

EFFECT OF SELECTED ORGANIC MULCHES ON GROWTH AND YIELD OF AMARANTHUS IN KILIFI COUNTY

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ABSTRACT

Amaranthus is an indigenous vegetable which acts as a source of nutrition and income within Kilifi County. Soil moisture stress due to unpredictable rains within the area is however, a major production constraint.. A study was carried out in Pwani University farm and Jaribuni secondary school farm to evaluate the effect of seaweed, neem leaves, cashew nut leaves and wood shaving mulches on growth and yield of amaranthus in Kilifi County. The experiment was laid down in randomized complete block design with three replications. The treatments included: seaweed, neem leaves, cashew nut leaves, wood shavings and control with no mulch. Data collected included: plant height, leaf length, leaf width, stem girth, number of branches, leaf number, chlorophyll content, leaf dry weight and days to 50% flowering. Neem leaves and seaweeds mulches increased leaf area by 30% and 46%, stem girth by 32% and 40%, number of branches by 41% and 61% respectively. Neem leaves and seaweeds mulch increased plant height by 70% and 76%, fresh weight by 25% and 35% and dry matter by 8.4% and 8.5%. The results demonstrate that the effects of mulches depend on the mulching material.

Keywords: Mulching, Amaranthus spp., soil physico-chemical properties, organic mulching, soil amendment.

1. INTRODUCTION

Amaranthus belongs to family *Amaranthaceae* and the genus Amaranthus is one of the oldest food crop in the world (Gigliola, 2012). It is a multipurpose crop whose leaves and grains are tasty and of high nutritional value, additionally it can be cultivated as an ornamental plant (Venskutonis and Kraujalis, 2013). Amaranth is a fast growing crop and because of its low production cost, it is one of the cheapest dark green vegetable in the tropical market and is often described as the poor man's vegetable. Unlike the other green vegetables, it is cultivated during dry season when no other green vegetables are available in the market (Singh and Whitehead, 1996). The amaranth can grow under varied soil and agroclimatic conditions (Katiyar et al., 2000; Shukla and Singh, 2000), and is also resistant to heat and drought with no major disease problems (Robert et al, 2008; Barrio and Anon, 2010). Besides its adaptable nature in various climatic conditions, the amaranth plant also has important nutritional and medicinal properties (Lakshmi and Vimala, 2000). According to Palada and Chang (2003) it grows best in loam or silty-loam soil with good water holding capacity although it can also grow on a wide range of soil type, soil moisture levels and soil pH. Amaranthus is one of the mostly produced vegetable for both commercial and consumption purposes in Kilifi County. And although it is grown by

many farmers across the County, production has remained relatively low (Chepkoech *et al.*, 2018). Erratic and unreliable rainfall in the County affects growth, establishment, flowering and seed development at different stages of crop growth and development (Ndiso, *et al.*, 2012). Mulching has been found to increase the availability of water and its content in soil by decreasing evaporative losses to alleviate harmful effects of drought (Awasthi, *et al.*, 2006). Surface mulching with natural organic material offers protection for plants against root borne diseases, in addition to moisture conservation, temperature amelioration and weed control (Kareem *et al.*, 2012). Organic mulches including sawdust, dry grass (lawn clippings), maize cobs, rice and wheat straw, water hyacinth etc., have been very effective for vegetable growth and yield by improving soil moisture content, heat energy, organic nitrogen, carbon and other minerals leading to improved soil nutrition (Saeed and Ahmad, 2009). Mulching has been used to obtain good vegetable growth and yield in crops like sweet potato, potato, tomato and pepper (Awodoyin and Ogunyemi, 2005; Rahman *et al.*, 2006). This study, therefore, compared the effect of four different types of organic mulches including; seaweed, wood shaving, Neem leaves and cashew nut leaves on growth and yield of amaranthus in Kilifi County.

2. MATERIALS AND METHODS

Study Site

The study was carried out in two different locations within Kilifi County. The first site was Pwani University farm, which is located at latitudes 3°S and 4°S and longitudes 39°E and 40°E while the second one was in Jaribuni latitudes 3°S and 4°S and longitudes 41°E and 42°E in Kauma location, Ganze Sub-county. Both sites experience low, erratic and unevenly distributed annual rainfall ranging from 500-1000 mm, 23-30°C temperature range and a mean relative humidity of 80% (Achiando *et al.*, 2013). The soils in Pwani University farm are ferralic and dystric cambisols while soils in Jaribuni are dystric nitisols (Jaetzold *et al.*, 2012).

