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Leaching of Nutrients in Luvisol

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Discovering Thoughts, Inventing Future

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Model of Waters Resource Management, based on Capture Fisheries Conflict Resolution

By Rusmilyansari

Universitas Lambung Mangkurat, Indonesia

Abstract - Fisheries conflicts is one issue that needs serious attention, because it could threaten the sustainability of marine resources.This study aims to determine the effectiveness of the causes of conflict and conflict resolution in the management of aquatic resources. Research using survey methods with quantitative approaches. Variables were divided into three groups: input variables (factors causing conflict); output (conflict resolution techniques) and outcome. The primary data source is 200 stakeholders of water resources. Statistical analysis using structural equation modeling. The results showed that the cause of the conflict is a competition factor in the utilization of marine resources, the presence of the opposite parties, the economic condition, the extent of the parties involved as well as the cultural background. Conflict resolution is the most effective use of facilitation techniques.

Keywords : management, waters resources, conflict resolution, capture fisheries.

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Model of Waters Resource Management, based on Capture Fisheries Conflict Resolution

Rusmilyansari

Abstract - **Fisheries conflicts is one issue that needs serious attention, because it could threaten the sustainability of marine resources.This study aims to determine the effectiveness of the causes of conflict and conflict resolution in the management of aquatic resources. Research using survey methods with quantitative approaches. Variables were divided into three groups: input variables (factors causing conflict); output (conflict resolution techniques) and outcome. The primary data source is 200 stakeholders of water resources. Statistical analysis using structural equation modeling. The results showed that the cause of the conflict is a competition factor in the utilization of marine resources, the presence of the opposite parties, the economic condition, the extent of the parties involved as well as the cultural background. Conflict resolution is the most effective use of facilitation techniques.**

Keywords : management, waters resources, conflict resolution, capture fisheries.

I. Introduction

Since the issuance of Law No.32of 2004 on Regional Government, the local authorities have an important role in resource management. Marineand fisheries sector development in South Kalimantan will behamperedif the conflict fisheries do not getattention in proportion. Utilization of marine resourcestend to be unlimited and more oriented to economic interests, adversely impact the sustainability of marine resources.

Conflicts among users of water resources in southern Kalimantan escalated since 1979 until 2011. There are several cases of conflicts such as andon fishermen using purse seine usage with higher technology than the local fishermen, fishing ground scramble case, case of catch sea cucumbers using a compressor, case of modification lampara by adding outer board, case of bagan, and cases of illegal fishing (Rusmilyansari. 2012).

Management of aquatic resources is essentially the management of human use. Management of human behavior is setting them in terms of resource management. Priscoli (2002) suggests that natural resource conflicts can be caused by poor communication, different perceptions, ego battles, differences in personality and stereotype issues, differences of opinion about the good and the bad, different interests and structural factors. Conflict fisheries varies between regions and over time. Bennett and Neiland (2000) stated that the conflict is multidimensional and generally involve multiple parties in complex relationships.

The Government has sought to address the fisheries conflicts that arise by issuing rules, but the results have not been effective.Research on water resource management model based conflict resolution is important because it will contribute significantly to the fishery resource management planning, because without proper management, conflicts can inhibit the development of fisheries and marine in South Kalimantan. This study aims to determine the causes of conflict and determine the effectiveness of conflict resolution in the management of aquatic resources.

II. Research Methods

The experiment was conducted in the coastal village of South Kalimantan. Selection of the study area conducted purposive as the base area of conflict Kotabaru district, Tanah Bumbu district and Tanah Laut District. The study was conducted in 2012.

Research using a survey of 200 stakeholders methods of fishing resources. comprising government agencies, nongovernmental organizations, village chiefs, community leaders, fishermen, and academics. Information was collected using a structured questionnaire aimed to determine the perceptions of the three groups of variables respondenden the variable causes of conflict, conflict resolution and variable variables outcome.

Variable factors causing conflict consists of people's economic condition (X1), the extent of the parties involved (X2), the presence of the opposite party (X3), a growing issue in society (X4), number of fishermen (X5), kompotesi in resource use (X6), the presence of a character in conflict (X7), public perception of the stock (X8), a certain desire in society (X9), the existence of regulatory and law enforcement (X10), cultural backgrounds (X11). Conflict conflict resolution techniques fishery consists of litigation (Y1), negotiation (X2), Facilitation (X3), avoidance (X4). Outcame variables consist of community participation in fisheries management (Z1), resource sustainability (Z2), the management of fisheries resources with justice (Z3).

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Data were analyzed using structural equation modeling statistics. According Wijanto (2007) Structural equation modeling is an integrated approach between factors, structural models and path analysis, but it is an integrated approach to the analysis of the data by construction concept.

III. Results and Discussion

a) Causes of Conflict

Referring to the analysis of structural equation modeling (Figure 1 and Figure 2) showed a significant relationship between the causes of conflict, conflict resolution and outcome. There are indicators that the causes of conflict significantly contributed to the causes of the conflict, namely: competencies in resource use, the presence of the opposite parties, the economic condition, the extent of the parties involved and the cultural background.

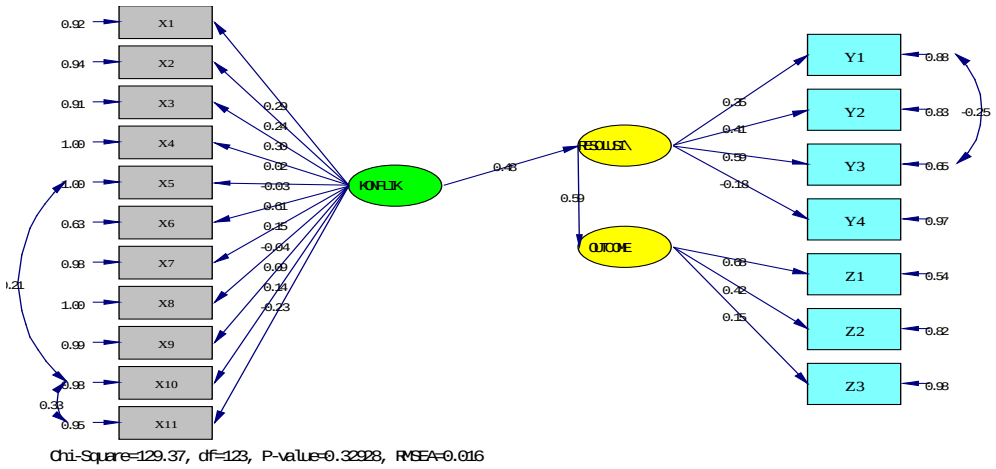


Figure 1 : Structural equation modeling showed that the estimated value

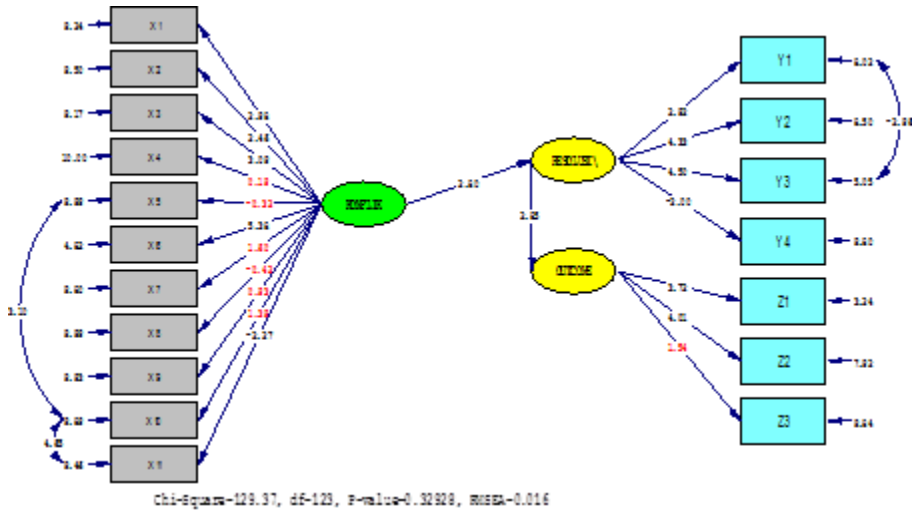


Figure 2 : Structural equation modeling showed-calculated value

Factors causing conflict in South Kalimantan caused by the interaction of several factors. This is consistent with research Walter (2000) who pointed out that the conflict is not only caused by a single factor but a combination or accumulation of various factors that cause conflict. The results Bennett (2004) also stated that the cause of the conflict variables can be derived from three-dimensional variables, namely actors, resource conditions and environmental conditions. Additionally reinforced by research Boediono (2005) which states that the cause of the conflict consists of one or a combination of several variables causes of conflict.

The first factor is influential as a factor of conflict is Competition. Competition is the greatest indicator of the effect as the cause of conflict fishing in the waters of

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South Kalimantan. Competition in this study is a resource dimension. Competition is closely linked to community activities, such as competition in the use of fishing gear and fishing ground scramble.

Competition in the utilization of fishery resources also relates to the behavior of fishers in the operation of fishing gear. The existence of different fishing gear or have a higher technology tends to be considered a contender for the local fishermen. For example, the presence of purse seine fishing using lights, cantrang fishing with high technology and the hunting of sea cucumber fishing using compressor. The presence of such a device believed to be a competitor and a very deplete water resources. This is consistent with Dahuri et al. (1996) which states use conflicts occur due to multiple competing resource users to use the same resource in the same sea space, and implement activities that take advantage of the resources that do not fit with the others.Lasut and Kumurur (2001) also found that competition among users for the same land or facilities may lead to conflict among users. Other researchers also said the same thing, In (Cincin-Sain and Knecht 1998) conflict generally occurs due to several reasons such as the area of competition, resource competition, or competition over resources that are interrelated. Neither the Warner (2000) identified four things that can explain the emergence of conflicts over natural resources, such as natural resource competition (increased dependence on natural resources can increase competition).

The second, factor influencing the conflict factor is is the opposition. The opposition in this study include the actor dimension. In this case opposition occured where many parties who have direct or indirect interests in fisheries resources. The opposition is due to the policies that are inconsistent, as happened in the case of fishing ground. In that case, a group of fishermen who joined INSAN (Saijaan Fishermen Association) does not support the division of fishing areas.

The third, factor influencing the conflict is economic condition. The economic condition of the people in this regard include the environmental dimension. Perceptions of economic conditions of fishing communities is the trigger conflict fishing. Poverty and high dependence on coastal and marine resources often leads to people engage in activities that degrade the quality of resources

Differences in economic conditions of fishermen in South Kalimantan look at the difference fisheries conducted consisting of traditional fishermen, as well as the spring and modern social classes in fishing communities. The differences seen in the fishing equipment (boats, nets, and other equipment), differences in the level of capital investment scale its business, as well as the level of technology used fishing equipment. Fishing gear is used including gillnet, purse seine, charts and so on. This condition has the potential to increase the scale of exploitation of marine resources. As stated Nikijuluw (2002) that the majority of people living in coastal areas are poor, this is caused by the limited ability and knowledge, limited access to capital, technology, information, and market and community involvement in decision-making and resource allocation coastal islands small island. This condition, also has the potential for exploitation by irresponsible fishing.

Further influencing factors as causes of the conflict is an actor. The extent of the parties involved regarding the characteristics of individuals and groups. Increasingly diverse character of the individual in a region increasingly lead to conflict. These differences are d to individual expertise, the agreement to a group, individuals in the group as well as the strength of social relationships.

Finally, the influencing factors as the cause of the conflict is cultural. Culture negative effect as a cause of conflict. Thus the smaller the difference in cultural background of the community, the greater the likelihood of conflict. This is understandable because of cultural differences in coastal communities in South Kalimantan has become part of life of coastal communities. As in Tanah Bumbu regency has several ethnic groups. Based on the history since the 17th century. Bugis tribes borrowed land in the Coastal South Kalimantan, later founded the kingdom Pagatan. Until now many coastal areas of ethnic people from Bugis, Mandar, Bajau, Banjar, Java, Madura and Bali.

b) Effectiveness of Conflict Resolution in Water Resource Management

Conflict resolution techniques performed in South Kalimantan consists of litigation, negotiation, facilitation and avoidance. By passing tenik right and appropriate to the needs of the completion of the case, the results are significantly influenced the development of fisheries. In this case an increase in community participation in fisheries management and resource sustainability.

Referring to tructural equation modeling analysis showed that the greatest indicator of contribution is facilitation, conflict resolution techniques thus best suited to study the causes of conflict in the region is facilitated. This is consistent with Koesno (1979) which says that the characteristics of Indonesian society that prefers harmony and cooperation, an important prerequisite for the successful use of Alternative Dispute Resolution techniques. It is also evident that the use of conflict resolution techniques correlated significantly with outcome variables especially community participation in fisheries management and resource sustainability.

In the case of conflict andon fishermen using purse seine and conflicts taking trepang and pearl oysters. Occurred among fishermen in South Kalimantan with Central Java, including the fishermen

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inter-provincial scale. So done with the involvement of government (Figure 3). Based on Figure 3 shows the relationship between the conflicting parties and involves a lot of facilitators. In this case the facilitator will help create a climate for problem solving and help frame the issue so that it can be solved. Facilitators can also suggest formatting options or procedures to help the group work more effectively.

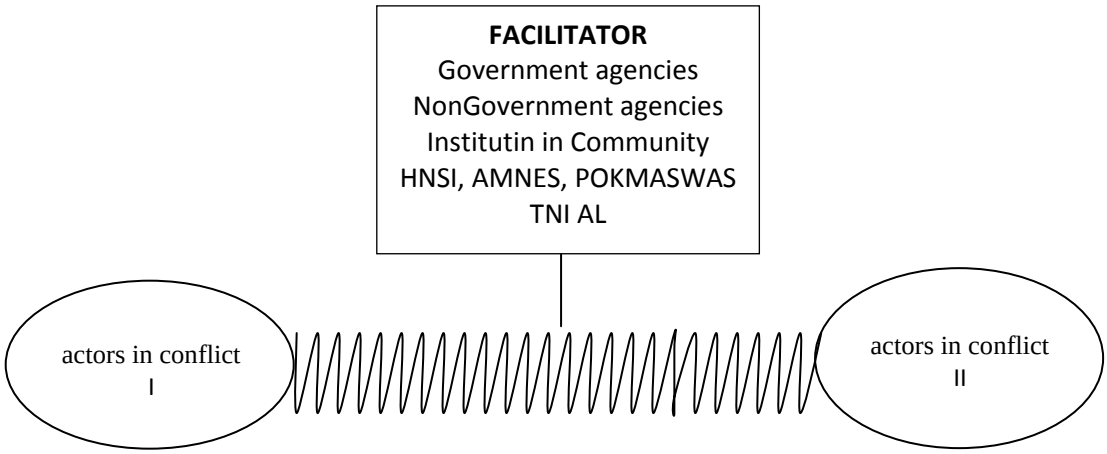


Figure 3 : Relationship between the stakeholders in the process of conflict resolution

Facilitation techniques performed by qualified facilitators just as mediator, should not affect decisions made. The deal is expected to reach a state of "continuous agreement (durable settlement). In order to achieve a durable settlement to the conditions according to Lincoln (1986) there are three (3) things that have to be considered, namely: (1) substantive interest, namely: content need, funds, time, materials and resources (2) procedural interest, namely the need and certain behavior or the way something can be resolved (3) relationship or phsychological interest, namely the requirement refers to one's feelings, how one is treated and preconditions for creating an ongoing relationship.

