

The allelopathic potential of rice

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Abstract;

An experiment was conducted at the College of Education laboratories to test the effect of allelopathy compound released from rice residues on wheat plant , and determined whether the reduction in growth of wheat crop rotation was due to toxicity of rice residues .

randomized complete block design Means were compounded using

Results showed that :

- 1-The residues of rice significantly reduced vegetative and root growth .
- 2-Aqueous extracts of rice significantly reduced seed germination and seedling growth of wheat .
- 3-The toxicity of the residues appeared two weeks after residues decomposition of soil and continue &for indicatded that six weeks.
- 4-The results strongly suggest the toxicity effect of rice residuc was acausative factor responsible for reduction of wheat growth .

الجهد الاليلوباثي للرز

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الخلاصة:

اجريت هذه الدراسة في مختبرات كلية التربية للبنات /جامعة الكوفة بهدف اختبار النشاط الاحيائي للمركبات الاليلوباثية المتحرره من مخلفات نبات الرز ضد نبات الحنطة ولمعرفة فيما اذا كان ذلك التأثير السمي السبب وراء انخفاض انتاجية الحنطة المزروعة بعد حصاد نبات الرز من الحقل نفسه وتبين من النتائج مايلي :-

- ١ - ان مخلفات نبات الرز قد سببت اختزال نمو المجموع الخضري لنبات الحنطة .
- ٢ - ادت المستخلصات المائية لمخلفات نبات الرز الى اختزال انبات بذور الحنطة ونمو بادراتها .
- ٣ - كما اشارت النتائج الى ان سمية المخلفات المضافة الى التربة ظهرت بعد اسبوعين من التحلل وكانت على اشدها واستمرت لمدة ستة اسابيع ثم تلاشت بعد ذلك .

اشارت هذه النتائج الى ان السموم المتحرره من مخلفات نبات الرز هي احد العوامل المسؤولة عن اختزال نمو نبات الحنطة المزروعة بعد حصاد الرز مباشرة.

Introduction

Allelopathic is an environmental phenomenon which has an important role in the environmental and agricultural systems through its effect on the production of many of the plants and biochemical interactions among the plants and through the interactions between the plants, and the interactions between the plants and micro-organisms. (Rice, 1984).

The term allelopathy is a Greek word consists of two parts: first; Allelon which means an opposite things. the second part is: pathose which means the suffering of the plants due to this opposing. Many studies had been done about this phenomenon and its role in the environmental system suggest that the allelopathic effects result from releasing of compounds named as (allelochemicals) which considered as a secondary metabolites which result from any part of the plant e.g. leaves, roots, stem, flowers, seeds, leaves and roots are the main sources for these compounds (Regiosa et. al, 1999).

The studies referred to the presence of many of the plants that cause allelopathic potential on the other plants that also present in the field or these that grow after them, this through releasing of allelopathic products to the environment by leaching, root exudates, plants decomposition by micro-organisms and volatilization method.

These products have an inhibition and activation affects for plants and micro-organisms through its on many biological actions.

The effects of allelopathic products depend on its nature and its concentration, number of these compounds cause an inhibiting affects on seeding germination and growth, while others cause an activating effects, (Puviss 1990).

There are different effects of the residues of the *Sorghum bicolor* L., & *Pisum sativum* L. & *Brassica napus* L. on growth of wheat.

The *Sorghum bicolor* L. cause a clear inhibition for wheat growth while *Pisum sativum* L. has less inhibition and the *Brassica napus* L. which had been decomposed in soil cause increase in the wheat production in comparison with other plants, the allelopathic effects were due to the allelopathic compounds which released by plants.

Regiosa et. al, (2000) referred that the informations about the effect of allelopathic compounds in the physical and biochemical processes in plants were little effects due to the presence of number from these compounds, each compound has more than one of the physiological effects. The allelopathic effects occurred due to number of these compounds that act synergistically. These effects occurred in nature by the presence of stress agents that effect on growth and development of many plants so, it is necessary to explain the phenomenon of allelopathy according to the types, classes of plants for the production of allelopathic compounds during different stages from its life cycle (Einhellig & Waller, 1999).

