabes FI, Sigstad EE; A calorimetric study of the allelopathic effect of cnicin isolated from *Centaureadiffusa*Lam on the germination of soybean (*Glyicine max*) and radish (*Raphanussativus)*. Thermochimica Acta, 2007;458: 84-87.
12. Ullah A, Ahmad Khan E, Baloch MS, Nadim MA, Sadiq M, Noor K; Allelopathic effects of herbaceous and woody plant species on seed germination and seedling growth of wheat. Pakistan Journal Weed Science Research, 2013; 19 (3): 357-375.
13. Regina GB; Allelopathy in crop/weed interactions and update. Pest Management Science, 2007; 63 (4): 308-326.
14. Cheema ZA, Muhammad Z, Ahmad R, Murtaza G; Application of allelopathic water extracts for suppressing the rice weeds. Crop and Environment, 2010; 1: 1-5.
15. Gundiff RH, Markunas PC; Abbreviate techniques for determination of alkaloids in tobacco using the extraction procedure. Tobacco Science, 1964; 8: 136-137.
16. Reeves DW, Price AJ, Patterson MG; Evaluation of three winter cereals for weed control in conservation-tillage non-transgenic cotton. Weed Technology, 2005; 19: 731-736.
17. Chang HC; Roles of allelopathy in plant biodiversity and sustainable agriculture. Plant Sciences, 1999;18: 609-636.
18. Ioannis V, Kico D; Allelopathic potential of bermudagrass and johnsongrass and their interference with cotton and corn. Agronomy Journal, 2005; 97: 303-313.
19. Jabran K, Cheema ZA, Farooq M, Hussain M; Lower doses of pendimethalin mixed with allelopathic crop water extracts for weed management in canola (*Brassica napus*). International Journal of Agriculture Biology, 2010; 12: 335-340.
20. Kruse M, Strandberg M, Strandberg B; Ecological effects of allelopathic plants - a review. National Environmental Research Institute, Silkeborg. Denmark. 2000; 66.
21. Mafeo TP, Mashela PW; Allelopathic inhibition of seedling emergence in dicotyledonous crops by *Cucumis*bio-nematicide. African Journal of Biotechnology, 2010; 9 (49): 8349-835.
22. Creamer NG, Bennett MA, Stinner BR, Cardina J, Regnier EE; Mechanisms of weed suppression in cover crop-based production systems. Hortscience, 1966; 31: 410-413.
23. Goetze M, Rica T, Gladis CH; Allelopathyc effect of *Nicotianatabacum* and *Eucalyptus grandis* extracts on the germination of three vegetables species. Agrochemical, 2004; 10: 43-50.
24. Farooq M, Jabran K, Cheema ZA, Wahid AM, Siddique KH; The role of allelopathy in agricultural pest management. Pest Management Science, 2011; 67(5): 493-506.
25. Yang C, Lee C, Hung C; Effect of three allelopathicphenolics on chlorophyll accumulation of rice seedling. Institute of Botany, Academia Sinica, 2002; 4: 299-304.
26. Ferreira MI, Reinhardt CF; Field assessment of crop residues for allelopathic effects on both crops and weeds. Agronomy Journal, 2010; 6: 1593-1600.
27. Hierro JL , Callaway RM; Allelopathy and exotic plant invasion. Plant and Soil, 2003; 256: 29-39.
28. Florentine SK, Westbrooke ME, Graham R; Invasion of the noxious weed *Nicotiana glauca* after an episodic flooding event in the arid zone. Arid Environments, 2005; 60: 531-545.

29. AOSA; Seed vigor testing handbook. Contribution N° 32. Association of Official Seed Analysis (AOSA), Springfield, Illinois, USA. 1983.
30. SAS Institute. Inc. SAS/STAT Users Quide, version 6.12.SAS Institute. Inc. Cary, NC. 2006
31. Sang U, Chon K, Nelson CJ, Coutts JH; Osmotic and auto toxic effects of Leaf extracts on germination and seedling growth of Alfalfa. Agronomy Journal, 2004; 96: 1673-1679.
32. Kayode J, Ayeni JM; Allelopathic effects of some crop residues on the germination and growth of Maize (*Zea mays* L). The Pacific Journal of Science and Technology, 2009;1: 345-349.
33. Abdul Baki AA, Anderson JD;. Vigor determination in soybean by multiple criteria. Crop Science, 1973; 13: 630-633.
34. Fenandez M, Aparicioa JC, Sillerob, Rubialesa D; Intercropping with cereals reduces infection by Orobanchecrenata in legumes. Crop Protection, 2007; 26: 1166-1172.
35. Gibson LR, Liebman M; A laboratory exercise for teaching plant interference and relative growth rate concepts. Weed Technology, 2003;17: 394-402.
36. Kong CH, Wang P, Xu XH; Alleopathic interference of Ambrosia trifida with wheat (Triticum avesticum). Agric. Ecosys. Environ., 2007; 119:416-420.