In the context of water resource management in South Kalimantan, the government can do with policy attention Influential factors as causes of conflict. Then conducting conflict resolution should be prudent and careful in using resolution techniques, because these techniques certainly have their advantages and disadvantages. To respond to this, and before approving a method of conflict resolution, the local communities need to prepare as well as possible. In this case one of the effective ways is organizing.

Malik et al. 2003 states that the organizing, the parties involved can learn from each other. On the one hand, the outsiders can learn from the experiences of local community issues or problems other communities. Organizing goal is to integrate the funds, manpower, knowledge, experience, technique and strategy between the local community with the care oursiders efforts on natural resource conflict resolution.

IV. Conclusion

1. Factors that cause water resource conflicts in South Kalimantan is the competition in the presence of resource use are contradictory, the economic conditions, many at least the parties involved as well as the cultural background.
2. Conflict resolution that has the largest and most significant contribution to public participation in fisheries management and resource sustainability is influential in the use of facilitation techniques.

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Agronomic Characteristics of Dihaploid Lines of Oriental Tobacco Obtained *in Vitro*

By Gordana Miceska
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Summary - One of the most frequently used biotechnical methods today is the method of double haploids. By application of induced androgenesis in the in vitro Laboratory of Tobacco Institute - Prilep 10 dihaploid lines of oriental tobacco were obtained in 2004. For assessment of agronomic characteristics of the dihaploid lines and their analogues (P 146-7/1, Yk 301/23 and Hyb. 301/H), in the course of 2005 and 2006 three haploid lines were set up in field conditions (P 146- 7/1 DH, Yk 301/23 DH and Hyb. 301/H DH) and investigations were made of the number of leaves and plant yield per hectare. With reference to the characteristic number of leaves, dihaploid lines showed a signifi cantly low variational coefficient (CV = 1.75, 2.96: 4.70 %) compared to their analogues, which indicated that they were morphologically stable. According to their agronomic characteristic (g/plant and kg/ha), they were somewhat better or equal to those of their analogues.

Keywords : *oriental, tobacco, dihaploids, in vitro, androgenesis.*

GJSFR-D Classification : *FOR Code: 820305, 079999*



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Agronomic Characteristics of Dihaploid Lines of Oriental Tobacco Obtained *in Vitro*

Gordana Miceska

Summary - One of the most frequently used biotechnical methods today is the method of double haploids. By application of induced androgenesis in the in vitro Laboratory of Tobacco Institute - Prilep 10 dihaploid lines of oriental tobacco were obtained in 2004. For assessment of agronomic characteristics of the dihaploid lines and their analogues (P 146-7/1, Yk 301/23 and Hyb. 301/H), in the course of 2005 and 2006 three haploid lines were set up in field conditions (P 146-7/1 DH, Yk 301/23 DH and Hyb. 301/H DH) and investigations were made of the number of leaves and plant yield per hectare. With reference to the characteristic number of leaves, dihaploid lines showed a signifi cantly low variational coefficient (CV = 1.75, 2.96: 4.70 %) compared to their analogues, which indicated that they were morphologically stable. According to their agronomic characteristic (g/plant and kg/ha), they were somewhat better or equal to those of their analogues.

Keywords : oriental, tobacco, dihaploids, in vitro, androgenesis.

I. Introduction

The method of double haploids is one of the most frequently implemented biotechnical methods today. Guenter Setz (Burchet, 2004) said: "If induction of hybrids was the biggest event in selection and the use of glass houses the second biggest, technology of double haploids will be the third one".

The basic aim of this method is to reduce the breeding process in field conditions, where the process of self pollination and selection continues as long as uniformity of the varieties is achieved and until 100 % of them become homozygous. These varieties are comparable with standard varieties. It takes nine to 11 years to standardize some variety or to release a new one (Patrascu and Ioan, 1984). Namely, in reductional division of sex cells, cells with unique inherited information are developed, i.e. even in the first generations decomposition of hybrid in dihaploid lines occurs, but by doubling the genome of each haploid, the dihaploids obtained differ from their parental forms in some morphological and agronomic characteristics (Dimitrova, 1991). Yet, each dihaploid progeny is homozigous. Some authors reported that dihaploid lines achieved higher yields compared to their analogues (Zagorska et al, 1978) and the others (Arcia et al., 1978; Deaton et al., 1986) consider that dihapoid lines are less productive. Variation in yield and quality of dihaploid lines can depend greatly on the initial genotype (Deaton et al., 1982).

The aim of this paper was to study the yield characteristics of dihaploid lines of oriental tobacco, in direct creation of new tobacco varieties, and also to confirm the application of induced androgenesis depending on the aims of selection in obtaining the homozigous dihaploid lines.

II. Materials and Methods

Estimation of dihaploid progenies in the period 2005 - 2006 in field conditions was made in Tobacco Institute - Prilep. The trial was designed as randomized block with four replications and it included three dihaploid oriental tobacco lines (P 146-7/1 DH, Yk 301/23 DH and Hyb.301/N DH) and their analogues. Results on agronomic characteristics of the investigated dihaploid lines and their analogues were statistically processed using LSD test analysis of variance (Najčeska, 2002) The main plot size was 1.87 m^2.

Dihaploidization was made by direct organogenesis of haploid plants, using the method of tissue culture (meristems, leaf segments 0.5 cm in size), on Murashige and Scoog (1962) nutrient medium, modified for direct organogenesis and optimized with various chemical substances: casein hydrolyzate - 1 mg/l; L-glutamine – 250 mg/l; glicine 200 mg/l; IAA-0.2 mg/l; BAP - 0.5 mg/l; adenine-20 mg/l; kinetine-3 mg/l and myoinosite-100 mg/l. The first progenies were grown in Biological laboratory in vegetative broth 3:1 (perlite:soil) up to obtaining seed material.

III. Results and Discussion

a) Morphological Properties

One of the most important tasks of selection is to increase the varieties yield. Knowledge of the genetic control of yield and of the factors that influence its variability in tobacco plant is essential for creation of new varieties with optimum yield (Dimitrova, 1991). By

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the methods of androgenesis and meristems culture (organogenesis and rhizogenesis) applied in *in vitro* laboratory of Tobacco Institute-Prilep, we obtained several dihaploid lines of oriental tobaccos 'Prilep' and 'Yaka', investigated in field conditions during 2005-2006.

Phenological investigations showed uniformity of dihaploid lines for the characteristic height of the plant with inflorescence and number of leaves per plant (Table 1).

Table 1 : Morphological properties

Varieties Lines	Height of the plant with inflorescence, cm			Leaf number per plant, cm		
	0	δ±Sδ	CV %	0	δ±Sδ	CV %
P 146–7/1Ø	71.4	2.21±0.60	3.81	46.35	1.10±0.22	2.38
P146–7/1DH	67.05	1.33±0.30	2.14	46.65	1.21±0.27	2.57
Yk.l.301/23 Ø	122.50	5.91±1.32	5.09	50.40	3.02±0.72	5.93
Yk.l.301/23DH	126.60	5.96±1.33	4.91	47.30	1.88±0.42	3.94
Hyb.301/N Ø	74.10	1.68±0.37	2.22	35.3	0.98±0.22	2.79
Hyb.301/N DH	71.35	1.24±0.36	2.64	48.9	0.58±0.12	1.53

0 – aritmetical means (cm); δ – standard deviation; Sδ – standard deviation error; CV – variational coefficient %

Investigations in 2005-2006 showed that variation of plant height was lower in dihaploid lines, compared to their analogues, and the coeffi cient of variation averaged from 2.14 % (P146- 7/1 DH) to 5.09 % (Yk.l 301/23 Ø). For the character leaf number per plant, all dihaploid lines also showed lower coefficient of variation compared to their analogues.

Our investigation is in agreement with those of Dimitrova (1991) and Enčeva et al. (2000) who reported lower coefficient of variation in dihaploid lines compared to their analogues, showing signifi cant uniformity in relation to these characters.

Dry tobacco yield in dihaploid lines ranged 18.26 g/plant and 3010 kg/ha (P 146-7/1 DH and Hyb. 301/H Ø) to 21.90 g/plant and 3610 kg/ha (Yk.l. 301/23 Ø). According to this, the dihaploid line Hyb. 301/N DH achieved 14.62 % higher yield per plant and hectare compared to its analogue Hyb. 301/H Ø (18.26 g/plant; 3010 kg/ha), i.e. statistically signifi - cant diff erence of 1 % (Tables 2 and 3). Both dihaploid lines P 146-7/1 and Yk. l. 301/23 gave lower yields compared to their analogues.

Many authors reported that yields of dihaploid lines vary depending on whether they originate from the same haploid or from diff erent ones (Arcia et al., 1978; Deaton et al., 1986; Šmalcelj and Ćurković Perica, 2000).

Berbeć and Laskowska (2003) reported that some dihaploid lines of the variety Wiślica have higher yields and some of them lower yields, compared to their analogues.

Table 2 : Dry tobacco yield, g/plant

Varieties Lines	Years		Average	Difference from the control	
	2005	2006		Absolute	Relative
P 146–7/1Ø	17.12	25.05	21.08	–	100.00
P146–7/1DH	15.29	21.23	18.26	–2.82	86.62
Yk.l.301/23 Ø	19.67	24.13	21.90	–	100.00
Yk.l.301/23DH	19.32	22.54	20.93	–0.97	95.57
Hyb.301/N Ø	18.64	17.89	18.26	–	100.00
Hyb.301/N DH	21.01^{++}	20.85^{++}	20.93	+2.67	114.62
LSD 5%	1.42^{++}	2.13^{+}			
LSD 1%	1.97^{++}	2.95^{++}			

Table 3 : Dry tobacco yield, kg/ha

Varieties Lines	Years		Average	Difference from the control	
	2005	2006		Absolute	Relative
P 146–7/1Ø	2822	4129	3475	–	100.00
P146–7/1DH	2521	3499	3010	–465	86.62
Yk.l.301/23 Ø	3243	3978	3610	–	100.00
Yk.l.301/23DH	3185	3716	3450	–160	95.57
Hyb.301/N Ø	3072	2949	3010	–	100.00
Hyb.301/N DH	3464^{++}	3437^{++}	3450	+440	114.62
LSD 5%	86.11^{+}	351.98^{+}			
LSD 1%	119.30^{++}	487.65^{++}			

Table 4 : Percentage of high grades (I and II), %

Varieties Lines	Years		Average	Difference from the control	
	2005	2006		Absolute	Relative
P 146–7/1Ø	43.48	16.60	30.04	–	100.00
P146–7/1DH	47.66	17.65	32.65	+2.61	108.69
Yk.l.301/23 Ø	0.00	2.16	1.08	–	100.00
Yk.l.301/23DH	5.36	5.08	5.22	+4.14	483.33
Hyb.301/N Ø	4.59	14.81	9.70	–	100.00
Hyb.301/N DH	0.00	21.54	10.77	1.07	111.03

Table 5 : Average purchase price, € /kg

Varieties Lines	Years		Average	Difference from the control	
	2005	2006		Absolute	Relative
P 146–7/1Ø	1.95	1.71	1.83	–	100.00
P146–7/1DH	2.04	1.61	1.82	–0.01	99.71
Yk.l.301/23 Ø	1.69	1.48	1.58	–	100.00
Yk.l.301/23DH	1.70	1.52	1.61	+0.43	101.32
Hyb.301/N Ø	1.67	1.63	1.65	–	100.00
Hyb.301/N DH	1.63	1.67	1.65	0.00	100.00

In relation to quality, it can be stated that the investigated dihaploid lines of oriental tobacco had higher quality compared to their analogues. The higher grades percentage ranged from 1.08 % (Yk.l.301/23 Ø) to 32.65 % (P 146-7/1 DH) (Table 4). Accordingly, dihaploid lines quality was better for 8.69 % (P 146-7/1 DH), 383.33 % (Yk.l. 301/23 DH) and 11.03 % (Hyb.301/N DH), compared to their analogues.

Average purchase price varies from 1.58 €/kg for Yk l. 301/23 Ø to 1.83 €/kg for P 146-7/1 Ø. All investigated lines have lower values for this parameter

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compared to their analogues, except for the variety Yk.l. 301/23 DH with 1.61 €/ kg, which is 1.32 % higher than its analogue Yk.l. 301/23 Ø.

Table 6 : Economic eff ect, € /ha

Varieties Lines	Years		Average	Difference from the control	
	2005	2006		Absolute	Relative
P 146–7/1Ø	5494.30	7068.30	6278.70	–	100.00
P146–7/1DH	5073.20	5646.30	5359.70	–919.00	85.36
Yk.l.301/23 Ø	5496.10	5900.10	5700.80	–	100.00
Yk.l.301/23DH	5388.80	5623.50	5506.10	–194.70	96.58
Hyb.301/N Ø	5011.20	4808.50	4909.80	–	100.00
Hyb.301/N DH	5800.10^{++}	5754.00^{++}	5777.00	+867.20	117.66
LSD 5%	140.02^{+}	577.19^{+}			
LSD 1%	193.89^{++}	799.66^{++}			

A part from the line Hyb.301/N DH, all dihaploid lines of investigated tobacco varieties, showed lower economic effect compared to their analogues. Economic effect of Hyb.301/N DH was 17.66 % higher compared to its analogue Hyb.301/H Ø, which is statistical difference of 1 %. This data was confirmed with the investigations of Deaton (1982), who reported that genotype from which dihaploid lines came signify-cantly affected their yield variability and their quality level.

III. Conclusions

Based on the data obtained during our investigations, compared to those from the literature, the following conclusions can be drawn:

- The obtained dihaploid progenies with uniform morphological characteristics present an initial material for further investigations in breeding.
- Some of the investigated dihaploid lines (Hyb. 301/N DH) gave higher yields per stalk and per hectare for even 14.2 % compared to their analogues and they also achieved better quality.
- Biochemical methods (plant tissue culture and androgenesis) can be successfully applied in breeding programs for oriental tobaccos, in creation of new, superior homozygous lines.