Wheat considered from the crop plants that has an economical and dietary importance it is the main key for diet production, about $\frac{3}{4}$ of human needs from energy are gained by wheat, also act more than $\frac{1}{2}$ of its protein needs.

Rice is from the important economical products in the world especially in Iraq. In Iraq, rice cultural in the middle and southern parts in alteration with the wheat. It has noticed that their production had decreased although the presence of good management for fields by watering, fertilization.

Decreasing in production of wheat after cropping of rice was due to the toxin effect of rice residues on the wheat growing. Therefore, this study had done to support this supposition and to

know allelopathic effects of rice and also to know it's effect on seed germination of wheat *Triticum aestivum* L and seeding growth.

Materials and Methods :

1-Collection of plant's residues :

At 1st October, 2008 plant's residues were collected from roots , stem and leaves from rice fields in Abbasiya in Najaf city.

To know the amount of dry material that the plant had added to the soil , number of plants had been cut after cropping and the soil that surround each plant had also taken in a cycle shape about 15cm in diameter , 20cm in depth and weighed after drying to count the amount of dry material by dividing the dried weight of the plant by the weight of the surrounded soil the results was 4gm of dry(Rice ,1984) weight added for each kilogram from soil .

2-Crushing & conserving of samples :

Rice samples were dried by exposing to sun for a few hours , fragmented into small pieces , put on a cloth at the laboratory temperature with a continues flipping over to prevent putrefy. After drying , the samples were crushed by a mill type (Wiely mill standard No. 3 Arthur). Then , the milled residues sieved by asieve (50-60 mesh) & the powder was saued in nylons in the laboratories until the extraction process.

3-Samples Extraction :

Two hundered gm of the powder were weighed & put in a flask volume 500ml . 200ml for (80%) ethanol were added, the powderwas left for 24 hours with shaking from time to time .

The transpired material concentrated by rotary evaporator to convert it concentrated in order to get rid of alcohol & water (Harbone 1973) , the extracted material was weighed after drying . when the total weight of the extracted material, it should be preserved in a plastic bottles volume 50ml . Samples storedor kept in a freezer till it is used for studying of it's actions against the wheat .

4-Testing the effects of rice residues on growth of wheat :

In a mixed soil , rice powder (4 , 2gm residues/kg soil) then placed in a plastic anvil (500gm) apeatmoos added (4 , 2gm peatmoos/kg soil)respectively , then wheat seeds were sown 10 seeds for each anvil . After 2 weeks Number of seedlings were lowered or ithnned to 3 plants for each anvil , then left to grow for 3 weeks later . At last, plants were cropped and their roots were removed from soil by a running water then all of the plants were dried by electric oven 65 c° the results compared with adry weight .

5-Test the period of action of poisons that released from the decomposition of rice residues in the soil and it's effect on the growth of wheat :

A –samples preparation :

Residues of roots , stems and leaves rice were dried for a week inside a glass house , fragmented into pieces (2-3cm) in length then added to the soil in (10, 20 ,40 ,60gm residues /kg soil), on the other hand soil without residues is used for comparison . After mixing of residues with a soil , the

mixture was put in a plastic anvil size (5kg soil) . An amount of water added for each anvil to reach the field capacity. Each anvil was closed with a perforated piece of nylon for ventilation , then the anvils were placed randomly in a dark place inside the glass house .Samples were taken from each treatment after (1, 2 ,4 ,6 ,8 ,10)weeks from decomposition .

B –collection of the toxin that released from rice residues and evaluation of it's effect on the wheat growth :

To collect the plant toxin that released to the soil , 200gm from the soil was taken , For each sample , 200ml ethanol (80%) was added . Let the samples were left 24 hours with shaking from time to time then the samples extracted three times by ethanol (80%) by the previously mentioned method (Harbone , 1973) .

After drying of the plants , the residues dissolved in 50ml of D.W. , the size filled to reach 100ml for using in evaluation of the biological actions against the wheat .Nine cm in diameter Petridishes were used containing white sand , 20 seeds of wheat , for each dish 15ml from the aqueous extracts were added .

