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ALLELOPHATIC EFFECTS OF LEAF EXTRACT FROM NUTGRASS (*CYPERUS ROTUNDATUS* L.) ON THE GERMINATION AND SEEDLING GROWTH OF PAW PAW (*CARICA PAPAYA*) IN DIFFERENT SOILS TYPES

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ABSTRACT

Weed infestation of horticultural crops in gardens, parks and orchards has become a menace bedeviling productivity of fruits and vegetables. Nutgrass (*Cyperus rotundatus* L) is one of the weeds found on Horticultural farms whose leachets and exudates influences the performance of crops grown in farms and orchards on different soils. Paw paw is a common orchard crop grown for commercial purpose in the tropic with intense economic returns. This study investigates the allelophatic effects of nutgrass extracts (50g/cm3, 100g/cm3, 150g/cm3, 200g/cm3, 300g/cm3 and control) in different soils (Sandy, Loamy, clayey and Silty) on the seedling growth of Paw paw (*Carica papaya* L) in a split plot experiment replicated 3 times. The study unveiled that with increased concentration of nutgrass extract the growth performance of pawpaw seedlings significantly decline. Similarly the soils with better porosity, high water holding capacity as well as high in nutrient retention (such as loamy and silty soils) support better seedling performance in pawpaw. It is therefore noted that to reduce the allelo- effect of decomposing leachets and exudates from weeds (Nutgrass) on farms, regular weeding and complete destruction and removal of weeds (Nutgrass) around the base of paw paw plant in the orchards is recommended. Sandy soil has less effect on allele activity of Nutgrass than other heavy soils.

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INTRODUCTION

Pawpaw (*Carica papaya* L.) is an important agricultural export crop for developing countries, the export revenues of the fruit provide a livelihood for thousands of people, and contribute to the growing supply of healthy food products in international markets. Its production was estimated at 11,223,031 metric tons (t), including, 713,800 t from India (38.61%), 1,871,300 t from Brazil (17.50%), 703,800 t from Nigeria (6.79%), Indonesia (695,214 t), Mexico (616, 215 t) and Ethiopia (232,400 t) (Olusegun et al., 2016). Other countries involved in commercial pawpaw production are Sri Lanka and Tanzania (Belel and Belel, 2015). These estimated production values were however influenced by many environmental factors in the field including the allelophatic exudates from associated weeds species that commonly grow in papaw farms. Allelopathy refers to the beneficial or harmful effects of one plant on another plant, both crop and weed species, from the release of bio-chemicals, known as allelochemicals, from plant parts by leaching, root exudation, volatilization, residue decomposition, and other processes in both natural and agricultural systems (Belel and Belel, 2015). Also a growing interest in harnessing the potential of allelochemicals for weed management, as weed infestations significantly affect both the quantity and quality of crop yields (Pervin and Rabeya, 2024). Nutgrass is a common tropical weed that is found to grow in both nurseries and in the fields. The different soil types to which organic residue from decomposing vegetation of Nutgrass may give varying reactions due to difference in either their physicchemical composition or their response to phytochemicals exudates in the decomposing residue which may affect seedling germination or growth. Many crops and roots residues have been reported to have allelophatic effect on agricultural plants (Whittaker & Feeny, 1971; Price *et al.*, 2008). Previous studies of the effects of allelopathy on performance of certain crop by exudate from leaves, flowers, stem fruits or roots of weed species were reported by many researchers. Belel and Rahimatu (2012) on seed and leaf extract on groundnut; Belel and Belel (2015) reported on allelopathy due to seed and roots exudates in beans.

Statement of the problem

Despite several studies reported on allele-relation involving cereal, legumes and medicinal crops, little or no literature on the allelopathy as it affects vegetables and fruits especially in the tropical humid climate. The information on the allelophatic relationship between pawpaw and the common weeds such as Nutgrass are yet to be explored especially at the germination and seedling growth level.

Objectives of the study

This study therefore seek to understand the effects of different concentration of extract from the leaves of nutgrass on different types of soil on the germination and seedling growth of pawpaw with a view to improving the productivity and value of the crop at its early stages of life.