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Application of Game Theory to Cocoa Production Management Systems in Ondo State, Nigeria

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Abstract - Cocoa production is susceptible to a number of risks such as unavailability of enough land, unavailability of agro-chemicals, variation in product prices and a host of others. This study utilized game theory to determine the cocoa production management system which maximizes the income of farmers under risks. Data on cocoa production were collected from a random sample of 200 farmers practicing the three cocoa production management systems viz: Owner management system, Lease management system as well as Sharecropped management system. The games were constructed based on the income per hectare obtained from each of the three management systems. Maximax and Maximin criteria of game theory were used in the analysis. The Maximax criterion showed that the best management system to practice by cocoa farmers was Sharecropped management system (Income per hectare of ₦214,847) while the result of the Maximin showed that the best management system was Owner management system (Income per hectare of ₦92,463). The study therefore recommended for optimistic farmers to practice Sharecropped management system while Owner management system is recommended for pessimistic farmers.

Keywords : *cocoa production, game theory, agro-chemicals, management systems, decision criteria.*

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Application of Game Theory to Cocoa Production Management Systems in Ondo State, Nigeria

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Abstract - Cocoa production is susceptible to a number of risks such as unavailability of enough land, unavailability of agro-chemicals, variation in product prices and a host of others. This study utilized game theory to determine the cocoa production management system which maximizes the income of farmers under risks. Data on cocoa production were collected from a random sample of 200 farmers practicing the three cocoa production management systems viz: Owner management system, Lease management system as well as Sharecropped management system. The games were constructed based on the income per hectare obtained from each of the three management systems. Maximax and Maximin criteria of game theory were used in the analysis. The Maximax criterion showed that the best management system to practice by cocoa farmers was Sharecropped management system (Income per hectare of ₦214,847) while the result of the Maximin showed that the best management system was Owner management system (Income per hectare of ₦92,463). The study therefore recommended for optimistic farmers to practice Sharecropped management system while Owner management system is recommended for pessimistic farmers.

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I. Introduction

Agricultural production is the mainstay of the Nigerian economy; considering the fact that over 80 percent of the economically active populations are involved in agricultural production and that over 90 percent of the food consumed in the country is from the local agricultural production. It is the second largest earner of foreign exchange; next to the petroleum sector, and also it provides a ready market for industrial products (Ayanwale, 2002). The main agricultural sub-sector which contributes immensely to Nigeria's GDP is cocoa. Cocoa contributes about 15% to the total Nigerian export in 1970 (Adebile and Amusan, 2011). Cocoa which belongs to the family *Steruliacaea* and genus *Theobroma* was discovered in 18th century at the Amazon basin and later spread to other tropical areas of South and Central America, and West Africa (Opeke 1987). Since the end of the first world war, West Africa has been the highest producer of cocoa. The crop was eventually introduced into Nigeria in 1887 (Ayorinde 1966). Nigeria as a developing country was rated the second largest world producer of cocoa in the 1960s (Adegbola and Abe, 1983), and, for a long time, the crop has been generating substantial foreign exchange earnings for the country. However, the production of this important cash crop for export has suffered a reduction in the recent years in the country owing to a number of factors. Villalobos (1989) identified some of these factors as: low yield, inconsistent production patterns, disease incidence, pest attack and use of simple farm tools. In addition, Oduwole (2004) identified ageing cocoa farms as one of the factors responsible for the decline in cocoa production in south western Nigeria. He observed that many farms were over 40 years old and such farms constitute as much as 60% of the cocoa farms in Nigeria. However, in a study conducted by Daramola *et al*. (2003), it was found that most cocoa farms in Ondo and Osun states are very old with low productivity. Government in her effort to curb these problems has introduced some policies aiming at resuscitating cocoa production in Nigeria. One and perhaps the most recent policy is the establishment of National Cocoa Development Committee (NCDC). The committee is saddled with the responsibility of increasing cocoa output in Nigeria.

According to Nkang *et al*, (2009), there are three cocoa production management systems. These are Owner-managed farms, Lease-managed farms and Sharecropped farms. These management systems are practiced across all cocoa producing regions in Nigeria. One fundamental issue is the approach to the understanding of how different farm management systems have implications on cocoa production. For this reason and other reasons, the theory of games has been utilised to analyse cocoa production management systems especially in this study. Game theory is a situation where outcomes depend on the behaviour of all competitors (Gough and Hill 1979). Game theory is a probabilistic model which as already mentioned is used in analyzing, and driving rules for making decisions when two or more people are competing for some objectives. Game theory attempts to look at the relationships between participants in a particular model

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and predict their optimal decisions (Investopedia, 2010). According to Wikipedia (2010), economists and business professors suggest two primary use of game theory: *descriptive* and *prescriptive*. In the descriptive use, game theory has been used to study a wide variety of human and animal behaviors; thus when finding the equilibrium of games we can predict how actual human prediction can be understood. One frequently cited example of descriptive use of game theory is the Nash equilibrium (Investopedia, 2010). In the prescriptive (normative) use, game theory has also been used to attempt to develop theories of ethical or normative behavior. That is, an attempt to look at economic and human practices as they ought to be, talking about judgment and looking at what is right and what is wrong. One frequently cited example of descriptive use of game theory is the prisoner's dilemma (Investopedia, 2010). Game theory bridges mathematics, statistics, economics, and psychology to model conflict between two or more rational decision-makers.

Game theory was developed in 1953 by John Von Newmann (Mathematician) and Oskar Morgenstem (Mathematical Economist), and was greatly in use then in the field of Economics (Oziegbe, 2011). According to the empirical studies by Gough *et al*. 1991, game theory is being used with low frequency by corporate managers in the developed countries. On the other hand, from the surveys in underdeveloped country like Nigeria, corporate managers do not use the theory at all; moreover, most of the managers have little or no idea about the technique (Oziegbe, 2011).

Game theory is a theory of rational behavior for interactive decision problems. In a game, several agents strive to maximize their expected utility index by chosen particular courses of action and each agent final utility payoffs depend on the profile of courses of action chosen by all agents. The interactive situation, specified by the set of participants, the possible courses of actions of each agent and the set of all possible utility payoffs, is called a game; the agents playing a game are called the players (Fudenberg and Tirole, 1991.)

Agricultural productions are risky activities. These risks can be caused by production, market, credit etc. (Ferdosi, 1995). Some policies have been made to reduce the risk in traditional practices and support programmes by farmers and government such as diversification, rotation, price stabilization, crop insurance as well as delivery contracts (Ferdosi, 1995; Martin, 1997; Mishra and Perry, 1999; Olesen, 2003). If producers wants to maximize their profits, they have to accept the risk of production and marketing process. Growers must take risks if they are to have any chance of obtaining profit. It is not possible for a management strategy to be potentially profitable and free from risk. Growers must balance the risks of loss against the potential for profit among alternative management strategies. Farmers have to manage risk and uncertainty. In these structures, management of farms has become more important than in previous years. The main objective of this paper, therefore, is to discuss some of the various ways in which the choice of farm management systems can influence the effective and efficient cocoa production through the use of the game theory.

II. Methodology

a) Study Area

The study was conducted in Ondo State. The state is one of the thirty-six states in Nigeria and was carved out of the old Western State in 1976. Ekiti state was carved out of the state in 1996. Ondo State has a land area of 14,769Km$^{2.}$ Going by 2006 census, the state has a population of 3,441,024million. There are eighteen Local Government Areas (LGAs) in Ondo state. Out of these, fifteen Local Government Areas produce cocoa. The occupation of the inhabitants of the State is predominantly farming. Ondo State is the highest cocoa producing State in Nigeria (Ojo, 2003). Geographically, Ondo state is located in south west of Nigeria between Longitude 4.30^{o}E and 6.00^{o}E of the Greenwich and Latitude 5^{o}45^{1} and 8^{0}15^{1} of the equator. Kogi and Ekiti states bounded the State to the North; Edo and Delta States in the East; Ogun and Osun States in the west and Atlantic Ocean in the south. With respect to the climate, it is tropical with two distinct seasons of rainy and dry season in the state. The rainy season occurs between April and October, while the dry season begins in November and last till April. Although in recent times, minor alterations are noticeable in rainfall regimes due to global climatic change. The state is blessed with a moderate year temperature of around 25^{o}C. Annual rainfall varies from 2000mm in the southern part to 1,150mm in the Northern extremes (Ondo state, 2003).

b) Data Collection

The study employed stratified random sampling technique for the selection of its respondents. There was random selection of four notable cocoa producing Local Government Areas (LGAs) out of a total of fifteen cocoa producing LGAs in the state. The selected LGAs included two high cocoa producing LGAs (Idanre and Ondo East) and two low cocoa producing LGAs (Akoko South East and Akoko North West). The classification is in accordance with Cocoa Research Institute of Nigeria classification of the cocoa producing LGAs in the state and is based on the quantity of cocoa beans being produced by each LGA. From each of the four selected LGAs, there was random selection of two communities while the respondent households were randomly selected from the selected communities. However, from the eight communities, a total of two hundred respondent households were randomly selected. Meanwhile, the two hundred respondents cut across the three cocoa production management systems in the

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study area viz: Owner management system, Lease management system and Sharecropped management system. The number of samples taken from each community depended on the entire population of cocoa farming households in the communities. Hence, the sampling was carried out proportionate to size.

High cocoa producing LGAs are the LGAs where the substantial proportion of cocoa produce in the State comes from and as such there are some good conditions favouring the production of cocoa in the area. These conditions include more available land for cocoa production, availability of agro-chemicals and increase in product price. However, low cocoa producing LGAs are the LGAs where a little proportion of cocoa produced in the State comes from. This is due to the fact that the conditions of cocoa production in the area are not favourable. These conditions include less available land for cocoa production (because the cocoa farmers in the LGAs devotes the substantial proportion of their land for food crop production), unavailability of agro-chemicals and decrease in product price.

For each of cocoa production management systems, the highest and lowest income per hectare was calculated under good and bad conditions. Following Sahin *et al,* (2009), successful production situation represented a good condition where there is more available land for cocoa production, availability of agro-chemicals and increase in product price. On the other hand, unsuccessful production situation represented a bad condition where there is less available land for cocoa production, unavailability of agro-chemicals and decrease in product price.

c) Decision Criteria

In game theory, there are different criteria for which decision can be taken. Some of these include maximax criterion, maximin (Wald's) criterion, Laplace criterion, Hurwicz's criterion and Salvage regret criterion (Burhan and Handan, 2001). Each criterion requires different strategies. However, in this study, two criteria will be considered, these are maximax criterion and maximin (Wald's) criterion.

d) Maximax Criterion

The maximax criterion indicates that the decision-maker should choose the alternative which maximizes the maximum value of the outcome. This optimistic approach implies that the decision-maker should assume the best of all possible worlds (Business Dictionary, 2011).

e) Wald's (maximin) Criterion

According to the maximin criterion, the players tries to choose "the best of the worst". The player in this study is farmer. This means that the farmer selects the management system which will maximise his minimum income. This strategy gives the farmer maximum security. The reasons behind this strategy for the farmer can be several. The farmer has only small equity in his farm; he has large and different family responsibilities and so on. If the farmer pursues the maximin strategy he can be regarded as a pessimist or an ultra careful (Barnard and Nix, 1979).

Table 1 : Strategies of players which represent production conditions

Strategies	Characteristics of production conditions
Good conditions	-More available land for cocoa production -Availability of agro-chemicals -Increase in product price
Bad conditions	-Less available land for cocoa production -Unavailability of agro-chemicals -Decrease in product price

III. Results and Discussion

a) Maximax Criterion

Considering the Maximax criterion, the farmer is optimistic about production, availability of land and pricing conditions. An optimistic farmer will therefore adopt Sharecropped management system. Share-cropped management system had the highest average income per hectare of N214,847 in good conditions. This is followed by Owner management system with N168,000 (Table 2).

Optimists prefer the adoption of Sharecropped management system might be due to the fact that the management system is a joint management system. Under the Sharecropped management system, a farm is jointly managed by the original owner of the farm and the sharecropper. The owner of the farm provides the agro-chemical input needed for the farm while the sharecropper provides the labour input. The proceeds from the farm is shared between the owner of the farm and the sharecropper in certain proportion. Hence, the fact that the resources to maintain the farm managed by sharecropped management system come from different sources enables the farm to be properly managed and hence enabling the system to have more income per hectare than the other management systems thus

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making the optimists to prefer the management system. Another advantage of sharecropped management system is that in case of crop failure, the loss is shared by the two parties instead of it being borne by an individual. Sharecropped system of farm management is a means by which the State (Ondo) can provide job for the people from other parts of the country since sharecroppers are mostly from the Southern or Southeastern part of the country. However, the greatest disadvantage of Sharecropped management system is that sole decision on the farm can not be taken. Any major decision on the farm has to be jointly agreed upon by the two parties.

b) Maximin (Wald's) Criterion

According to the Wald's criterion, the player (which is farmer in this case) tries to choose the best of the worst. Table 2 shows that the highest income per hectare under bad condition is obtained from owner management system with N92,463 per hectare. The farmer is regarded as a pessimist based on this criterion. This means that the farmer selects the management system that will maximize his minimum income. The strategy gives the farmer maximum security. Owner management system of cocoa production might however be preferred by the pessimists due to the fact that under the system, the farmer gets a full control of the farm. There is no need to consult anybody before a decision on the farm is taken. Also, under owner management system, the proceeds from the farm does not need to be shared with anybody. The whole proceeds belongs to the owner of the farm. However, one of the disadvantages of the system is that the whole cost of maintaining the farm is borne by the owner of the farm. Hence the owner provides the cost of agro-chemicals as well as the cost of labour. Also, the owner of the farm solely bears the risk of the farm. The risks may include crop failure as a result of bad weather or the incidence of fire outbreak on the farm.

Table 2 : Game theory results for cocoa farmers

Criteria	Income per hectare (N)	Preferred management system
Maximax	214,847	Sharecropped management system
Minimax	92,463	Owner management system

Source: Field survey, 2011.

The decision criteria used in the study are maximax and minimax. These were used to take decision on the best cocoa production management systems to be chosen by the optimistic and pessimistic farmers. Based on the result of the findings, the optimistic farmer will choose sharecropped management system while pessimistic farmer will choose owner management system. This is due to the fact that optimistic farmers are not risk averse while pessimistic farmers are risk averse in nature.

IV. Conclusion

Decision criteria used in the study are maximax and maximin criteria. Optimistic farmer will adopt sharecropped management system while pessimistic farmers will adopt owner management system on the farm. This is due to the fact that optimistic farmers are not risk averse while pessimistic farmers are risk averse in nature.