Dishes were closed with a perforated waxed paper for ventilation . Dishes placed randomly inside the auto-clave for growing . After 7 days the percentage of growing was counted according to the following equation :

Total of germination seeds

$$\text{Germination percentage} = \frac{\text{-----}}{\text{Total Number of seeds}}$$

Longth of redicale plumule and awhole plant was them measured .

Statical analysis :

Factorial experiment with in randomized complet block design with three replication . Means were compared using the least significant difference at 0.05 probability level .

the results :

Table (1) : referred to the siggificantly effect of addition of rice residues in concentrations (2 &4 gm residues/kg soil)this addition led to vecluctionin the root and vegetative parts of rice and effect on whole plants . significant reduction was found for all signs of growth except the vegetative parts in concentration (2gm residues /kg soil)while concentration (4gm residues/kg soil) which caused 14.40 % reduction.

Table (1) : The effected of rice residues in wheat growth.

Percentage of plant reduction	Dry weight(mean)*			moduli
	plant	Vegetative parts	Root parts	
Comparison No. (1):				
0.00	74.30	51.37	22.93	2gm betmos/kg soil
23.10	54.64	46.57	8.07	‡gm residues/kg soil
	6.50	N.S	0.70	L.S.D.at 0.05 level
Comparison No. (1):				
0.00	75.97	54.57	21.4	‡gm betmos/kg soil
14.40	63.13	51.83	11.3	4gm residues/kg soil
	0.90	0.60	0.30	L.S.D. at 0.05 level

*every Number. in the table represents mean of three repetitions each repeat
represents a mean for three plants .

The effect of the toxicity that released from the rice residues which decomposed in the soil at different times was significantly in reducing seed germination of the wheat in comparison with control treatment table (2) . There is no significant sign among the last three concentrations and also no incorporeal differences among the last two concentrations with treatment (10gm residues/kg soil).

But there were a significance differences between concentrations of (10 & 20 gm residues/kg soil) , the percentage of reduction is high .

The results showed that the highest germination percentage occurred after (4 , 8 , 10 weeks)coming after that the period(1and 6 weeks) from decomposition . peak of reduction was after 2 weeks from decomposition .

When we noticed the interactions between the periods of decompositions & the concentration used we found that after one week from decomposition concentrations of (20 & 40 gm residues /kg soil) were significantly reduced. after 2 weeks (20 & 60gm residues/kg soil) reduce the germination . Later , no signs of negative effect on the wheat germination was found .

Table (2) : The effect of the toxicity that released from rice residues that decomposed in the soil during rice seed germination

Mean	Decomposition period (week)						Concentrations
	١٠	٨	٦	٤	٢	١	
72.4	81.3	78.0	71.3	74.6	58.0	71.3	0 gm residues/ kg soil
61.9	68.0	78.0	54.7	71.3	44.7	54.7	١٠ gm residues/ kg soil
53.0	78.0	68.0	54.7	68.0	58.7	44.7	20gm residues/ kg soil
56.3	71.3	61.3	61.3	64.7	48.0	31.3	40gm residues/ kg soil
59.7	78.0	61.0	48.0	68.0	34.7	68.0	٦٠ gm residues/ kg soil
	75.9	69.3	58.0	69.0	38.0	54.0	Mean

Table (3) explained that the toxicity which released from the rice residues decomposed in the soil had a clear effect on the length of the rootlets of the wheat in comparison with the control treatment . Almost the decrease in the radicle growth scored with (20gm residues /kg soil) , then (10gm residues /kg soil) which had no significant difference from (40 &60 gm residues /kg soil).

According to the period of decompositions , the almost decrease in the rootlets length occurred after 1& 2 weeks from decomposition then the reduction lowered with increase in period , rootlet length become (2.71-2.73)cm after (4 & 6 weeks) from decomposition respectively , then the decrease lowered till it reached 4.61cm after 8 weeks & 4.88cm after 10 weeks from decomposition .

