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Effect of Neem Leaf Mulch Rates on the Growth, Yield and Blossom End Rot of Tomato (*Solanum lycopersicum* L.) in Awka

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Abstract

The experiment was carried out at the Teaching and Research Farm of Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Awka. The aim was to evaluate the effect of neem leaf rates on the establishments, growth, yield and blossom end rot of tomato (*Lycopersicon esculetum*), in Awka, Anambra State. Four rates of Neem leaves were used as mulch which served as treatments (0.00 kg ha^{-1}, 2775 kg ha^{-1}, 5550 kg ha^{-1} and 8338 kg ha^{-1}) on the PADMA 108 F1 variety of tomato. The neem leaves were applied on well prepared beds, one week before transplanting. Plots mulched with 5550 kg ha^{-1} gave highest number of fruits per plant (16.70) while control plot gave lowest number of fruits per plant (4.90). Mulching with 8338 kg $ha^{-1}$of neem gave highest fruit weight (0.339 t ha^{-1}) while control plot gave lowest fruit yield (0.207 t ha^{-1}). Number of tomato fruits per plant affected by blossom end rot was highest in control plot (11.00) and reduced in plot mulched with 8338 kg ha^{-1} of neem (4.00). Therefore, the use of 8338 kg ha^{-1} of neem leaves is recommended for improved yield and increased resistance to blossom end rot in tomatoes in Awka.

Keywords: Mulch, Neem, Rates, Tomato, Yield

Introduction

Tomato (Solanum lycopersicum L.) belongs to the family Solanaceae. It is one of the most important vegetables worldwide (Tipu et al., 2014). Tomato is a perennial crop but can be cultivated annually in the screenhouse, or on the field. It contains high amount of lycopene which is responsible for the red pigment in the crop. Lycopene is also a source of antioxidant that lowers the risk of cancer and helps in improving heart conditions (Górecka et al., 2020). Tomato is rich in vitamin B29, vitamin C, and vitamin K, as well as Beta carotene which are also converted to vitamin A in the body (Szabo et. al., 2019). They also contain essential minerals like potassium that helps in controlling blood pressure. They can be consumed as fresh in salads, or processed into soup. It can also serve as a raw material to produce ketchup, paste and other canned products (Ali et al., 2020).

The largest producers of tomato in the world are China, India and United States respectively. In Africa, Egypt remains the largest producer (Maphosa and & Ddamulira, (2020) with an annual production of 6.6 million tonnes.This is followed by Nigeria with 3.9 million tonnes (Atlasbig, 2023), and the figure is expected to rise to 4.6 million tonnes by 2026, representing an annual increase of 2.5% (ReportLinker, 2022)

However, despite the growth been experienced in tomato production across Nigeria, the commercial production of the crop in the Eastern parts of the country is impeded by biotic (pest and diseases) and abiotic (rainfall, Relative humidity, sunlight, etc) factors. In order to mitigate these challenges without causing environmental contamination, many observers have advocated the adoption of conservation practices (Shiksha et al., 2023)). Particularly, the use of mulching has been suggested as a practical measure to ameliorate the challenge. Mulching is the practice of covering the upper soil/ground to make the soil more favorable for plant growth. It prevents the direct evaporations of moisture from the soil, thus limit water loss and helps to conserve soil moisture. An example of mulch material is neem leaf. The neem leaf and other parts of the plant are useful for manure, soil conditioner, urea coating agent, insecticide, fumigant etc. Neem, therefore, is a potential growth-promoter for production of tomato in the Southeastern Nigeria that is characterized by highly leached soils, high density pests and disease pathogens that causes great agricultural losses. Hence, the aim of this study was to determine the effect of neem leaf mulch rates on the growth, yield and blossom end rot of tomato.

Materials and Methods

The experimental site was located at the Teaching and Research Farm of the Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. Awka is characterized by tropical rainforest with temperature range of 27°C - 30°C. It is located at 447metres above sea level, between latitude 06^0 15^1 N and longitude 07^0 08^1. The average annual rainfall is 1900.2 mm (Chukwudi *et al.*, 2017).

The variety of tomato used was the PADMA 108 F1 which was sourced from an Agro-allied company in Awka. The tomato seedling received four treatments of varying rates of Neem leaf as mulch material. The treatments were applied at the rate of 0kg/ha, 2775kg/ha, 5550kg/ha and 8338kg/ha, replicated three (3) times, making a total of 12 plots. The plots were raised beds with measurements of 4m x 2m and a 1m space between them. The total land area used for the experiment was $210m^2$, and there were four plots.