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Leaching of Nutrients in *Luvisol* as Affected by Catch Crops and Straw

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Abstract - The aim of this work was to determine the impact of green manure (Trifolium pratense L, Raphanus sativus var. oleiformis L.) and barley (Hordeum vulgare L.) straw on filtration of precipitation and leaching of chemical elements (N, K, Ca, C_{org}) in Haplic Luvisol. The lysimetric data during 1987– 2008 was used in the study. Lysimetric equipment surface area was 1.75 m^2; the test soil layer is 0.60 m.Catch crops reduce precipitation filtration by 7.0-8.3 % on average. Insertion in autumn of straw and catch crops increases the concentration of N, Ca and K and C_{org} in lysimeter waters. Substantial increase in concentration takes place mostly during the first months after insertion and in warm and rainy autumn period. Due to lower precipitation of catch crops the loss of Ca and K, as compared with unfertilized soil, did not substantially increase, and the C_{org} decreased from 10.6 to 8.3-8.5 kg ha^{-1} TOC.

Keywords : *lysimeter; leaching; catch crops; straw; leaching; nitrogen; potassium; calcium, c_{org}.*

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Leaching of Nutrients in *Luvisol* as Affected by Catch Crops and Straw

Liudmila Tripolskaja [α], Colin A. Booth [σ] & Michael A. Fullen [ρ]

Abstract - The aim of this work was to determine the impact of green manure (Trifolium pratense L, Raphanus sativus var. oleiformis L.) and barley (Hordeum vulgare L.) straw on filtration of precipitation and leaching of chemical elements (N, K, Ca, C_{org}) in Haplic Luvisol. The lysimetric data during 1987–2008 was used in the study. Lysimetric equipment surface area was 1.75 m^2; the test soil layer is 0.60 m.Catch crops reduce precipitation filtration by 7.0-8.3 % on average. Insertion in autumn of straw and catch crops increases the concentration of N, Ca and K and C_{org} in lysimeter waters. Substantial increase in concentration takes place mostly during the first months after insertion and in warm and rainy autumn period. Due to lower precipitation of catch crops the loss of Ca and K, as compared with unfertilized soil, did not substantially increase, and the C_{org} decreased from 10.6 to 8.3-8.5 kg ha^{-1} TOC.

Keywords : lysimeter; leaching; catch crops; straw; leaching; nitrogen; potassium; calcium, c_{org}.

I. Introduction

About 40 % of the farmland in Lithuania are light textured soils, and fertilization with a variety of organic fertilizers is necessary to maintain their productivity. Currently green manure crops are being extensively used as the source of organic matter. However, due to favourable conditions for decomposition of organic matter and surplus moisture content, resulting in the percolative soil moisture regime, part of the mineral elements released from the green manure may be leached into groundwater and adversely affect its chemical composition (Kutra et. al., 2006; Strusevičius et. al., 2009; Adomaitis et. al., 2010; Baigys, 2010). In order to reduce the nutrient leaching after autumn crop harvest, in Lithuania various catch crops are cultivated for green manure. According to the soil characteristics and hydrothermal conditions of autumn, the following plants are considered most suitable for cultivation: fodder radish, spring rape, red clover, orchard grass (Nedzinskas, Nedzinskienė, 1999; Arlauskienė, Maikštienienė, 2008).

Nutrient leaching losses are associated not only with the agrarian use of soils, but also with climatic factors – amount of precipitation and air temperature. The mean annual amount of precipitation on the territory of Lithuanian is 681 mm, the mean annual air temperature is 6.2 °C; that creates the conditions for filtration of atmospheric precipitation and consequent leaching of chemical components from the arable soil layer (Galvonaitė et. al., 2007). Meteorological data of the past decades (1993–2003) indicate the tendencies of climate warming: average annual air temperature increased by 0.1–0.9 °C. The most evident increase is observed in late autumn and spring temperatures; the number of days with below zero temperatures decreased (Galvonaitė, Valiukas, 2005). Longer autumn and spring periods have a positive impact as well because it allows growing more catch crops for green manure and using them to improve soil fertility. However, plant selection and cultivation technologies must be based not only on their impact on soil in supplementing it with organic matter and nutrients but also on the impact produced on the leaching of chemical elements.

The aim of this work was to determine the impact of green manure (clover, fodder radish) and barley straw on filtration of precipitation, plant nutrition and leaching of chemical elements (N, K, Ca, C_{org}), which influence the soil agrochemical properties.

II. Materials and Methods

Experiments were performed at the Vokė Branch of the Lithuanian Research Centre for Agriculture and Forestry (54°37´ N, 25°08´ E) in 2002–2008. Lysimetric equipment consists of a cylindrical concrete structure with a surface area of 1.75 m^2, the test soil layer is 0.60 m (corresponding to the drainage depth). Lysimeters are filled with typical soil of Southeastern Lithuania – sandy loam *Haplic Luvisol (LVh)*. Agrochemical characteristics of the arable layer (0–20 cm) were the following: pH_{KCl} 5.4–5.6, available phosphorus (A-L) – 208–225 mg kg^{-1}, potassium (A-L) – 101–112 mg kg^{-1}, organic carbon (C_{org}) – 0.77–0.80 %. Changes in the leaching of nutrients due to application of green manure and straw were investigated in the segment barley (*Hordeum vulgare* L.) → potato (*Solanum tuberosum* L.). The test was performed in three replications (2002–2003, 2004–2005 and 2006–2007). Testing scheme (variants of organic matter): 1) control variant (without organic matter), 2) barley straw + N_{30}, 3) aftercrop fodder radish for green manure + N_{30} + barley straw, 4) red clover catch crop for green manure + barley straw.

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Barley of the cultivar 'Aura' were sown during the third decade of April, seed rate – 180 kg ha^{-1}. Before sowing the barley, $N_{60}P_{60}K_{60}$ fertilizers were used. Catch crop clover (*Trifolium pratense* L.) sown in spring into the barley crop (variant 4) and aftercrop fodder radish (*Raphanus sativus* var. *oleiformis* L.) sown after barley harvest (variant 3) were used for green manure. Barley straw was chipped to 4–6 cm in length and left on the soil surface, while in lysimeters of the control variant (variant 1) it was removed. In order to obtain larger amount of fodder radish biomass (variant 3), they had been fertilized with N_{30} before sowing. The same nitrogen amount (N_{30}) was used to optimize the processes of straw mineralization in variant 2. In the years following the addition of green manure potato cultivar 'Goda' was cultivated. The potatoes were fertilized with $N_{90}P_{60}K_{90}$.

a) Estimation of the filtration of precipitation and calculation of chemical elements leaching losses

The amounts of filtrate were calculated for separate months, periods of a year (seasons) and years. Season length of spring (March–May), summer (June–August) and autumn (September–November) matched the calendar periods of a year. Estimation of atmospheric precipitation in winter corresponded with the accounts of filtration during this period, i.e. the precipitation amount in December of the current year (n) was summed up with precipitation amount of January and February of the following year (n + 1). Such calculation is based on the temperature regime of winter period, because at temperatures below 0 °C solid precipitation occurs, which takes a liquid form only at positive air temperatures, and the infiltration can start much later than the precipitation occurrence. Thus, the amount of atmospheric precipitation filtrate per year was calculated from 1 March of the current year till 28 February of the following year (12 months); the studies lasted from 1 March, 2002 to 28 February, 2008. Nitrate concentration (NO_3^- mg L^{-1}) in lysimetric water was determined monthly, concentrations of potassium, calcium and organic carbon – once per season. The weighted concentrations of the elements were calculated for separate months, seasons and years. The average concentration was calculated by the formula:

$$K_{average} = (K_1*V_1 + K_2*V_2 + K_3*V_3) / (V_1 + V_2 + V_3),$$

where $K_{1,2,3}$ – concentration of a chemical element in mg L^{-1} in lysimetric water of one lysimeter of a particular variant (1, 2, 3 – replications) over a given period (month, season),

$V_{1,2,3}$ – amount of atmospheric precipitation filtrate in L m^{-2} from one lysimeter of a particular variant over a given period (month, season, year).

The standard deviation (S) of the concentration and coefficient of variation (V %) were calculated.

Elements leaching losses (kg ha^{-1}) were calculated by multiplying the average concentration and the amount of filtrate of a particular period:

$$FN = K_{average} \times F \times 1000000/10000$$

when $K_{average}$ – the average element concentration over a season (year) mg L^{-1}, F – amount of the filtrate L m^{-2}, 1000000 – transfer coefficient from mg to kg; 10000 – transfer coefficient from m^{-2} to ha.

b) Methods of chemical analyses

The amount of total nitrogen was determined employing the Kjeldahl (ISO 11261) method, of nitrates – by colorimetry, of Ca – ISO 7890-86 (atomic absorption), K – LST ISO 9964-3; 1998 (flame emission), C organic – ISO-8245:1999 method.

All experimental data were analysed using Analysis of Variance (ANOVA).

III. Results

a) Biomass yield of catch crop plants and straw

Meteorological conditions during the vegetation season had a significant impact on the yield of barley and other plants grown for green manure. Depending on the applied agro-technical measures and the hydrothermal conditions of a year, the dry matter (DM) yield of barley straw ranged from 0.358 to 0.992 kg m^{-2}, and during the study period (2002–2008) approximately 585 g m^{-2} of DM were added into the soil with the straw (Table 1). Green mass yield of fodder radish very much depended on soil moisture conditions at sowing time and ranged from 102 to 337 kg m^{-2} of DM. Together with barley straw and green mass of fodder radish the soil was supplemented with 766 g m^{-2} of DM. The biomass yield of red clover catch crop was by 22 % on average higher than of fodder radish, but the yield variation was larger – from 0.169 to 0.640 kg m^{-2} of DM. Throughout the study period, higher amount of organic matter (1024 kg m^{-2} DM) was added with green mass of clover catch crop, while the amount added with fodder radish was by 34 % lower (766 kg m^{-2}).

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Table 1 : The total amount of green manure and straw biomass as well as biogenic elements added into soil during the study period

Organic matter	Dry matter yield g m^{-2}	*S.D.*	Added with straw and green manure biomass g m^{-2}		
			N	K	C_{org}
Barley straw	585	327	6,2	19,4	234
Fodder radish and straw	766	156	17,4	37,2	306
Undersown red clover and straw	1024	393	26,0	39,0	410

Considerably higher (26.0 g m^{-2}) nitrogen content was added into soil with clover and straw than in case of other fertilization variants. Depending on the hydrothermal conditions during plant vegetation, variation in the content of nitrogen added with green manure was quite high – 52.4 and 85.1 %. Less nitrogen were added into soil with straw than with the green manure crops – an average of 6.2 g m^{-2} over the study period. Potassium accumulation in the biomass of fodder radish and red clover did not differ significantly and was 37.2 and 39.0 g m^{-2} respectively, while in barley straw it was almost twice lower.

Filtration of atmospheric precipitation

During the study period, annual precipitation amount ranged from 607 mm (in 2006) to 785 mm (in 2005). Deviation from the climate normal (681 mm) made 11–15 % respectively (Table 2). Filtration of precipitation depended not only on the precipitation amount, but also on the intensity and plant cover. According to the average survey data, in sandy loam Luvisol 46.4 % of the annual precipitation infiltrated to a depth of 0.60.

Table 2 : The amount of atmospheric precipitation and its infiltration into sandy loam Luvisol

Indicator	*Year*						*Mean*
	2002	2003	2004	2005	2006	2007	
Annual amount of precipitation mm	615	647	724	785	607	722	683
Treatments	*Infiltration of atmospheric precipitation L m^{-2}*						
Without organic fertilisers	199,7	226,8	382,6	348,7	455,2	370,4	330,6
Straw + N_{30}	198,5	212,9	382,4	345,1	430,6	389,4	326,5
Fodder radish + N_{30} + straw	166,7	216,1	353,4	328,8	387,0	367,0	303,2
Red clover + straw	186,2	223,0	311,4	340,8	399,0	383,2	307,3

Analysis of the filtration of precipitation in the course of a year evidently demonstrated that under climatic conditions of Southeastern Lithuania the filtration was higher in spring – approximately 116.6 L m^{-2} or 36.9 % of the annual amount of filtered water percolated then (Fig. 1). During autumn and winter the infiltration slightly decreased and was similar – 72.3 and 83.4 L m^{-2}, or 22.8 and 26.3 % of the annual amount. During the summer period higher amount of precipitation evaporates from the ground or is consumed by plants, therefore only an average of 44.5 L m^{-2} of water percolates through the soil. Sometimes the filtration ceases for the summer. Only abundant atmospheric precipitation over a short period of time, as happened in 2005 and 2007, may significantly increase the filtration in summer. Due to such seasonal dynamics of atmospheric precipitation filtration, the agro-technical measures, which increase the contents of nutritional elements or their availability in soil, should be particularly carefully applied in autumn.

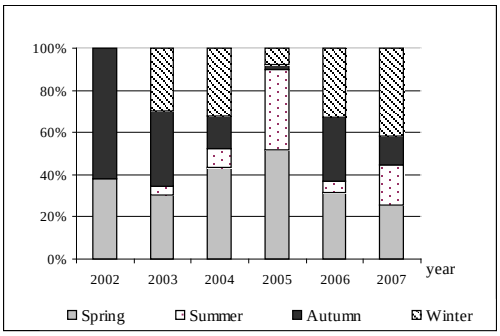


Figure 1 : The distribution of the amount of atmospheric precipitation according to the seasons of the year

Analysis of the effect of catch crops on filtration of precipitation revealed that it was strongest in August–October, i.e. during the vegetation of catch crops. It was determined that catch crops reduced the percolation of precipitation by 7.0–8.3 % per year on average, and in autumn periods of the years of their cultivation – by 21.7–19.4 %. Such a phenomenon is very important in order to reduce nutrient leaching from agricultural land,

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especially lately as the duration of autumn period increases.

b) Leaching of Nutriens

Nitrogen (N). Decomposition rate of organic fertilizers and migration of mineralized chemical elements in the soil depend on various factors, but especially on the hydrothermal regime. In leachate of the non-fertilized soil lower concentration of NO_3^- was observed in spring (37.8 mg L^{-1}), while during other seasons it was quite similar (57.2–67.2 mg L^{-1}). The coefficient of variation was quite high – 35.4–95.6 %.

Compared with the control variant, the addition of straw supplemented with mineral nitrogen fertilizers (N_{30}) increased the nitrate concentration in lysimetric water in autumn – by 25.9 mg L^{-1} on average (Fig. 2). Probably, mineral nitrogen (N_{30}), added in order to activate the decomposition of straw, is not immediately incorporated into the biological cycle and, in case of heavy rainfall, part of it migrate into the deeper soil layers. No significant differences ($p>0.05$) in nitrate concentrations compared with the control variants were recorded during other seasons because only small amount of nitrogen got into the soil with straw.