LITERATURE REVIEW

These allelophatic chemical compounds are released by living organisms and have an influence on the health and survival of other living things (Iqbal *et al.*, 2020). These allele chemicals are released under certain conditions and they have an impact on both soil bacteria and other plants in the vicinity, influencing seed germination, root and stem growth, and other plant functions (Yu *et al.*, 2003; Iqbal *et al.*, 2020). The production of these compounds is highly influenced by different phases of plant growth, genetics and environmental variables (Yu *et al.*, 2003). A large number of plants impose inhibitory effects on the germination and growth of neighboring or successional of plants by releasing allelophatic chemicals into the soil, either as exudates from living tissues or by decomposition of plant residues (Khan *et al.*, 2009). Allelopathy plays an important role in many agro ecosystems (Singh *et al.*, 2008). Most of the initial work performed with laboratory bioassays of allelochemicals had generally focused on seed germination and seedling growth (Oraon and Mondal, 2020). The utilization methods of growth response and biochemical effects (allelopathy) are equally interested in poor germination and growth of vicinity vegetation (Singh *et al.*, 2008; Pezzopane *et al.*, 2021). Some studies have showed an inhibitory effect of the aqueous extracts at different concentrations on seed germination and seedling growth compared to control (Soleymani and Shahrajabian, 2012; Shahid *et al.*, 2017).

METHODOLOGY.

The study Area

The study was conducted in both the Crop Science laboratory and the orchard farm of the Horticultural Technology Department of Federal Polytechnic, Mubi. Mubi is the headquarters of Mubi-North local Government which is located on Latitude 10o15’N and Longitude 13o16’ E at an altitude of 696 m above sea level. The climate is characterized by alternating dry and wet season. The rains last from April to October with a mean annual rainfall from 700 to 1050 mm (Udo, 1970; Adebayo, 2004).

Sample preparation

Fresh samples of the weed plant (*Cyperus rotundatus)* was collected from Agricultural fields in Federal Polytechnic Mubi. The leaves of *Cyperus* *rotundatus* was collected and removed from the plant and washed several times with running tap water, then rinsed with distilled water. The leaves were then dried in the oven at 80oC for 24 hrs and the dried samples were then ground to powder form.

Preparation of extract:

The plant (sample) that were collected and washed with tap water, followed by several washings with distilled water. The leaves were placed into the hot air oven at 80oC for 24 h for drying and sterilization. This was then be transferred into a sterilized motorized blending machine for grinding to a fine powder. The ground samples were then sieved through a 8.0 mm size wire mesh net screened and the larger particles were removed. The fine particles were weighed into 50 g, 100 g, 150 g and 300 g by using a digital weighing scale. Each of the sieved powdered sample were then be dissolved into 100 cm^3 of distilled water to make up the various concentrations and were left for 24 h. The concentration was then be filtered by using funnel and muslin cloth into various conical flasks. The concentration of 0.5 g/cm^3, 1.0 g/cm^3, 1.5 g/cm^3, 2.0 g/cm^3 and 3.0 g/cm^3 were obtained after filtration. The various concentrations are now ready for germination and seedling growth tests.

Experimental set up:

The field experiment was conducted at the orchard farm of the Department of Horticultural Technology using the split plot design involving control plot and five concentrations of *Cyperus rotundatus leave* extracts as main factor. Seventy two polythene bags filled with different soil types (sandy, clayey, loamy, silty) as sub factor was used. Five seeds each of Pawpaw were planted in each Polythene bag that were filled with equal volumes of different soils. Five (5) mls of the leaves extracts at different concentration were added to the different soil in the polythene bags; and distilled water for the control polythene bag. The treatments were replicated three times. The germination and seedling growth of each treatment was recorded in on weekly basis for 2 months. The germinated seed were counted immediately after germination while the plant height, number of leaves, Tap root width and Total root length were measured. The results were expressed in terms of the average of the treatments in the three replicates.

Statistical analysis: The data that were obtained from the experiment were be analyzed statistically by subjecting them to analysis of variance (ANOVA) of Gomez and Gomez (1984) using SAS system for windows. Significant differences among means were separated using Minimum Significant Difference (LSD) procedure (Little & Hills, 1986).