Media comprising of top soil, poultry manure and sharp sand in the ratio 3:2:1 respectively was used to raise the seedlings in nursery trays after decomposition. Healthy and good quality seedlings were selected and transplanted at the field at three weeks after planting. Transplanting was done in the evening at a spacing of 40 x 40 cm giving a plant density of 62,500 plants per hectare. Weeding was done at two weeks intervals by hand weeding and use of hoe while staking was done using ropes tied to wooden poles.

Data were collected three weeks after transplanting, and the data were collected for 6 WAT to assess the effect of the neem mulch on the growth and yield of the tomato plants. The parameters measured include Percentage establishment (%), plant height (cm), leaf area (cm^2), number of leaves, stem girth (cm), number of fruits, fruit weight, fruit length, circumference and diameter, number of plants generally affected by diseases and number of plants infected by the blossom end rot and gray mould.

The experiment was set up in a factorial experiment fitted into randomized complete block design. All data were subjected to analysis if variance (ANOVA) using the GENSTAT version 4 analytical software. Mean separation was done using the Least Significance Difference at 5% probability level.

Results

Plant Height and Stem Girth

The mean of the plant heights for the different levels of neem leaf mulch showed no significant difference at 4WAT, 5WAT and 6WAT, but showed significant difference at 3WAT. The 2775kg/ha rate recorded the least mean plant heights at 3WAT, 4WAT, 5WAT and 6WAT (31.3cm, 46.70cm, 60.70cm and 61.90cm respectively), while 8338kg/ha recorded the highest at 3WAT and 4WAT (50.10cm and 61.30cm respectively) and 5550kg/ha recorded the highest mean plant heights at 5WAT and 6WAT with 71.40cm and 76.60cm respectively (Table 1). The means of the stem girths showed no significant difference between the Neem leaf mulch rates at 3WAT, 4WAT and 5WAT, but was significantly different at 6WAT. The 5550kg/ha neem leaf mulch rate recorded the highest plant girth mean at 4WAT, 5WAT and 6WAT (3.23cm, 3.40cm and 3.59cm respectively) while 0.00kg/ha recorded the least plant girth at 3WAT and 4WAT. However, 2775kg/ha neem Leaf Mulch rate recorded the least plant girth at 6WAT and 8338kg/ha neem Leaf Mulch rate recorded the highest plant girth at 3WAT.

Number of Leaves, Leaf Area, Number of Branches and Number of Flower

The highest leaf area mean at 3WAT was recorded by Neem Leaf Mulch rate of 5550kg/ha ($16.75cm^2$), 8338 kg/ha Neem Leaf Mulch rate recorded the highest at 4WAT, 5WAT and 6WAT ($24.70cm^2$, $27.10cm^2$ and $27.10cm^2$ respectively) while 2775kg/ha Neem Leaf Mulch rate recorded the least leaf area mean at 4WAT, 5WAT and 6WAT (12.10cm2, $13.80cm^2$ and $15.40cm^2$ respectively). Also, 2775kg/ha Neem Leaf Mulch rate recorded the least number of leaves at 3WAT, 4WAT, 5WAT and 6WAT (86.7, 113, 132 and 170) and 5550kg/ha Neem Leaf Mulch rate recording the highest number of leaves at 3WAT, 4WAT, 5WAT and 6WAT (181.2, 344, 468 and 561). These means were all significantly different from one another (Table 2).

There was significant difference in the number of branches among neem leaf mulch rates at 3WAT, 4WAT, 5WAT and 6WAT (Table 3). The application of 2775kg/ha neem leaf mulch rate recorded the least mean number of branches at 3WAT, 4WAT, 5WAT and 6WAT (13.33, 14.22, 15.20 and 16.20 respectively) while 5550kg/ha Neem Leaf Mulch recorded the highest mean number of branches at 3WAT, 4WAT, 5WAT and 6WAT (19.55, 24.11, 32.20 and 39.70 respectively).

The means of number of flowers recoded no significant difference between the different neem leaf mulch rates at 3WAT and 4WAT while there were significant difference at 5WAT and 6WAT (Table 3). The 5550kg/ha neem leaf mulch rate recorded the highest number of flower at 3WAT, 4WAT and 5WAT (3.56, 7.44 and 14.60 respectively) and 2775kg/ha recorded the least number of flower at 3WAT, 4WAT, 4WAT and 6WAT (0.78, 3.11, 3.60 and 0.78 respectively). At 6

WAT, 8338kg/ha Neem Leaf Mulch rate recorded the highest number of flower.