The applied agro-technical measures produced varying effects on nitrogen migration. Compared with the control, the addition of cereal straw supplemented with mineral nitrogen fertilizers (N_{30}) increased the annual nitrogen leaching by 9.0 kg ha^{-1} or 12.9 %, and the addition of clover green mass and straw – by 8.0 kg ha^{-1} or 11.5 %. Cultivation of aftercrop fodder radish following the addition of cereal straw was very efficient for the reduction of nitrogen and precipitation filtration. Such agro-technical measure reduced the nitrogen leaching by 16.9 kg ha^{-1} or 24.2 % on average, compared with the control variant and by 25.9 and 24.9 kg ha^{-1} compared with the addition of straw supplemented with N_{30} or of red clover and straw.

Cultivation of aftercrop fodder radish for green manure produced a different effect on the concentration of nitrates, although fodder radish, likewise the straw, were fertilized with mineral nitrogen fertilizers (N_{30}) before sowing (August). However, the used fertilizers were rapidly consumed by intensively growing plants, and nitrogen concentration in lysimetric water in autumn was significantly lower (24.0–64.6 mg L^{-1}) than in case of other agro-technical measures. In winter, spring and summer periods, as fodder radish biomass mineralization proceeded, no significant increase in nitrate concentration was established, but the tendency towards the increase was observed.

During autumn, clover accumulated more biomass and higher amount of nitrogen was added into soil with clover than with fodder radish. Although clover is a highly nitrogenous plant, hosting nitrogen accumulating bacteria on their roots, but their use for green manure, as compared with the control variant, did not increase the nitrate concentration during the autumn. This may be related to a slower decomposition of clover biomass, because at positive winter temperatures in 2006–2007, the nitrate concentration in lysimetric water slightly increased, and it is an evidence of the ongoing process of biomass mineralization. The analysis of the research data of the whole study period suggests that the effect of clover green mass on nitrate concentration depended on the amount of the added biomass. In case of rich harvest, as it was in 2004, in the course of decomposition of clover biomass the nitrogen effect on nitrate concentration was clearly evident for longer than a year. Regression and correlation analyses of the research data showed that in the year following the addition of green manure a strong relation of the nitrate concentration in lysimetric water (y) in spring and summer periods with the content of nitrogen added with clover and straw biomass (x) could be observed; it is described by regression equations:

$$y_{spring} = 0{,}358x + 15{,}65,\ R^2 - 0{,}747;$$

$$y_{summer} = 0{,}665x - 3{,}1815{,}65,\ R^2 - 0{,}688.$$

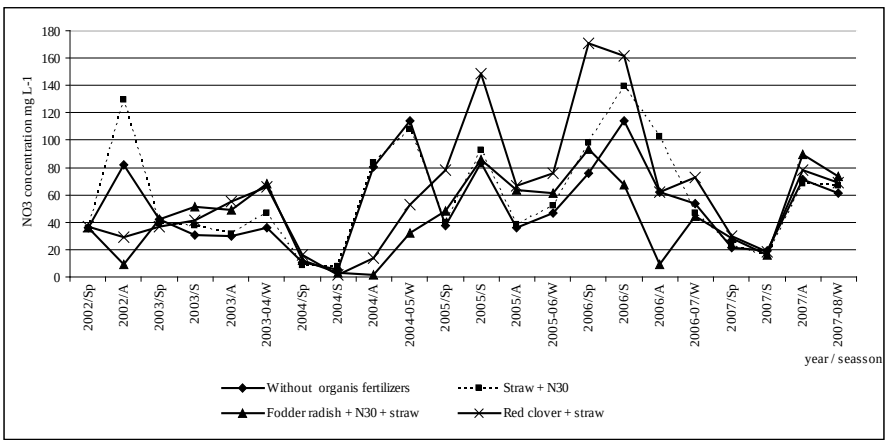


Figure 2 : The impact of green manure and straw on nitrate concentration in leachate (NO_3- mg L^{-1}) according to the seasons of the year

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In the autumn of the year following the addition of clover (10–12 months after addition) its effect on nitrate concentration decreased (R^2 – 0,117) and was insignificant.

The studies show that the least nitrogen leaching (4.3–7.6 kg ha^{-1} N) is recorded in summer because filtration of precipitation during this period is negligible, and in some years it may cease for the summer (Fig. 3). Regarding the nitrogen leaching losses, other seasons were quite similar – an average of 10.5–16.0 in spring, 3.9–15.9 in autumn, 11.3–14.1 kg ha-1 in winter. Effect of the applied agro-technical measures on nitrogen leaching was particularly evident during autumn – at the period of catch plants growth. They significantly reduced the filtration of precipitation; nitrate concentrations in lysimetric water were also lower, and therefore the nitrogen leaching decreased significantly ($p < 0.05$) compared with the control: by 65.5 % in case of fodder radish cultivation and by 31.9 % while growing clover. Plough in of straw supplemented with mineral nitrogen fertilizers (N_{30}) had no significant effect on filtration of precipitation but increased the concentration of nitrates in water, leading to 40.7 % ($p > 0.05$) average of nitrogen leaching losses in autumn.

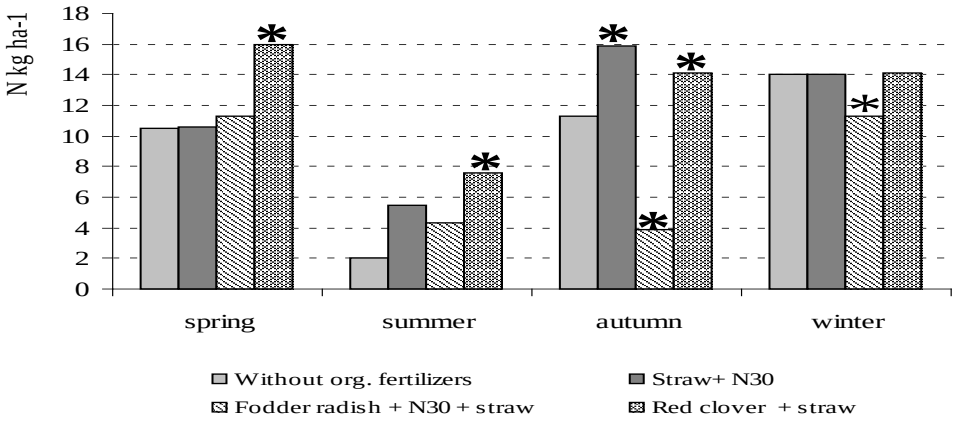


Figure 3 : The impact of green manure and straw on nitrogen leaching (N kg ha^{-1}) according to the seasons of the year

Note. * – significant differences from the control variant (without organic fertiliser) at 95 % significance level.

The effect of the addition of plant biomass in autumn on nitrogen leaching remained evident during other seasons as well. In winter significantly lower (19.3 %) nitrogen leaching was determined in the soil where biomass of fodder radish and straw had been added. Compared with control, the effect of clover biomass on nitrogen leaching in winter was significant during the year of its addition into the soil. During other years no significant increase was observed.

According to the data of 2002–2008, the average annual nitrogen leaching losses were 52.9–77.8 kg N ha^{-1}, depending on the applied agro-technical measures. Hydrothermal conditions played the key role in filtration of atmospheric precipitation, so nitrogen leaching losses in different years ranged from 7.7–43.1 kg N ha^{-1} in 2002 to 45.3–90.5 kg ha^{-1} in 2006.

The applied agro-technical measures produced varying effects on nitrogen migration. Compared with the control, the addition of cereal straw supplemented with mineral nitrogen fertilizers (N_{30}) increased the annual nitrogen leaching by 9.0 kg ha^{-1} or 12.9 %, and the addition of clover green mass and straw – by 8.0 kg ha^{-1} or 11.5 % (Table 3). Cultivation of aftercrop fodder radish following the addition of cereal straw was very efficient for the reduction of nitrogen and precipitation filtration. Such agro-technical measure reduced the nitrogen leaching by 16.9 kg ha^{-1} or 24.2 % on average, compared with the control variant and by 25.9 and 24.9 kg ha^{-1} compared with the addition of straw supplemented with N_{30} or of red clover and straw.

Table 3 : The effect of straw and green manure on chemical elements leaching of a sandy loam *Luvisol*

Treatment	Leaching kg ha^{-1}			
	N	K^+	Ca^{2+}	C_{org}
Without organic fertiliser	69,8	19,7	135,5	10.6
Straw + N_{30}	78,8*	20,7	136,4	9.9
Fodder radish + N_{30} + straw	52,9*	20,6	119,7*	8.3*

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Red clover + straw	77,8*	24,2*	137,1	8.5*
LSD_{05}	3,56	2,78	8,28	1.98

Note. * – significant differences from the control variant (without organic fertiliser) at 95 % significance level.

Potassium (K^+). Rather high amount of potassium 37.2–39.0 g m^{-2} was added into the soil with the green manure biomass; in the course of the biomass decomposition the soil is enriched with mobile potassium compounds and the plant requirements for potassium are optimized. Changes of potassium concentration in the leachate during the period of investigation show that straw and green manure increased its leaching, and their effect had a tendency to increase after each addition of the biomass (Fig. 4). Increased potassium concentration in lysimetric water was recorded not only in autumn, when mineralization of freshly added organic matter begins, but also the next year, i.e. 10–12 months after its addition. However, it should be noted that the increase in concentration was not always significant; only the tendency towards the increase could be mentioned. The average concentration of potassium in the leachate of non-fertilized soil was 6.0±2,67 mg L^{-1} K^+, and, depending on the hydrothermal conditions of a year, ranged from 2 to 14 mg L^{-1}. After the addition of green manure and straw its concentration increased by 1–5 mg L^{-1} K^+ and was from 6.7 ± 3,11 up to 8.60 ± 4,13 mg K^+ L^{-1}. Compared with the control variant, potassium concentration statistically significantly increased (+2.60 mg L^{-1}) only in leachate of the soil fertilized with red clover biomass.

During the study period, coefficient of variation in potassium concentration was high (44.4–49.9 %), because its leaching was influenced not only by the amount and intensity of atmospheric precipitation but also by the amount of the added organic matter.

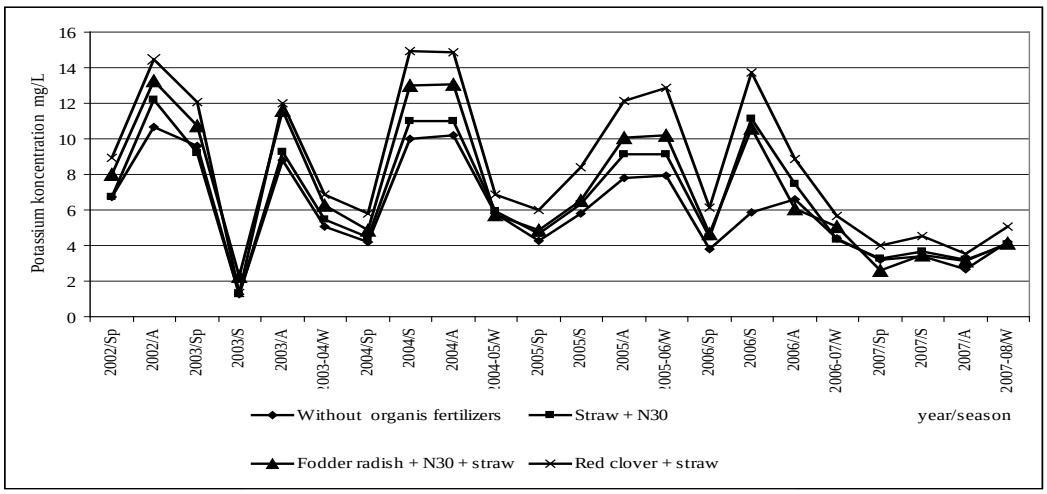


Figure 4 : The impact of green manure and straw on potassium concentration in leachate (K^+ mg L^{-1}) according to the seasons of the year

In sandy loam soil, with no catch crop cultivated for green manure, the average amount of leached potassium was 19,7 kg K^+ ha^{-1} per year (Table 4). The smallest losses (3.11–3.73 kg K^+ ha^{-1}) were determined in summer; it is related with lower filtration of precipitation and smaller potassium concentration in the leachate. Almost twice higher losses were determined in spring and autumn (5.82–97.39 and 6.52–7.69 kg K^+ ha^{-1} respectively) when filtration of precipitation was significantly higher. Although not very strong, but frequent increase of potassium concentration in leachate after the addition of green manure preconditioned the fact that its leaching losses, despite infiltration reduction while growing catch crops, were almost identical as in the control variant or even higher. Compared with the control variant or the variant of fertilization with straw and fodder radish, the leaching of potassium statistically significantly increased (3.6–4.5 kg K^+ ha^{-1} or 11.7–22.8 %) only after the addition of red clover. It should be mentioned that significant increase in potassium leaching was recorded not immediately after the red clover addition but in the period of spring – autumn of the next year. This evidently suggests the prolonged period of potassium release from organic compounds and its slower migration in the soil profile, compared with nitrogen compounds.

Calcium (Ca^{2+}). In this experiment, the leaching of calcium was also studied because it is an important element not just for plant nutrition it also stabilizes the soil acidification processes. In acidic soils, that are characteristic of the Eastern Lithuania, the exchange calcium is not abundant (700-900 mg kg^{-1} Ca), therefore it is important that the applied agro-technical measures would not induce the migration of calcium from the arable layer.

The research showed that the average annual concentration of calcium in the control variant was

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41,1±0.21 mg Ca L^{-1} , in the variant fertilized only with straw or together with green manure it changed insignificantly – from 38.2±3.46 to 44.63±3.99 mg Ca L^{-1} (Fig. 5). Statistical processing of the test data showed only a slight upward tendency in the concentration of calcium during the whole study period. The concentration somewhat increased in the leachate of soil fertilized with clover biomass, but the changes were statistically insignificant ($p>0.05$). During the study period the variation in calcium concentration was 0.51–9.05 %.