The interactions between decomposition periods & concentration had an significant effect on the length of the rootlets in comparison with the control treatment. During the first four periods of decomposition(except the last two concentrations after 6 weeks from decomposition) the reduction was not significant , after (8 & 10 weeks)there were no any signs for significant differences in the length of rootlet among all of the used concentrations

Table (3) : The effect of toxicity which released from the rice residues that decomposed through different periods on the radicle length of the wheat (cm)

Mean	Decomposition period (week)						Concentrations
	١٠	٨	٦	٤	٢	١	
3.92	5.02	4.71	3.44	3.64	3.80	2.0	0 gm residues/ kg soil
2.81	4.99	4.29	2.09	2.52	0.84	2.10	١٠ gm residues/ kg soil
2.63	4.90 5.90	4.69	2.37	3.04	0.13	0.63	20gm residues/ kg soil
3.13	4.98	4.70	2.75	2.36	2.43	1.57	40gm residues/ kg soil
4.06	4.88	4.68	2.92	2.08	1.72	2.09	٦٠ gm residues/ kg soil
	4.88	4.61	2.73	2.71	1.79	1.86	Mean

The table (4) represents the concentration of the rice residues that had an incorporeal effect on the length of plumule in comparison with the control treatment, highest reduction was achieved with (20gm residues /kg soil)

According to the decomposition periods , highest length of the plumule after (4 weeks)about (3.64cm) , while the interaction between (periods & concentration) significantly affected in the plumule growth .

Table -4- showed that all concentrations used had reduced the length of pulumle significantly in comparison with the control treatment . The almost decrease in the length of plumule was obtained from (20gm residues/kg soil) after 2 weeks from decomposition

Table (4):The effect of toxicity released from rice residues that decomposed in the soil during different periode on length of wheat plumule (cm) .

Mean	Decomposition period (week)						Concentrations
	١٠	٨	٦	٤	٢	١	
4.62	3.29	3.65	4.8	4.89	6.26	4.74	0gm residues/ kg soil
3.01	2.98	3.29	2.7	3.70	1.77	33.56	١٠ gm residues/ kg soil
2.43	2.87	3.08	2.7	3.02	0.17	2.21	20gm residues/ kg soil
3.02	2.95	3.50	3.2	3.06	2.80	2.52	40gm residues/ kg soil
3.35	2.98	3.44	3.6	3.53	2.95	3.56	٦٠ gm residues/ kg soil
	3.01	3.40	3.4	3.64	2.79	3.32	Mean

The effect of the rice residues concentration in the length of wheat was significant , the highest reduction occurred with (20gm residues/kg soil)which differed significantly from the rest of the used treatments which had no differences among them table-5-

While Periods of decompositions referred to high reduction in a plant length after 1 or 2weeks from decomposition .

Then the reduction was lowered with increasing the decomposition period to reach (9.01& 9.03)cm after (8 &10)weeks respectively . the interactions between the concentrations and periods referred to the presence of significant effect on the plant length :

The highest reduction in the plant length occurred with (20gm residues/kg soil) after 2 weeks from decomposition.

Table (5) :The effected of toxicity released from the rice residues that decomposed during different periods in the soil in wheat length(cm)

Mean	Decomposition period (week)						Concentrations
	١٠	٨	٦	٤	٢	١	
9.55	9.50	9.36	9.3	9.5	11.1	8.64	0 gm residues/ kg soil
6.87	9.30	9.30	5.8	7.2	2.61	6.67	١٠ gm residues/ kg soil
5.91	8.77	8.76	5.7	7.0	1.30	3.84	20gm residues/ kg soil
7.20	8.94	9.25	7.2	6.4	6.23	5.09	40gm residues/ kg soil
7.42	8.85	9.12	7.5	6.6	5.74	6.66	٦٠ gm residues/ kg soil
	9.03	9.01	7.1	7.1	5.61	6.18	Mean

Discussion

Allelopathy is an ancient phenomenon discovered before 2000 years (Molish , 1973) represent good and worse biological interactions among the types of the plants including micro-organisms (Haig *et. al*, 1998) .