RESULT AND DISCUSSION

The alleophatic effect of different concentrations of nutgrass extract and soil types on the days to germination, establishment count, and the heights of pawpaw seedlings are presented in Table 1 below:

Concentrations of nutgrass extract significantly increased the number of days to seed germination. The higher the concentration of extract the more number of days it took the seed to germinate. This shows that the allelochemicals in the nutgrass extract may have retarded the process of inbibition by the seed and thereby delayed germination. However, 50g/cm3 and 150g/cm3 seem to respond significantly faster in germination compared to higher concentrations of nutgrass extract but later than when compared to the control plot. Similarly, the response of days to germination on different soil types showed a highly significant germination with silty soils providing a faster germination compared to other soils. Except for silty soil, all other soils recorded same number of days to germinate.

Furthermore, establishment count was highly different with decreasing number of seedling as the concentration of nutgrass extract increases. The control plot as well as the 50g/cm3 gave a better established seedlings. The higher concentration of 300g/cm3 was with least number of established

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seedlings. Clayey soil had a lower number of established seedlings compared to all other soils. This may likely be due to the compacted nature of the clayey soil particles.

Also the height of seedlings from weeks 1 to 6 is presented in Table 1. Seedling heights get retarded with increasing concentration of extract from weeks 1 to 3 as compared to the control treatment. However at week 4 there was no difference in height for all concentrations of extracts. This may be due to adaptation of the environment and intense physiological activities by seedling in all treatments. However, at weeks 5 and 6, the trend of reduced seedling heights intensifies with increased concentration of extract. The control treatment as well as 50g/cm3 were same at weeks 5 and 6, and were taller than all treatments in week 5.

The height of seedlings in different soil also showed that seedlings grow taller in sandy soils in weeks 1 to 5 but seedling growing in clayey soil tend to maintain same height with taller sandy seedlings at weeks 2 and 3. There was no significant difference in height among seedling at week 4 and 6

The interaction between nutgrass and soil in days to germination, establishment count plant height at weeks 1,2,3 and 5 (Table 1) shows that both nutgrass extract and soil type con significantly improve the performance of Pawpaw seedlings if the observed allelopathy are properly managed while taking cognizance of the prevailing soil conditions that favors pawpaw production. The root exudates from pawpaw plants and the leachets from dropping pawpaw leaves may equally counteract the allelophatic potentials in the weeded nutgrass in the soil. The relationship between nutgrass and soil at weeks 4 and 6 is not significantly different.

Table 1: Allelophatic Effect of Nutgrass extract and soil type on the days to germination, establishment count and height of Paw Paw (*Carica Papaya L.*) seedlings

Treatment	**Days to Germinat**	**Establish ment**	**Plant height (cm)**					
			Wee	**Week**	**Week**	**Wee**	**Week**	**Week**

	ion	**count (No.)**	**k 1**	**2**	**3**	**k 4**	**5**	**6**
Nutgrass extract								
Control	5.47a	4.33a	9.41a	14.51a	20.08a	25.74	34.12a	44.87a
50g/cm3	6.90b	4.16a	7.85b	12.32b	19.34b	25.97	34.51a	40.98ab
100g/cm3	7.78a	3.58b	7.10c	11.88b	18.11c	27.24	31.59c	39.09ab
150g/cm3	6.80b	3.58b	7.34c	10.01c	17.33d	24.60	32.18b	37.59b
200g/cm3	7.83a	3.08c	7.25c	9.87c	15.46e	23.61	28.14d	38.85b
300g/cm3	8.00a	2.91c	6.11d	9.59c	13.74f	22.47	27.61e	37.27b
Level of significance (P>0.05)	**	**	**	**	**	Ns	**	**
MSD	0.233	0.44	0.41	0.66	0.45	6.75	0.43	6.43
Soil type								
Sandy	7.16b	3.72a	7.78a	11.62a	18.17a	24.41	32.17a	38.00
Loamy	7.23ab	3.63a	7.38c	11.34bc	16.96c	26.62	31.07bc	39.96
Clayey	7.43a	3.42b	7.58b	11.38ab	17.43ab	24.61	31.26b	38.00
Silty	6.69c	3.66a	7.30c	11.11c	16.81c	24.10	30.92c	39.02
Level of significance (P>0.05)	**	**	**	**	**	Ns	**	Ns
MSD	0.20	1.50	0.16	0.24	0.33	4.41	0.24	4.01
Interaction (Nutgrass X soil)								
Level of significance (P>0.05)	**	**	**	**	**	Ns	**	Ns
F-value	24.40	19.83	18.40	12.22	13.41	1.14	57.15	1.17