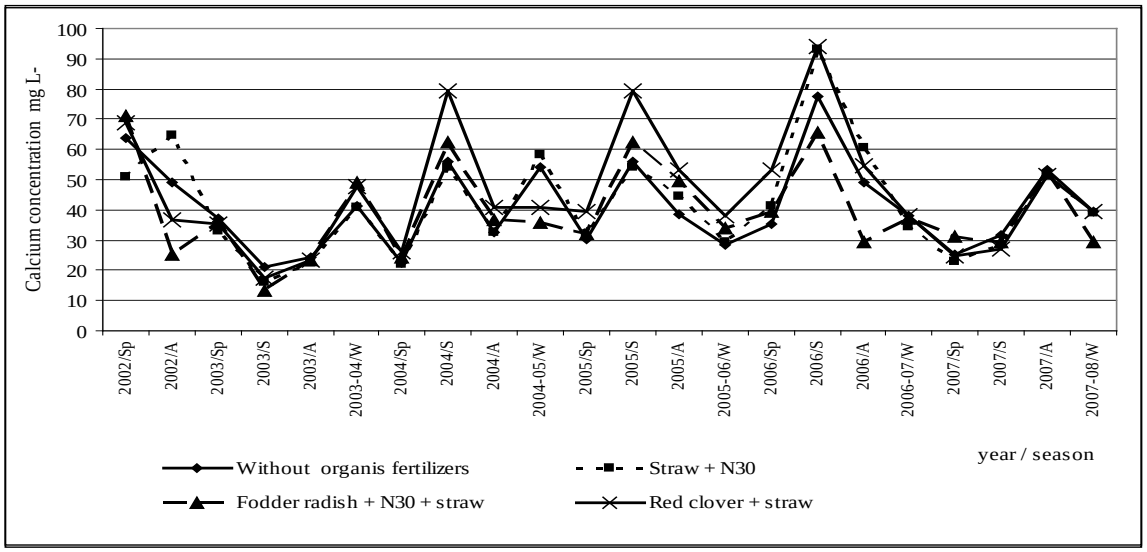


Figure 5 : The impact of green manure and straw on calcium concentration in leachate (Ca^{++} mg L^{-1}) according to the seasons of the year

As the green manure and straw had no significant effect on calcium concentration, so its leaching losses in the soil of all variants were similar, except for the variant with fodder radish (Table 5). From sandy loam soil an average of 119.7–135.5 kg Ca^{2+} ha^{-1} leached per year. Less calcium leaches in summer (21.1–25.7 kg Ca^{2+} ha^{-1}), higher amounts – in spring and autumn (37.1–43.9 and 25.2–42.6 kg Ca^{2+} ha^{-1} respectively).

Cultivation of fondre radish for green manure reduced the calcium leaching by 16.3 kg ha^{-1} or 10.9 % on average. This is due to two factors: lower filtration of precipitation in autumn in fodder radish crop and lower amount of calcium released from radish green biomass. The clover green mass accumulates more calcium than fodder radish biomass, and its decomposition results in larger amount of mobile calcium compounds. Therefore during the year following the addition of clover, the calcium leaching increased significantly (15.7 kg of Ca^{2+} ha^{-1} or 12.5 %) compared with the control variant. But during the year of clover cultivation, due to lower filtration of precipitation, the calcium losses were lower than in the leachate of the control variant.

Total organic carbon (TOC). Investigations on OC concentration in lysimetric water showed that during the experimental period incorporation of catch crops (fodder radish, red clover) biomass and straw did not increase TOC leaching (Figure 6). Significant ($p<0.05$) decreases in TOC concentration after green manure incorporation was only observed in 2002. In other years, treatment differences were not significant ($p>0.05$). Analysis of TOC seasonal data shows no consistent changes in the concentration after green manure and straw incorporation, since many factors affect OM destruction and leaching of mobile organic compounds. However, experimental data averaged over the period (2002-08) suggest that incorporation of green manure in late autumn decreased annual TOC concentration in lysimetric water by 0.56-0.57 mg l^{-1} (17.6-17.9%). These results were determined by the 2002 data, but in the other experimental years there was no observed change ($p >0.05$) in TOC concentration.

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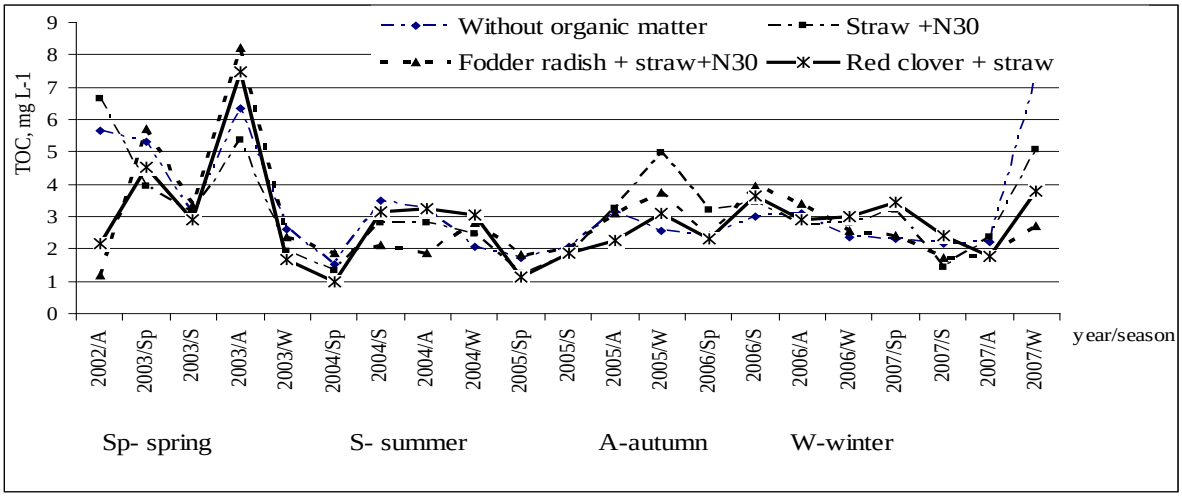


Figure 6 : Organic carbon (TOC) weighted concentration (Corg mg L^{-1}) in lysimetric water

TOC leaching losses varied considerably, with the least in 2004 and 2005 (6.49-8.31 and 5.48-6.83 kg ha^{-1}, respectively), whereas in the other years they were almost double (10-15 kg ha^{-1}) (Table 6). In treatments grown with undersown red clover, infiltration during summer declined by 38.7%, and by 16.5% in autumn, whereas fodder radish (sown in late August) reduced infiltration by 25.3% and 16.9%, respectively. Due to the decreased infiltration, TOC leaching losses after green manure incorporation were lower than those in the soil with only straw or barley stubble incorporated. Significant ($p<0.05$) reductions in TOC leaching due to green manure growth was identified in lysimeters with undersown red clover in 2002 (autumn) and in 2004 (summer and autumn), which grew plentiful (0.41-0.64 kg m^{-2}) during these times. In 2006, TOC leaching from the treatments with green manure crops was also lower, yet differences between treatments were not significant ($p>0.05$). In the years of green manure effect (2003, 2005) TOC leaching losses, due to the decomposition of green manure, did not change significantly ($p>0.05$) but, in comparison with the control treatment, it did reduce TOC leaching.

IV. Discussion

Due to warming climate in Europe (Krauciunene et al., 2010), the plant growth season becomes longer and it facilitates the cultivation of cover crops. In the course of the last 100 years, in Lithuania the temperature increased by 0.1-0.9 °C (Galvonaitė et al. 2007), and plant growth season elongated by 7 days (Kalvane et al., 2009). Changing climatic conditions cause the need for a new assessment of the impact of green manure on soil properties and nutrient leaching.

Studies have shown that in case of prolonged warm period of the year, cover crops for green manure effectively reduce rainfall leaching in sandy loam soil. It was determined that catch crops (red clover, fodder radish), on average, reduce the leaching by 19.4-21.7 % in autumn and by 7.0-8.3 % during the year. Stauffer (2000) determined that under rotations with cover crops, percolate formation was reduced by 10-15%, compared to rotations without or with a reduced presence of cover crops. Dry matter yield had no direct effect on the formation of percolate.

During the decomposition of green manure and straw various chemical elements present in them turn into mobile mineral compounds and can be re-used by plants or increase the nutrient leaching losses (Goulding, 2000 ; Adomaitis et. Al., 2010 ; Erickson et. Al., 2005). Studies showed that the influence of cover crops on nitrogen leaching depended on its chemical composition and biomass decay time (Hansen, Djurhuus, 1997; Jonson et. al., 2005 ; Shi, 2013). In autumn fodder radish consume a lot of mineral nitrogen for their biomass formation, which significantly reduces rainfall filtration. This consequently reduces the concentration of nitrates in filtering water and their leaching by an average of 24.2 % during the year. Capacity of non-leguminous plants for rapid absorption of soil mineral nitrogen in autumn is comprehensively described by various authors (Farthofer et. al, 2004 ; Askegaard et. al., 2006). The content of nitrogen accumulated in red clover biomass was by about 50 % higher than in the fodder radish biomass, so their influence on nitrogen leaching was different. Intensive decomposition of clover biomass begins in spring with the rise in temperature, thus a significant increase of nitrate concentration in lysimetric water took place in the spring (52.4 %) and summer (52.0 %) of the following year. Despite the lower filtration, significantly elevated levels of nitrate concentration resulted in increased nitrogen leaching (by 11.5 % during the year) after clover biomass insertion. Nitrogen migration to deeper soil layers after the insertion of clover was also described by Nykänen et al. (2008). Contrarily, Dabney et al. (2010) stated that winter cover crops reduce the nitrogen

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leaching from 70 to 45 kg NO_3-N ha^{-1}, while summer cover crops – up to 30 kg NO_3-N $ha^{-1.}$

Under Lithuanian climatic conditions insertion of cover crops for green manure increased potassium concentration in lysimetric water during the following year. The increase was not always statistically significant ($p > 0.05$). Only after red clover insertion a substantial increase in potassium concentration (+2.60 mg L^{-1} K^+, $p < 0.05$) and its higher leaching (4.5 kg ha^{-1} K+or 22.8%, $p < 0.05$) were determined. According to Askegaard et. al. (2003), in sandy soils (<5 % clay) the green manure crop rotation reduces the potassium leaching from 42 to 21 kg ha^{-1}, while the addition of barley straw helps to reduce the amount of exchange potassium in the soil.

Green manure crops had no significant effect on calcium migration in sandy soils, except for fodder radish, which is related with a lower rainfall filtration in autumn. For this reason calcium leaching decreased by 16.3 kg ha^{-1} or 10.9 % ($p < 0.005$). Under different climatic conditions application of cover crops (Crotalaria juncea, Sorghum bicolor_S. bicolor var. sudanense) increased K, Ca and Mg concentrations and considerably higher leachate concentrations of these elements occurred in the treatment with the leguminous cover crop, sunn hemp, than in sorghum sudangrass treatment. However, only the amount of leached Mg was significantly higher in the sunn hemp (5.7 kg ha^{-1}) than in sorghum sudangrass (Wang . et. al., 2003)

Decomposition of green manure generates different humic compounds which can stabilize or increase the amount of humus in the soil (Blombäck et. al., 2003; Tripolskaja et. al., 2008), but their mobile forms leach into the subsoil. These studies showed that in the sandy loam *Luvisol* incorporation of green manure did not essentially increase ($p > 0.05$) TOC concentration in lysimetric water or its leaching. Positive effect of green manure *(Trifolium pratense,* mixture of *Trifolium repens* and *Lolium multiflorum)* on the reduction of organic carbon leaching was also determined on *Endocalcari-Endohypogleyic Cambisol* (Arlauskienė et. al., 2011). Walmsley et. al. (2011) assessed dissolved carbon leaching from an Irish arable soil. They established that carbon leaching was twice as large from the non-inversion tillage + cover crop treatment. The leaching increased because of increased dissolved inorganic carbon concentrations. However, cover cropping and related additional inputs of organic matter into soil did not increase concentrations and leaching losses of DOC. Smukler et al. (2012) adds that cover crops successfully reduced runoff and loads of several constituents during the storm events, when compared to fallow. Losses of dissolved organic carbon (DOC) were reduced by 58%. Estimates of leaching losses of DOC in the cover cropped fields, however, were 70% higher than the fallow fields in the winter rainy season and were 30% higher than the fallow fields in the summer irrigation season.

V. Conclusions

1. In sandy loam *Luvisol* the catch crops grown for green manure (fodder radish, red clover) reduce the infiltration of atmospheric precipitation by 7.0–8.3 % on average, and in the autumn period of the year of their cultivation – by 19.4−21.7 %. Therefore, plough in of their biomass in spring can serve as a measure preventing the nutrient leaching.
2. Application of mineral nitrogen fertilizers to improve the straw mineralization leads to increased nitrate leaching during the first months after addition (October–December). In case of surplus precipitation, the increase of nitrate concentration can be significant.
3. Application of straw supplemented with N_{30} for fertilization increased the nitrogen leaching losses by 9.0 kg ha^{-1} or 12.9 %, while the addition of clover green mass and straw – by 8.0 kg ha^{-1} or 11.5 %. Fodder radish intensively assimilated mineral nitrogen, reduced filtration of precipitation thus leading to significant reduction of nitrogen leaching compared with the control variant (by 16.9 kg ha^{-1} or 24.2 %) and by 25.9 and 24.9 kg ha^{-1} respectively compared with the application of straw supplemented with N_{30} or clover and straw.
4. Fertilization with barley straw and fodder radish green mass produced no effect on the migration of potassium in the soil. But the addition of red clover green mass, compared with non-fertilized soils, significantly ($p < 0.05$) increased the annual average potassium concentration in the leachate by 2.60 mg of K^+ L^{-1} and the leaching losses – by 4.5 kg K^+ ha^{-1} or 22.8 %.
5. As a result of fertilization with barley straw as well as fodder radish and clover biomass, calcium concentration in the leachate slightly increased, but the changes were statistically insignificant ($p > 0.05$). Calcium leaching losses significantly increased (15.7 kg Ca^{2+} ha^{-1} or 12.5 %, $p < 0.05$) only in the year following the addition of red clover, but over the entire study period the changes were insignificant. Due to lower filtration of precipitation, the aftercrop fodder radish, compared with the control variant, significantly ($p < 0.05$) reduced the calcium leaching losses.
6. TOC leaching losses from a sandy loam soil were low and amounted to, on average, 8.3-10.6 kg OC ha^{-1}. Depending on annual meteorological conditions and experimental treatments, leaching losses varied from 1.97-14.92 kg OC ha^{-1} per year. Mean OC concentration in lysimetric water was 2.61-3.18 mg OC l^{-1} (control and with green manure or straw, respectively). Incorporation of barley straw

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and catch crops for green manure (fodder radish, red clover) in late autumn did not have any significant ($p>0.05$) effect on the TOC concentrations of lysimetric water.