Table 1: Effects of neem leaves on plant height and stem girth of tomato at different weeks after transplanting

	Plant height (cm)				Stem girth (cm)			
Neem Leaf Mulch (kg/ha)	3WAT	4WAT	5WAT	6WAT	3WAT	4WAT	5WAT	6WAT
0.00	37.60	50.10	60.90	62.40	2.15	2.28	2.71	2.80
2775	31.30	46.70	60.70	61.90	2.21	2.63	2.71	2.74
5550	34.10	54.30	71.40	76.60	2.79	3.23	3.40	3.59
8338	50.10	61.30	65.80	72.60	2.80	2.91	3.05	3.07
$LSD_{0.05}$	14.15	ns	ns	ns	ns	ns	ns	0.77

Table 2: Effects of neem leaves on number of leaves and leaf area of tomato at different weeks after transplanting

	Number of leaves				Leaf area (cm^2)			
Neem Leaf Mulch (kg/ha)	3WAT	4WAT	5WAT	6WAT	3WAT	4WAT	5WAT	6WAT
0.00	114.6	189.0	229.0	229.0	10.4	17.0	19.3	20.9
2775	86.7	113.0	132.0	170.0	10.8	12.1	13.8	15.4
5550	181.2	344.0	468.0	561.0	16.8	22.1	24.8	26.9
8338	85.4	187.0	222.0	281.0	11.9	24.7	27.1	27.1
$LSD_{0.05}$	39.6	119.6	180.9	214.4	5.9	8.3	9.1	9.9

Table 3: Effects of neem leaves on number of branches and number of flowers of tomato at different weeks after transplanting

	Number of branches				Number of flowers			
Neem Leaf Mulch (kg/ha)	3WAT	4WAT	5WAT	6WAT	3WAT	4WAT	5WAT	6WAT
0.00	13.56	15.67	18.20	20.60	2.55	5.11	4.10	2.89
2775	13.33	14.22	15.20	16.20	0.78	3.11	3.60	0.78
5550	19.55	24.11	32.20	39.70	3.56	7.44	14.6	8.44
8338	14.67	22.22	30.10	33.20	1.67	5.00	8.80	9.45
$LSD_{0.05}$	5.78	6.87	10.3	12.28	ns	ns	7.45	5.79

Fruit Circumference, Fruit Length, Fruit weight and number of fruits at the harvest period

The 0.00kg/ha treatment recorded the least mean Fruit Circumference (12.44cm), Fruit Length (7.00cm) and Fruit Weight (33.1g) at harvest and 8338kg/ha recorded the highest mean fruit circumference (15.83cm), fruit length (8.49cm) and fruit weight (54.3g). There is significant difference in the mean number of fruits between the different Neem Leaf Mulch rates. 5550kg/ha Neem Leaf Mulch rate recorded the highest mean number of fruits (16.70), while 0.00kg/ha with 4.90 fruits recorded the least number of fruits (Table 4).

Percentage establishment and percentage number of plants at maturity/harvest and plants infected

Table 5 shows that the percentage establishment was highest (93.09%) with the 2775kg/ha quantity of neem leaves as mulch material and the lowest establishment (66.54%) with 8338kg. That is to say that at the beginning there was higher establishment percentage with lower mulching. At maturity/harvest it was observed that the percentage of plants that reached this stage became higher with increased mulch material.

Thus, 5550kg/ha of neem mulch material recorded the highest plant percentage while 0.0kg/ha recorded the lowest.

Table 5 shows significant difference among the neem mulch rates with respect to blossom end rot. The 8338kg/ha rate recorded the least blossom end rot and gray mold disease incidence (0.67). It also recorded the least general disease occurrence/incidence (4.00) while 0.0kg/ha recorded the highest blossom end rot and gray mold disease incidence (5.67). It also recorded the highest general disease occurrence (11.0).

Table 4: Effect of neem leaf on the fruit circumference, fruit length, fruit weight and number of fruits at the harvest period

Neem Leaf Mulch (kg/ha)	Fruit circumference (cm)	Fruit length (cm)	Fruit weight (t/ha)	Number of fruits
0.00	12.44	7.00	0.207	4.90
2775	13.87	7.60	0.249	5.40
5550	14.70	7.91	0.286	16.70
8338	15.83	8.49	0.339	11.10
$LSD_{0.05}$	1.233	0.975	10.07	10.81

Table 5: Effect of neem leaves as mulch rates on percentage establishment, percentage number of plants at maturity/harvest, number of plants affected by blossom end rot/gray mould and number of plants infected by other diseases