Note: ** = Highly significant, MSD= Minimum significant difference, g/cm3= grams per centimeter cube, No.= number, values with different letters within a column are significantly different (P> 0.05)

Table 2 below presents the Allelopathic effect of nutgrass extract and soil type on the number of leaves of pawpaw seedlings from week 1 to week 6.

At week 1, there was significant effect of both nutgrass extract as well as soil type on the number of leaves produced by seedlings. However at week 2, the higher concentration of extract gave more leave than the control treatment. The trend of leave production fluctuates between concentrations but each varying highly significantly to the other. This pattern is unpredictable and may be associated with fluctuating soil climate. Also at weeks 3 to 6 trend of leave production stabilized amongst treatment with a significant reduction compared to the control treatment as the concentration of extract increases.

The soil effect on the number of leaves showed more leaves in seedling grown on loamy soil at week 2, which drastically reduced in week 3. The number of leaves is not significantly different amongst soils in weeks 4 and 6. The trend in week 5 indicates loamy and silty soils to produce same number of leaves compared to both control and clayey soil.

The significant interaction between nutgrass extract and soil type on the number of leaves at week 2,3 and 5 can equally be attributed both leachets and exudates from Pawpaw leave and roots as well as the corresponding soil reactions during their relationship in the rhizosphere. Soil has an important role to play in organic matter decomposition. The interactive relationship between soil and nutgrass extract is not significantly different at weeks 1 and 4.

Table 2: Allelophatic Effect of Nutgrass extract and soil type on the number of leaves of Paw Paw (*Carica Papaya L.*) seedlings

Treatment	**Number of leaves**					
	Week 1	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**
Nutgrass extract						
Control	3.00	4.25c	8.83a	12.25a	16.83a	21.91a
50g/cm3	3.00	4.50b	8.08b	11.25a	14.83b	21.83a
100g/cm3	3.00	4.25c	6.83c	11.08a	14.75b	20.00b
150g/cm3	3.00	4.00d	6.83c	10.91a	13.50c	18.66c
200g/cm3	3.00	3.75e	6.83c	8.83b	14.50b	18.91c
300g/cm3	3.00	4.75a	6.33c	8.33b	13.08c	18.33c
Level of significance (P>0.05)	Ns	**	**	**	**	**
MSD	0.00	0.25	0.50	1.98	0.92	0.94
Soil type						
Sandy	3.00	4.16b	7.27ab	10.72	14.05b	20.00
Loamy	3.00	4.50a	7.16b	10.16	15.11a	19.88

Clayey	3.00	4.16b	7.33ab	10.05	14.27b	20.11
Silty	3.00	4.16b	7.38a	10.83	14.88a	19.77
Level of significance (P>0.05)	Ns	**	*	Ns	**	Ns
MSD	0.00	0.34	0.20	1.04	0.25	0.35
Interaction (Nutgrass X soil)						
Level of significance (P>0.05)	Ns	**	**	Ns	**	**
F-value	0.00	0.92	18.89	1.69	47.25	13.44

Note: ** = Highly significant, MSD= Minimum significant difference, g/cm3= grams per centimeter cube, No.= number, values with different letters within a column are significantly different (P> 0.05)

The effects of both nutgrass extract and soil type on leave length, petiole length, Total root length and Tap root thickness of Pawpaw seedling is presented in Table 3 below:

The average length of pawpaw leave at week 6 decreased with increased concentration of nutgrass extract. The different concentration had significantly reduced the length of the leaf at each level of comparison revealing a progression in the impact of extract concentration on leaf length. However for the soil impact, seedlings grown on sandy soils produced longer leaves compared to other soils. The leaves of seedlings grown on loamy and clayey soils are moderate and same in length. Silty soils gave shorter leaves.