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Allelopathic Effects of Aqueous Extracts of Plant Residues on Two Tropical Weeds of South Western Nigeria

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Abstract - The allelopathic effects of aqueous extracts of plant residues from *zea mays* (root and tassel) and *cajanus cajan* (leaves and stem) were examined on the two weeds, *euphorbia heteropyhlla* l. and *bidens pilosa* l. the results obtained showed that the aqueous extracts retarded the germination and the initial growth of both weeds. the effects were concentration dependent as the degree of retardation increased with increase in the concentrations of the extracts. the retardation of germination of *e. heterophylla* seeds was more pronounced in seeds treated with extracts from *c. cajan* leaf. The % germination decreased from 18% in the 5g concentration to 10% in 25g/200mL concentration at 144hrs experimental time. Similarly, the retardation of germination of *B. pilosa* seeds was more pronounced in *C. cajan* stem extract treated seeds. The % germination decreased from 52% in the 5g concentration to 20% in 25g/200mL concentration at 144hrs experimental time. The radicles of the two weeds were also retarded by the extracts. The retardation of radical lengths of *E. heterophylla* and *B. pilosa* seedlings were more pronounced in *Cajanus cajan* stem extract treated seeds as no radicle emerged until 72hrs experiment time. The radicle length of *E. heterophylla* seedling at 144hrs experiment was 0.93cm in the 5g concentration which reduced to 0.29cm in 25g/ 200mL extract concentration.

Keywords : *allelopathy, cajanu s cajan, euphorbia heterophylla, bidens pilosa.*

GJSFR-D Classification : *FOR Code: 070308*



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Abstract - The allelopathic effects of aqueous extracts of plant residues from *zea mays* (root and tassel) and *cajanus cajan* (leaves and stem) were examined on the two weeds, *euphorbia heteropyhlla* l. and *bidens pilosa* l. the results obtained showed that the aqueous extracts retarded the germination and the initial growth of both weeds. the effects were concentration dependent as the degree of retardation increased with increase in the concentrations of the extracts. the retardation of germination of *e. heterophylla* seeds was more pronounced in seeds treated with extracts from *c. cajan* leaf. The % germination decreased from 18% in the 5g concentration to 10% in 25g/200mL concentration at 144hrs experimental time. Similarly, the retardation of germination of *B. pilosa* seeds was more pronounced in *C. cajan* stem extract treated seeds. The % germination decreased from 52% in the 5g concentration to 20% in 25g/200mL concentration at 144hrs experimental time. The radicles of the two weeds were also retarded by the extracts. The retardation of radical lengths of *E. heterophylla* and *B. pilosa* seedlings were more pronounced in *Cajanus cajan* stem extract treated seeds as no radicle emerged until 72hrs experiment time. The radicle length of *E. heterophylla* seedling at 144hrs experiment was 0.93cm in the 5g concentration which reduced to 0.29cm in 25g/ 200mL extract concentration. The radicle length of *B. pilosa* seedling at 144hrs experimental time was 1.25cm in 5g concentration which decreased to 0.59cm in 25g/ 200mL concentration. The plumule lengths of the two weeds were also retarded by the extracts. The plumule length of *E. heterophylla* seeds were mostly retarded by extract from *C. cajan* stems. Plumule length in the 5g concentration was 0.53cm which decreased to 0.06cm in the 25g extract concentration. .*B. pilosa* seedlings were retarded mostly by extracts from *C. cajan* leaves. Plumule length was 1.20cm in the 5g extract concentration which decreased to 1.03cm in 25g/200mL extract concentration. Statistical analyses ($P < 0.05$) revealed that there were significant differences in the germination, radicle and plumule lengths obtained in the extract treated seeds when compared to the control especially at between 120 and 144hrs experimental time.

Keywords : allelopathy, cajanu s cajan, euphorbia heterophylla, bidens pilosa.

I. Introduction

The presence of weeds in agricultural fields greatly reduces crop yields. This has forced farmers to use herbicides as possible control measure. At present, these herbicides are highly expensive beyond the reach of resource-poor farmers. Quite often they are not available in the rural areas where majority of the farmers reside. Situations abounds where farmers procured resources from diverse sources and yet the herbicides were unavailable to purchase and when available, they could be adulterated and useless. Also the herbicides are environmentally unfriendly.

Consequent on the above, there has been a resurgent of interest in the search for sustainable weed control strategies that would address the problems stated above. Attempts made elsewhere included the use of allelopathy. In Nigeria, there abounds a gross dearth of studies on the allelopathic effects of crop residues until recently when allelopathic effects of some crop residues were considered on some agricultural crops and weeds by Ayeni *et al.,* 2010, Ayeni and Kayode (2012), Ayeni and Kayode (2013). The study being presented here examined the allelopathic effects of two common plant residues on two common weeds in Ekiti State, Nigeria.

II. Materials and Methods

Laboratory experiment was conducted in the Department of Plant Science, Ekiti State University, Ado-Ekiti, Nigeria, in September 2010 to determine the effects of different concentrations of aqueous extracts from residues of maize tassels and roots as well as C*ajanus cajan* leaves and stems on the germination and growth of two tropical weeds (*E. heterophylla* and *B. pilosa).*

Z. mays' tassels and roots were obtained from the experimental farm of the Faculty of Agricultural Sciences of the Ekiti State University, Ado-Ekiti, Nigeria, after the corns had been harvested. *Cajanus cajan's* leaves and stems were obtained from a farmland in Ikere-Ekiti, a town located at about 15km from the campus of the University.

These materials were chopped into pieces and were air-dried for three weeks after which they were pounded using pestle and mortal. Seeds of *E. heterophylla* and *B. pilosa* were obtained within the University campus.

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a) Extract Preparation

Portions of 5g, 10g, 15g, 20g, and 25g of each of the grounded samples of the crop residues were measured out using G&G Electric Top Loading Digital balance, JJ300Y, China. Each portion was soaked in 200ml distilled water in 500ml conical flasks. The mixtures were shaken intermittently for 24hrs at 25^0C ± 1^0C. The extracts for each crop residue was filtered and the filtrates were stored in a refrigerator for further usage.

b) Allelopathy Bioassay

In each treatment, two layers of Whatman No. 1 filter papers were put in each Petri dish (with a diameter of 9cm). Five seeds, each of the weeds, were sown in the Petri dish and each replicated ten times for each extract concentration. The filter papers were moistened daily with the different extract concentrations using syringe and needle. Control experiments were set up for each extract residues and were replicated ten times. All the Petri dishes were arranged on germination tables at room temperature between 25-30^OC. The seeds were considered as germinated upon radicle emergence and the number that germinated was counted and recorded for six days. The radicle and plumule growth elongations were recorded at 24hrs interval. The data obtained from the experiments were compared to those obtained from the control using Analysis of Variance (ANOVA, $P < 0.05$).

III. Results and Discussion

a) Seed Germination

The effects of aqueous extracts from the plant residues on the germination of seeds of the two weeds are shown in Tables 1and 2. The % germination of *E. heterophylla* seeds in all the four treatments was retarded (Table 1). It was observed that germination of seeds of *E. heterophylla* were retarded mostly by the extract from the *C. cajan* stem as no germination occurred until 72hrs experimental time (Table1 D).The effects of the extracts on the % germination (Table 1 A-D) increased with increase in the concentration of the extracts. This tends to show that the effects of the extracts were concentration dependent.

In *Z. mays* root extract treated seeds of *E. heterophylla* (Table 1 A), results obtained at 144hrs experimental time revealed that while the % germination in the control was 54%, those of 5, 10, 15, 20 and 25g/ 200mL concentrations were 34%, 24%, 24%, 24% and 20% respectively. In *Z. mays* tassel extract treated seeds (Table 1 B), results obtained at 144hrs experimental time was 54% in the control, those of 5, 10, 15, 20 and 25g/mL concentration were 54%, 40%, 32%, 18% and 10% respectively. Likewise, the % germination of *E. hereophylla* seeds in the *C. cajan* leaves aqueous extracts treated seeds (Table 1 C) was 28% in the control which decreased to 10% in 25g/200mL concentration. Also, in the *C. cajan* stem aqueous extract treated seeds (Table 1 D), % germination was 36% in the control which decreased to 6% in 25g/200mL concentration.

The germination of *B. pilosa* seeds in the aqueous extracts of the four treatments were shown in Table 2. It was also observed that the aqueous extracts also brought a considerable inhibition in the germination of *B. pilosa* seeds. In *Z. mays* root extract treated seeds (Table 2 A), the % germination of *B. pilosa* seeds was 90% in the control experiment, those of 5, 10, 15, 20 and 25g/ 200mL were 74%, 52%, 48%, 32% and 32% respectively. In the *Z. mays* tassel extract treated seeds (Table 2 B), the % germination was 72% in the control which decreased to, 30% in 25g/200mL concentration. Likewise, the *C. cajan* leaf extract treated seeds (Table 2 C) had 90% germination in the control experiment which decreased to 46% in the in 25g/200mL concentration. In *C. cajan* stem extract treated seeds (Table 2 D), control experiment had 70% which decreased to 20% in 25g/200mL concentration. It was observed that extract from the *C. cajan* stem retarded the germination of *B. pilosa* seeds more than the others.

Statistical analysis($P< 0.05$) showed that there were significant differences in the % germination of extract treated seeds between 96 and 144hrs experimental time in all the treatments except the extract from the *Z. mays* tassel in *B. pilosa* treated seeds where no significant different was observed in extract treated seeds and the control at low extract concentrations.

The study lend credence to the previous assertions of Oyun (2006) who reported that aqueous extracts from *Gliricidia sepium* caused a prolong delay of maize seeds germination. Also, Aisha *et al*. (2010) and Monica *et al*. (2011) reported the aqueous extracts of *Ascarum europaeum* L. inhibited the germination and growth of *Lycopersicum esculentum*

b) Radicle Length

The effects of the aqueous extract of the plant residues on the radicle lengths of the two weeds are shown in Tables 3 and 4. The results showed that the four plant residues retarded the radicle lengths of the weeds. *E. heterophylla* seeds treated with aqueous extract of *C. cajan* stem were mostly retarded (Table 3 D). At 144hrs experimental time, the radical length in the control experiment was 2.38cm, those of 5, 10, 15, 20 and 25g/ 200mL concentrations were 0.93cm, 0,83cm, 0.72cm, 0.51cm and 0.29cm respectively. Likewise, *B. pilosa* seeds treated with extract from *C. cajan* stem resulted in more inhibition of the radicle lengths (Table 4 D). Radicle length in the control experiment was 1.52cm, those of 5, 10, 15, 20 and 25g/200mL extract concentrations were 1.25cm, 0.99cm, 0.92cm,0,83cm and 0.59cm respectively.

Statistical analysis ($P< 0.05$) revealed that there were significant differences in the radical lengths of

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extract treated seeds between 72 and 144hrs experiment time in the three crop residues extracts except the extracts from *Z.mays* roots on radicle length on *B. pilosa* at the low extract concentrations (Table 4). The results obtained in this study corroborated the earlier assertions of Khan *et al.* (2011) who reported that litter from leaves and stem of *Rhazyastricta dence* significantly reduce the germination, radicle, plumule growth and number of roots of maize. Sisodia and Siddiqui (2010) reported that the radicle and plumule lengths of seedlings of test species were reduced significantly in response to the *C. bonplandianum* extracts.

c) Plumuleat Length

The effects of aqueous extracts of plant residues on the plumule growth of the two weeds were shown in Tables 5 and 6.The results also showed that the four aqueous extracts of the plant residues retarded the plumule length of the two weeds. The results revealed that the plumule length of *E. heterophylla* seeds treated with the aqueous extracts from *Z. mays* root was 2.83cm at 144hrs experimental time in the control experiment. The plumule lengths of the 5, 10, 15, 20 and 25g/200mL extract concentrations were 1.99cm, 1.40cm, 1.30cm, 0.84cm and 0.64cm respectively (Table 5 A). Also in the *Z. mays* tassel extract treated seeds, the plumule length of *E. heterophylla* in the control was 2.23cm, those of 5, 10, 15, 20 and 25g/200mL concentrations were 1.79 cm.1.47cm, 0.91cm, 0.90cm and 0.81cm respectively (Table 5 B). It was observed that extracts from *C. cajan* stem retarded the plumule lengths of *E. heterophylla* mostly with 1.31cm in the control which decreased to 0.06cm in 25g/200mL concentration (Table 5 D).

The results also revealed that the plumule lengths of seedlings emerged from *B. pilosa* extract treated seeds were retarded by the aqueous extracts of the plant residues. In the *Z. mays* root extract treated seeds (Table 6 A), plumule length in the in the control experiment was 1.52cm. Those of 5, 10, 15, 20 and 25g/200mL concentrations were 1.20cm, 1.17cm, 1.06cm, 0.93cm and 0.38cm respectively. Also in the *C. cajan* stem extract treated seeds (Table 6 D) plumule length was 2.17cm in the control experiment which decreased to 1.03cm in 25g/200mL concentration.

Statistical analyses ($P< 0.05$) revealed that significant differences abound in results obtained from *E. heterophylla* seeds treated with the aqueous extracts of the residues, most especially at higher extract concentrations, between 96 and144hrs experimental time.The results obtained from this study were in accordance with the work of Seerjana *et al.* (2007) who reported that the leaf aqueous extracts of *Parthenium hysterophorus* L.exhibited significant inhibitory effects on seed germination and seedling growth of all test species in cruciferous species. Abu- Romman (2010) also noted that allelochemicals released into the surrounding might inhibited or retarded root or radicle and shoot or coleoptile of plants. Aisha *et. al.* (2010) and Yarnia *et. al.* (2009), Kaul and Bansal (2002) also demonstrated similar results in their studies.

In conclusion, the study revealed that the root and tassel of *Z. mays* contain some allelochemicals which might be responsible for the inhibitory effects exhibited on the two weeds examined in this study. According to Sanchez- Moreiras *et. al.* (2004), *Z. mays* tassels' allelopathy was attributed to hydroxamic acid. Also, An *et al.* (2003) and Alberto *et al.* (2012) reported that *Z. mays* root allelopathy contained 2, 4- dihydroxy-7-methoxy-2*H* -1, 4- benzoxazin-3(4*H*) – one (DIMBOA). Nulifer (2006) revealed the phenolic acid in *Cajanus cajan* to include ptotocatechic, p- hydroxyl benzoic acid. All these chemicals might be responsible for the retardation in the germination and the initial growth of the two weeds examined here. It is hereby recommended that there is need for further studies on the potentials of turning these crop residues from waste materials to wealth.