Neem Leaf Mulch (kg/ha)	% Establishment	% Plants at maturity/harvest	Blossom end rot/ gray mould	Infected plants
0.00	86.88	45.99	5.67	11.0
2775	93.09	59.20	5.33	9.33
5550	80.32	59.53	3.00	6.33
8338	66.54	54.97	0.67	4.00
$LSD_{0.05}$	0.876	2.609	1.104	2.025

Discussion

The mulch generally enhanced the growth of tomato plants. This result agrees with previous studies which showed the superiority of mulched plants over the unmulched plants (Opara-Nadi, 1993; Hudu *et al*., 2002; Awodoyin and Ogunyemi, 2005), and the report that tomato benefited from mulching (Hochmuth *et al*., 2001).The increased growth and tomato fruit yield under the mulches may be explained by the conservation of moisture and reduction of temperature of top soil and suppression of weed growth. The result of the experiment revealed that the different growth parameters of tomato recorded variation due to the different levels of Neem leaf mulch (NLM) rates. The highest increase in the growth parameters of Plant girth ,number of branches and number of leaves by the 5550kg/ha Neem Leaf Mulch rate could be due to the water conserving effect of the mulch in addition to the release of nutrients due to its decomposition, adding to the available nutrients in the soil. The high plant height observed in the 8338kg/ha NLM rate is as a result of soil water conservation and gradual nutrient release, the low plant height recorded by same rate at the first 3weeks could be as a result of transplant stress/shock and increase in temperature due to decomposition of the fresh leaves. The result

on Leaf Area showed that Neem leaf mulch rates are affected the length and width of the tomato leaves. The observation could be attributed to the additional nutrient made available to the plants and the water conserving property of the mulch. This enhancement in the growth parameters by the higher neem mulch rates might be explained to be as result of addition of organic matter turned into humus and resultantly into increased nutrient retention capacity of the soil by increasing effective cation exchange capacity. The fact that mulch covers the soil surface preventing evaporation, and also protects the soil and its organic content from direct contact with warm air thus increasing soil microbial activity and consequently encouraging decomposition, is probably the reason for high growth. Similar findings were also made by Kuldeep (2016).

Yield attributes which determine yield is the resultant of the vegetative development of the plant. Yield is as a result of the coordinate interplay of the yield attributes: number of fruit per plant, weight of fruit per plant etc. which were improved due to mulch application. The maximum record of number of fruit per stand and number of flower per stand observed in 5550kg/ha Neem Leaf Mulch rates could be related to the maximum branching and relatively strong growth performance of the plants. 8338kg/ha Neem Leaf Mulch rates recorded the maximum fruit weight, length and circumference as it produced the largest fruits. This could be said to be as a result of its decomposition being slow due to the quantity, releasing maximum additional nutrient for use by the plants as well and the tendency of it providing maximum soil cover therefore having better moisture conservation property. In general, the cover of mulch creates a favorable micro climate for the activities of soil microorganisms which helps in maintaining and improving the soil physio-chemical and biological qualities, thereby improving the performance of growth and resultantly in yield attributes and yield.

From the study, it was observed that the lower the Neem leaf mulch, the more the survival and establishment percentage at the first few weeks after transplanting. As the plants grow and near maturity, the percentage of the plants that survived decreased from the highest Neem Mulch Rates to the lowest. This could be because the higher mulch rates at the initial stage suffocated the plants but as they decayed, they began to release their nematicidal and fungicidal compounds that protected the plants from diseases. This result is in tandem with the report of Subapirya and Nagini (2005) which stated that neem has compounds with antiviral, anti-bacterial and anti-protozoal activities. The number of plants that survived through harvest was observed to be more on the higher Neem leaves mulch rates while 0.0kg/ha Neem Leaf Mulch rate recorded the least, this could be due to the soil conditioning property of the mulch and its ability to improve the water holding capacity of the soil, nutrient availability and aeration of the soil, which are soil properties that ensures plant survival. This was also the observation of Shiksha *et al*., (2023). The reduction in survival of unmulched plants through harvest reduced as a result of disease infection in the field. The two identified diseases in the field (Blossom end rot; a fungal disease and Gray mold disease; a fungal disaese) attacked the fruits at maturity; just before ripening. These diseases affected more of the plots that received least treatment and the ones without treatment, while the plots with higher treatments recorded close to no disease attack, this may be attributed to the most active insecticidal ingredients for effective control of blossom end rot, leaf spot and fruit spot of tomato (Brahmachari, 2004; Gajalakshmi and Abbasi, 2004).

Conclusions

The different rates of neem leaves used as mulch for the experiment revealed that Neem leaves influences the growth and yield qualities in Tomato production. The neem as mulch material conserved moisture and maintained temperature of the soil. The higher Neem leaf mulch rate was effective in the control of diseases of tomato in Awka.