Petiole length at week 6 exhibited a similar growth pattern to the leave length. Petiole become shorter with increased concentration of extract. The soil effect on petiole length depicts a longer petiole in seedlings grown on sandy soils while shorter petiole were recorded on seedlings grown in loamy and silty soil.

The total root length of pawpaw seedling at weeks 3 and 6 (Table 3) showed a better root development with reduced concentration of nutgrass extract at both weeks 3 and 6. The soil effect also indicates longer roots in sandy and loamy soils. This may likely be due to high porosity of these soils allowing easy access for root penetration in both micro and macro pores in the soil. Silty soil gave shorter roots at week 3.

Tap root thickness are not significantly different in both week 3 and 6 for both nutgrass extract and soil type (Table 3)

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The soil is the environment for root growth and development. In the interaction between nutgrass extract and soil type on root length as well as taproot thickness which is shown to highly significant for pawpaw root growth. The antagonizing allelophathy that may be found in soil due to products of decomposition of litter of pawpaw leaves and other weeds may make a balance of the rhizosphere. This will support bacterial activity for better crop growth. Petiole length and leave length also has a better interaction between nutgrass extract and soil type (Table 3)

Table 3: Allelophatic Effect of Nutgrass extract and soil type on the leaf length, petiole length, total root length and Tap root thickness of Paw Paw (*Carica Papaya L.*) seedlings

Treatment			**Root measurement**			
	Leaf length at 6 weeks (cm)	**Petiole length at 6 weeks (Cm)**	**Total root length at Week 3**	**Total root length at Week 6**	**Tap root thickness at week 3**	**Tap root thickness at week 6**
Nutgrass extract						
Control	43.25a	26.86a	65.67a	167.28a	3.87	6.52
50g/cm3	39.41b	25.96a	62.13bc	164.74a	3.70	6.26
100g/cm3	35.25c	24.91b	63.21bc	167.97a	3.50	6.26
150g/cm3	31.66d	23.82c	62.60bc	148.28b	3.20	6.02
200g/cm3	30.58e	23.86c	61.82c	151.24b	3.38	5.71
300g/cm3	27.16f	22.38d	56.62d	138.15c	3.05	5.54
Level of significance (P>0.05)	**	**	**	**	Ns	Ns
MSD	0.76	0.93	1.34	4.61	1.20	1.68

Soil type						
Sandy	35.77a	25.43a	62.44a	158.74 a	3.51	6.12
Loamy	34.55b	24.21c	62.30ab	155.50 ab	3.45	5.99
Clayey	34.44b	24.75b	61.96b	154.59 b	3.47	6.11
Silty	33.44c	24.15c	61.33c	156.28 ab	3.35	6.00
Level of significance (P>0.05)	**	**	**	*	Ns	Ns
MSD	0.52	0.45	0.41	3.34	0.17	0.19
Interaction (Nutgrass X soil)						
Level of significance (P>0.05)	**	**	**	**	*	*
F-value	25.56	13.31	43.90	4.29	2.31	2.07

Note: ** = Highly significant, MSD= Minimum significant difference, g/cm3= grams per centimeter cube, No = number, values with different letters within a column are significantly different (P> 0.05),

CONCLUSION

Allelo-chemicals from the leaves of weeds growing in orchards and gardens has been known to affect the productivity of crops. Now that efforts are made to understand the concentration at which it exerts more effects, this work unveiled the relationships between nutgrass and Pawpaw in different soils. It showed that with increasing concentration of extract, growth performance of pawpaw declines. The growth of seedlings of paw paw is affected at all concentrations of extracts of nutgrass. Also soils light soils (Sand and Silt) tend to support seedling growth than heavy soils Clay and Loam.

RECOMMENDATIONS

Findings from this study suggest that allelopathy in extract of nutgrass can affect the performance of pawpaw irrespective of concentrations. It is therefore recommended that while growing pawpaw in plantations or orchards, the crop-weed relation should have zero tolerance especially at the base of the growing seedling. Similarly, pawpaw seedling should be managed in light soils such as sand and silt.

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CONFLICT OF INTEREST:

It is hereby declared that there is no conflict of interest among authors of this work

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