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Table1 : Effects of aqueous extracts of *Zea mays* (root and tassel) and *Cajanus cajan* (leaf and stem) on the germination of seeds of *E. heterophylla*

Extracts g/200mL	Experimental Time (Hrs)					
	24	48	72	96	120	144
A.						
Z. mays root 0	0a	8a	42a	54a	54a	54a
Z. mays root 5	0a	6a	24b	34b	34b	34b
Z. mays root 10	0a	4a	16b	24b	24b	24b
Z. mays root 15	0a	4a	16b	24b	24b	24b
Z. mays root 20	0a	2a	14b	24b	24b	24b
Z. mays root 25	0a	0a	10b	20b	20b	20b
B						
Z. mays tassel 0	0a	14a	30a	52a	54a	54a
Z. mays tassel 5	0a	10b	30a	38ab	42ab	54a
Z. mays tassel 10	0a	4b	18ab	32abc	36ab	40ab
Z. mays tassel 15	0a	2b	10b	24bc	32ab	32ab
Z. mays tassel 20	0a	2b	6b	18bc	18b	18b
Z. mays tassel 25	0a	0b	4b	10c	10b	10b
C						
C. cajan leaf 0	0a	12a	14a	18a	28a	28a
C. cajan leaf 5	0a	6a	12a	14a	18ab	18ab
C. cajan leaf10	0a	4a	10a	12a	14ab	14ab
C. cajan leaf 15	0a	2a	10a	12a	14ab	14ab
C. cajan leaf 20	0a	2a	8a	10a	12ab	14ab
C. cajan leaf 25	0a	2a	6a	10a	10b	10b
D						
C. cajan stem 0	0a	2a	14a	36a	36a	36a
C. cajan stem 5	0a	0b	10ab	16b	16b	16b
C. cajan stem 10	0a	0b	8ab	12b	16b	16b
C. cajan stem 15	0a	0b	8ab	8b	8b	8b
C. cajan stem 20	0a	0b	4ab	6b	6b	6b
C. cajan stem 25	0a	0b	0b	6b	6b	6b

Means followed by the same letter with the column for each treatment are not significantly different at (P< 0.05)

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Table 2 : Effects of aqueous extracts of *Zea mays* (root and tassel) and *Cajanus cajan* (leaf and stem) on the germination of seeds of *B. pilosa*

Extracts g/200mL	Experimental Time (Hrs)					
	24	48	72	96	120	144
A.						
Z. mays root 0	0a	36a	82a	86a	90a	90a
Z. mays root 5	0a	20b	50b	66a	74a	74a
Z. mays root 10	0a	12b	32bc	40b	48b	52bc
Z. mays root 15	0a	12b	28c	38b	46b	48c
Z. mays root 20	0a	4b	20c	24b	32b	32c
Z. mays root 25	0a	4b	20c	24b	32b	32c
B						
Z. mays tassel 0	0a	32a	42a	50a	72a	72a
Z. mays tassel 5	0a	14b	42a	50a	72a	72a
Z. mays tassel 10	0a	9b	38a	46a	58ab	60ab
Z. mays tassel 15	0a	2b	34a	46a	50ab	58ab
Z. mays tassel 20	0a	0c	30a	32a	44bc	46bc
Z. mays tassel 25	0a	0c	22a	28a	30c	30c
C						
C. cajan leaf 0	0a	54a	64a	72a	72a	90a
C. cajan leaf 5	0a	14b	56ab	70ab	70ab	78ab
C. cajan leaf10	0a	10b	48ab	54abc	64abc	64abc
C. cajan leaf 15	0a	4b	32bc	40bc	64abc	64abc
C. cajan leaf 20	0a	2b	20c	40bc	62abc	62abc
C. cajan leaf 25	0a	0c	12c	28c	46c	46c
D						
C. cajan stem 0	0a	34a	14a	56a	64a	70a
C. cajan stem 5	0a	12b	10ab	36b	50ab	52ab
C. cajan stem 10	0a	6b	8ab	28b	34bc	46b
C. cajan stem 15	0a	6b	8ab	22b	28bc	34b
C. cajan stem 20	0a	4b	4ab	20b	20bc	28b
C. cajan stem 25	0a	0b	0b	14b	16c	20b

Means followed by the same letter with the column for each treatment are not significantly different at ($P < 0.05$)

Table 3 : Effects of aqueous extracts of *Zea mays* (root and tassel) and *Cajanus cajan* (leaf and stem) on the radicle length (cm) of *E. heterophylla*

Extracts g/200mL	Experimental Time (Hrs)					
	24	48	72	96	120	144
A.						
Z. mays root 0	0.00a	0.03a	0.64a	1.17a	2.00a	3.68a
Z. mays root 5	0.00a	0.00a	0.36b	1.01a	1.74ab	2.46b
Z. mays root 10	0.00a	0.00a	0.31bc	0.75ab	1.72ab	2.05bc
Z. mays root 15	0.00a	0.00a	0.19bcd	0.72ab	1.23c	1.69bcd
Z. mays root 20	0.00a	0.00a	0.06cd	0.33c	0.72cd	1.19cd
Z. mays root 25	0.00a	0.00a	0.00d	0.00c	0.41d	0.76d
B						
Z. mays tassel 0	0.00a	0.00a	0.33a	0.70a	0.89a	2.41a
Z. mays tassel 5	0.00a	0.00a	0.06a	0.27a	0.89a	1.16b
Z. mays tassel 10	0.00a	0.00a	0.06a	0.20a	0.77a	1.10b
Z. mays tassel 15	0.00a	0.00a	0.02a	0.17a	0.35a	0. 79b
Z. mays tassel 20	0.00a	0.00a	0.01a	0.15a	0.31a	0.78b
Z. mays tassel 25	0.00a	0.00a	0.00a	0.12a	0.21a	0.26b
C						
C. cajan leaf 0	0.00a	0.11a	0.58a	1.48a	2.13a	3.07a
C. cajan leaf 5	0.00a	0.10a	0.22ab	0.59b	1.16b	1.75b

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C. cajan leaf10	0.00a	0.06ab	0.18ab	0.29b	0.49b	0.68bc
C. cajan leaf 15	0.00a	0.03ab	0.09b	0.29b	0.46b	0.63bc
C. cajan leaf 20	0.00a	0.00b	o.o2b	0.20b	0.29b	0.52c
C. cajan leaf 25	0.00a	0.00b	0.01b	0.16b	0.28b	0.35c
D						
C. cajan stem 0	0.00a	0.00a	0.69a	1.61a	1.95a	2.38a
C. cajan stem 5	0.00a	0.00a	0.17b	0.59b	0.88ab	0.93b
C. cajan stem 10	0.00a	0.00a	0.08b	0.48b	0.75b	0.83b
C. cajan stem 15	0.00a	0.00a	0.02b	0.43b	0.61b	0.72b
C. cajan stem 20	0.00a	0.00a	0.00b	0.28b	0.40b	0.51b
C. cajan stem 25	0.00a	0.00a	0.00b	0.17b	0.25b	0.29b

Means followed by the same letter with the column for each treatment are not significantly different at (P< 0.05)

Table 4 : Effects of aqueous extracts of *Zea mays* (root and tassel) and *Cajanus cajan* (leaf and stem) *on the radicle length of B. pilosa*

Extracts g/200mL	Experimental Time (Hrs)					
	24	48	72	96	120	144
A.						
Z. mays root 0	0.00a	0.52a	0.79a	1.02a	1.48a	1.89a
Z. mays root 5	0.00a	0.15b	0.46b	0.75ab	1.18ab	1.85a
Z. mays root 10	0.00a	0.09bc	0.40b	0.69ab	1.00b	1.86a
Z. mays root 15	0.00a	0.03c	0.36bc	0.50bc	0.86b	1.77a
Z. mays root 20	0.00a	0.02c	0.21bc	0.43bc	0.81bc	0.50b
Z. mays root 25	0.00a	0.01c	0.09c	0.22c	0.37c	0.47b
B						
Z. mays tassel 0	0.00a	0.95a	0.32a	0.95a	1.42a	2.20a
Z. mays tassel 5	0.00a	0.07ab	0.22ab	0.56b	1.21ab	2.11ab
Z. mays tassel 10	0.00a	0.02bc	0.16b	0.54b	1.11ab	1.77ab
Z. mays tassel 15	0.00a	0.00c	0.09bc	0.42bc	0.99ab	1.70ab
Z. mays tassel 20	0.00a	0.00c	0.08bc	0.32bc	0.89ab	1.59ab
Z. mays tassel 25	0.00a	0.00c	0.00c	0.17c	0.72b	1.29b
C						
C. cajan leaf 0	0.00a	0.20a	0.41a	0.95a	1.27a	1.89a
C. cajan leaf 5	0.00a	0.19a	0.26b	0.86ab	1.23ab	1.63ab
C. cajan leaf10	0.00a	0.15a	0.11c	0.61abc	0.99abc	1.41ab
C. cajan leaf 15	0.00a	0.10b	0.05c	0.54bc	0.98abc	1.39ab
C. cajan leaf 20	0.00a	0.00b	0.04c	0.32c	0.79bc	1.32ab
C. cajan leaf 25	0.00a	0.00b	0.02c	0.24c	0.59c	1.05b
D						
C. cajan stem 0	0.00	0.00a	0.42a	0.76a	1.05a	1.52a
C. cajan stem 5	0.00a	0.00a	0.23ab	0.67ab	0.98a	1.25ab
C. cajan stem 10	0.00a	0.00a	0.12b	0.39bc	0.69ab	0.99ab
C. cajan stem 15	0.00a	0.00a	0.10b	0.31cd	0.64ab	0.92ab
C. cajan stem 20	0.00a	0.00a	0.01b	0.25cd	0.55ab	0.83ab
C. cajan stem 25	0.00a	0.00a	0.00b	0.04d	0.39b	0.59b

Means followed by the same letter with the column for each treatment are not significantly different at (P< 0.05)

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Table 5 : Effects of aqueous extracts of *Zea mays* (root and tassel) and *Cajanus cajan* (leaf and stem) on the plumule length (cm) of *E. heterophylla*

Extracts g/200mL	Experimental Time (Hrs)					
	24	48	72	96	120	144
A.						
Z. mays root 0	0.00a	0.00a	0.08a	0.49a	1.27a	2.83a
Z. mays root 5	0.00a	0.00a	0.05a	0.42a	1.23a	1.99ab
Z. mays root 10	0.00a	0.00a	0.04a	0.37a	1.01ab	1.40bc
Z. mays root 15	0.00a	0.00a	0.02a	0.35a	0.78ab	1.30bc
Z. mays root 20	0.00a	0.00a	0.00a	0.28ab	0.53bc	0.84c
Z. mays root 25	0.00a	0.00a	0.00a	0.00b	0.36c	0.64c
B						
Z. mays tassel 0	0.00a	0.00a	0.10a	0.80a	1.48a	2.23a
Z. mays tassel 5	0.00a	0.00a	0.05a	0.60a	0.90ab	1.79a
Z. mays tassel 10	0.00a	0.00a	0.00a	0.38ab	0.74ab	1.47a
Z. mays tassel 15	0.00a	0.00a	0.00a	0.01b	0.48ab	0. 91b
Z. mays tassel 20	0.00a	0.00a	0.00a	0.01b	0.30b	0.90b
Z. mays tassel 25	0.00a	0.00a	0.00a	0.00b	0.21b	0.81b
C						
C. cajan leaf 0	0.00a	0.00a	0.07a	0.73a	1.53a	2.26a
C. cajan leaf 5	0.00a	0.00a	0.06a	0.61a	1.36a	2.02b
C. cajan leaf10	0.00a	0.00a	0.05a	0.26a	0.90a	1.47b
C. cajan leaf 15	0.00a	0.00a	0.00a	0.25a	0.90a	1.40b
C. cajan leaf 20	0.00a	0.00a	0.00a	0.17a	0.58b	0.98b
C. cajan leaf 25	0.00a	0.00a	0.00a	0.08b	0.48b	0.63b
D						
C. cajan stem 0	0.00a	0.00a	0.15a	0.62a	1.03a	1.31a
C. cajan stem 5	0.00a	0.00a	0.01b	0.21ab	0.45ab	0.53b
C. cajan stem 10	0.00a	0.00a	0.00b	0.06b	0.12b	0.16b
C. cajan stem 15	0.00a	0.00a	0.00b	0.04b	0.08b	0.12b
C. cajan stem 20	0.00a	0.00a	0.00b	0.03b	0.07b	0.10b
C. cajan stem 25	0.00a	0.00a	0.00b	0.03b	0.05b	0.06b

Means followed by the same letter with the column for each treatment are not significantly different at (P< 0.05)

Table 6 : Effects of aqueous extracts of *Zea mays* (root and tassel) and *Cajanus cajan* (leaf and stem) on the plumule length of *B. pilosa*

Extracts g/200mL	Experimental Time (Hrs)					
	24	48	72	96	120	144
A.						
Z. mays root 0	0.00a	0.45a	0.69a	0.91a	1.09a	1.52a
Z. mays root 5	0.00a	0.00b	0.28b	0.56b	0.88ab	1.20ab
Z. mays root 10	0.00a	0.00b	0.12bc	0.51bc	0.83ab	1.17ab
Z. mays root 15	0.00a	0.00b	0.09bc	0.38bc	0.67bc	1.06ab
Z. mays root 20	0.00a	0.00b	0.03c	0.33bc	0.53bc	0.93b
Z. mays root 25	0.00a	0.00b	0.00c	0.18c	0.27c	0.38c
B						
Z. mays tassel 0	0.00a	0.00a	0.54a	0.87a	1.45a	1.96a
Z. mays tassel 5	0.00a	0.00a	0.32ab	0.66ab	1.04ab	1.83a
Z. mays tassel 10	0.00a	0.00a	0.21bc	0.45bc	0.95ab	1.32a
Z. mays tassel 15	0.00a	0.00a	0.02c	0.34bc	0.60b	1.17ab
Z. mays tassel 20	0.00a	0.00a	0.00c	0.23c	0.52b	1.01b
Z. mays tassel 25	0.00a	0.00a	0.00c	0.06c	0.45b	0.87b

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C						
C. cajan leaf 0	0.00a	0.00a	0.49a	0.67a	0.89a	1.23a
C. cajan leaf 5	0.00a	0.00a	0.21b	0.86ab	0.79a	1.20a
C. cajan leaf10	0.00a	0.00a	0.04c	0.61abc	0.58ab	1.02ab
C. cajan leaf 15	0.00a	0.00a	0.01c	0.54bc	0.58ab	0.91ab
C. cajan leaf 20	0.00a	0.00a	0.00c	0.32c	0.38b	0.82ab
C. cajan leaf 25	0.00a	0.00a	0.00c	0.24c	0.02b	0.60b
D						
C. cajan stem 0	0.00a	0.12a	0.74a	1.19a	1.65a	2.17a
C. cajan stem 5	0.00a	0.04b	0.31b	1.05a	1.55a	1.97ab
C. cajan stem 10	0.00a	0.04b	0.28b	0.93ab	1.31a	1.55ab
C. cajan stem 15	0.00a	0.03b	0.15b	0.74ab	1.03a	1.37ab
C. cajan stem 20	0.00a	0.00b	0.08b	0.39b	0.98a	1.31ab
C. cajan stem 25	0.00a	0.00b	0.06b	0.37b	0.79a	1.03b

Means followed by the same letter with the column for each treatment are not significantly different at ($P < 0.05$)

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References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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