The result of the experiment therefore shows that production of tomato in Awka is possible with great reduction of pests and disease attacks as well as better fruit yields, through the practice of mulching with neem leaves. We therefore recommend the use of neem mulch at the rate of 550 kg and 8338kg for the production of tomato in South-eastern Nigeria.

References

Ali, M. D., Yousuf, S., Abu, Ali, I., Khandker, S. Neesa, L. Tanvir, E. M.. Kabir, A. Khalil, M.D. and Gan, S. (2020). Nutritional Composition and Bioactive Compounds in Tomatoes and Their Impact on Human Health and Disease: *A Review. Foods*. 10(1):45. doi: 10.3390/foods10010045. PMID: 33375293; PMCID: PMC7823427.

Atlasbig, (2022). World's leading tomato producing countries. Available at https://www.atlasbig.com/en-gb/countries-by-tomato-production. *Retrieved on 13/07/2023*.

Awodoyin, R.O. and Ogunyemi, S. (2005) Use of sicklepod, *Senna obtusifolia* (L.) Irwin and Barneby, as mulch interplant in cayenne pepper, *Capsicum frutescens* L., production. *Emirate Journal Agricultural Science*, 17 (1): 10-22.

Brahmachari, G. (2004). Neem- an omnipotent plant: A retrospection. *Chemical Biochemistry* 5: 408-421.

Chukwudi, P. N., Emma, E. E., Ifeanyi, C. E. and Nwabueze, I. I. (2017). Analysis of trends in rainfall and water balance characteristics of Awka, *Nigeria Journal and Geography and Regional Planning*, 10 (7): 186-196.

Gajalakshmi, S. and Abbasi, S.A. (2004). Neem leaves as a source of fertilizer cum-pesticide vermicompost. *Bioresource Technology*, 92: 291-296

Górecka, D., Wawrzyniak, A., Jędrusek-Golińska, A., Dziedzic, K., Hamulka, J., Kowalczewski, P, and Walkowiak, J. (2020). Lycopene in tomatoes and tomato products. *Open Chemistry*. 18. 752–756. 10.1515/chem-2020-0050.

Hochmuth G, Chandler C, Stanley C, Legard D, Duval J, Waldo E, Cantliffe D, Bish E. (2001). Containerized transplants for establishing strawberry crops in Florida. *Horticultural Science*, 37:443-446.

Hudu, A.I., Futuless, K.N. and Gworgwor, N.A. (2002) Effects of mulching intensity on the growth and yield of irrigated tomato (*Lycopersicon esculentum Mill*.) and weed infestation in semi-arid zone of Nigeria. *Journal of Sustainable Agriculture*, 21:37-45.

Kuldeep, C., (2016) Effect of tree leaf mulch on Pearl Millet (*Pennisetum glaucum L*.) in Guava (P*sidium guajava L*.) based agri horti-system in Vindhyan region. http://krishikosh.egrant.ac.in/handle/1/90825. Accessed on 28th October, 2019.

Maphosa, M. and Ddamulira, G. (2020). Tomato breeding in Sub Saharan Africa-Challenges and opportunities: A review. *African Crop Science Journal*. 10.4314/acsj.v28i1.10.

Opara-Nadi, O.A. (1993) Effect of elephant grass and plastic mulch on soil properties and cowpea yield. In: Mulongoy, K. and Merckx. R. (eds.), *Soil Organic Matter Dynamics and Sustainability of Tropical Agriculture*. John Wiley & Sons, New York. P. 351-360

ReportLinker (2022). Nigeria Tomato Industry Outlook 2022 – 2026. https://www.reportlinker.com/clp/country/484797/726344. *Retrieved on 13/07/2023*

Tipu, M., Amin, M., Dhar, M. and Alam, M. (2014). Effects of Mulching on Yield and Quality of Tomato Varieties. *Journal of Agriculture Science and Technology* 3. 12-14. 10.37591/rrjoast.v3i3.1106.

Shiksha S., Bikas B., Keshav B., Amrita S., Kapil K. (2023). The influence of different mulching materials on Tomato's vegetative, reproductive, and yield in Dhankuta, Nepal. *Journal of Agriculture and Food Research*. 11,100463. https://doi.org/10.1016/j.jafr.2022.100463

Szabo K, Diaconeasa Z, Cătoi A. F, and Vodnar, D.C. (2019). Screening of tentomato varieties processing waste for bioactive components and their related antioxidant and antimicrobial activities. *Antioxidants* 8:292. doi: 10.3390/antiox8080292 Available at https://pubmed.ncbi.nlm.nih.gov/31398838/