Number of researchers said that these effects were results from releasing of toxin compounds (phytotoxin) named as (allelochemicals) which are a secondary metabolic products . Leaves , roots were the main source for these allelopathic compounds these products may be present also in other parts from the plants as thanks , flowers, fruits , and rhizomes .

Roots produce an allelopathic compounds equal to that released from leaves but with less toxin effects . (Garlson *et. al*, 1999; Verbeek *et. al*, 1998).

Number of researchers in many countries noticed the reduction in the growth as a result of the germination of different plants alternatively or by germination of the same plant for several years in the same field although of good management for field by watering & fertilization .

In Iraq , burning of wheat or rice residues that remained in fields led to improvement of production because by burning the pathological agents that were inhibit that soil would disappear , so the insects , fungi and so on would disappear .(Rizvi & Rizvi, 1992) .

But this may be due to the effect of the residues of the previous plant on the next plant by it's (allelochemicals) that released into the environment by leaching or root secretion or by microbial decomposition of the residues of the plants , these products could be mixed with soil and affect the next growth in the same soil . (Rice , 1984) .

In this study the biological test was done to know the effects of aqueous extracts of root and vegetative parts of rice on the wheat growth .

Results were similar to that gained by (Chou & Lin , 1976) , that the aqueous extracts of the rice residues cause inhibition in the wheat growth about 70% , but the toxin effects decreased gradually till reached to 10% after 5 weeks .

Several allelopathic compounds were diagnosed ;(hydroxyl benzoic acid) , (p-coumaric acid) , (ferulic acid) , (vanillic acid) , (syringic acid) , (hydroxyl phenyl acetic acid) from the aqueous extracts of soil that contain these residues ,all of these products caused inhibition wheat growth .

These compounds had a significant inhibitory effect on the germination of wheat seeds and significant effect the growth of their seedling growth through it's effect on the cellular components , hormones anabolism and equilibrium of them , cell membrane & their permeability , closing and opening of stomatae , formation of pigments , respiration process , building of proteins , nitrogen fixation , anzyme activity and transporting tissues , relation between water & plant using ions and genetic materials (Rizvi and Rizvi , 1992).

Results were coincided with those found by (Chou,1999) which mentioned that the plant poisons released by rice residues within the soil would decrease the rice growth but not prevent it's growth .

The difference in the effect of allelopathic compounds (inhibition or activation)was due to it's chemical composition , concentration , toxin in a plant tissue & environmental conditions (Reigosa *et. al*, 2000) .

The results that we found showed the significance effect of rice residues on wheat growth , because of the high ability of rice in reduction of root and vegetative parts of wheat this means there was reduction in whole growth of wheat .

Reduction percentage about (11.4 & 20.1%) for (2 & 4 gm residues /kg soil) respectively . table (1) and these results were coincided with that found by (Einhellig, 1996) he noticed that a low concentration of rice residues caused great inhibition of growth but it did not coincide with the results that found by (Patrick , 1973)he found that the low concentrations might have a limited effect or might caused an activation during growth periods .

The reduction of the percentage reduction in growth with increasing residues concentrations might be due to presence of an inhibition to the micro-organisms in soil by residues which affected negatively on it's decomposition rate & releasing of toxin from it .(Zoble , 1997) .

The results certained that these toxin remained active for more than 6 weeks . tables (2 ,3 ,4 ,5)this means that these toxin could effect in growth of wheat seeds , plumule , radicle & plant length under the same conditions in which growth which contain the unburned rice residues .

So , the rice residues left in the field in which wheat would grow and

The researcher diagnosed the plant toxin that released from rice residues within the soil and these toxin not affect wheat only but also cause inhibition for cyanobacteria which grow in the rice and wheat fields that inhibit the atmospheric nitrogen . (Hicks *et. al*, 1998) .

It is necessary to remove a largest amount of rice residues before beginning in wheat farming. For more benefits ; we advice in increasing in number of researches about this field , increasing laboratory experiments , glass house experiments , in addition to a field experiments under natural conditions to get better and more actual results .

In addition to rice we should study the effect of other plant residues on wheat growth to have a knowledge about the allelopathic effects of those plants & chemical decomposition for allelopathic compounds .

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