Experimental Design and Crop Husbandry

The experiment was laid down in a randomized complete block design with three replications. The treatments included Neem leaves mulch, seaweed mulch; cashew nut leaves mulch, wood shavings mulch and control with no mulch. The amaranthus was planted at a spacing of 30 cm × 15 cm in plots of 2m × 3m making a total of 108 plants per plot, which was equivalent to 180,000 plants per hectare. Each block had 10 plots with a spacing of 0.5m between the plots making a block size of 6.5 m by 12 m. The distance between one block to the other was 1m, giving a total experimental area of 21.5 m by 12 m. Land was prepared by ploughing and harrowing. Amaranthus seeds were initially sown in nursery bed. The seedlings were transplanted after 3 weeks at a spacing of 30 by 15 cm. The mulching materials were applied immediately after transplanting. Drip irrigation was carried out to supplement the rainfall thrice per week in the evening hours, as recommended by Gulma *et al.* (2014). Weeds were uprooted fortnightly. Thunder broad spectrum pesticide was used to manage pests.

Data Collection

Soil chemical characteristics were determined at the beginning of the season before land preparation and after crop harvest. At the beginning of the season, soil samples were taken randomly from twenty points using soil auger at 30 cm soil depth in both sites. The samples

were thoroughly mixed and 1.0 kg composite sample for each planting site packed and taken to the laboratory for analysis. Five plants were tagged in the middle four (4) rows in each plot and used for collection of all agronomic data. Plant height was evaluated by measuring the height of the tagged plants from the ground level to the end of terminal bud using meter rule. Leaf area of the whole sampled plants was determined by measuring the individual leaf length and width. Stem girth of the tagged plants was measured using electronic digital vernier calliper. Number of branches was determined by counting the number of branches per plant while numbers of leaves was determined by counting the number of leaves per plant. All the data was collected on weekly basis. Chlorophyll content was determined on weekly basis on the tagged plants by use of SPAD meter. Economic yield was evaluated by determining the dry weight of amaranthus. Days to 50% flowering was determined by counting the number of plants which had flowered.

Data Analysis

All data obtained was subjected to analysis of variance using general linear model (GLM) SAS computer package. Means were separated using the least significant difference at 5% level of significance according to Steel and Torrie (1980).

3. RESULTS AND DISCUSSION

Effect of organic mulch on Amaranthus growth

In both sites, sea weeds treatment had the highest number of leaves with an increase of 61.9%, 68.8% while, neem leaves with an increase of 42.9% and 46.9% in site 1 and 2 respectively but was not significantly different from seaweeds. Neem leaves and sea weeds treatments had the highest number of branches with an increase of 59.1% and 40.9%; and 68.8% and 43.8% increase in site 1 and 2 respectively. Neem leaves and seaweeds mulches had higher increase in plant height, leaf area, stem girth, branch number, and leaf number, parameters of amaranthus in both sites. In both sites neem leaves and sea weeds treatments had the largest leaf area with a 31.6% and 30.4%, 45.7% and 43.5% increase in site 1 and 2 respectively. In both sites, neem leaves treatment had the tallest plant height with 69.7% and 76.0% in site 1 and 2 respectively and Sea weeds had a 43.5% and 47.6% in site 1 and 2 respectively increase in plant height but seaweeds was not significantly different from neem leaves in both sites. In both sites neem leaves and sea weeds treatments had the largest stem girth with a mean of 35.1%, 31.6%; and 39.5% and 34.9% in site 1 and 2 respectively. Cashew nut leaves treatment had an increase of 23.8% and 28.1% in site 1 and 2 respectively but was not significantly different from sea weeds. Cashew nut leaves and wood shavings had a leaf area of 8.9% increase in site 1 while in site 2 the increase was 13% both cashew nut and wood shavings.

Cashew nut leaves, wood shavings and the control treatments had the lowest number of branches. Cashew nut leaves treatment had a 31.3% and 34.2% respectively in site 1 and 2 increase in plant height but was not significantly different from sea weeds. Cashew nut leaves, and wood shavings had the lowest stem girth with a mean of 8.8%, 3.6%; and 9.3%, 4.6% in site 1 and 2 respectively but were not different from the control treatment. Cashew nut leaves, wood shavings and the control treatments had the lowest number of branches. These results are in agreement with Chitti, *et al.*, (2018) who reported the growth parameters of beet root was

significantly affected in all stages of crop growth with the application of organic manures. Majority of studies have indicated that crop production has benefited from the application of organic residues due to the possibility of recycling organic matter, N, P and K and other nutrients (Adeoye et al., 2008). A study by Tilander and Bonzi (1997) showed that the neem leaves, neem leaves + compost, wild grass and acacia phyllodes treatments all significantly influenced the soil by conserving water and reducing temperatures compared with the control. Neem seed cake contains more nitrogen (2–5%), phosphorus (0.5–1.0%), potassium (1–2%), calcium (0.5–3%) and magnesium (0.3–1.0%) than farmyard manure or sewage sludge (Radwanski and Wickens, 1981). Neem seed cake not only provides nutrition to the plant, but increases the population of earthworms and produces organic acids, which helps in the reduction of soil alkalinity (Korah and Shingte, 1968). This could be the reason for the increase in growth parameter for the treatment with neem leaves.

Seaweed extracts applied alone and combined with recommended rate of chemical fertilizer to *Capsicum annum* have a significant effect on increase of height and weight of shoot and root, number of leaves, number of buds, number of pods, length of pods and yield (Jayasinghe *et al.* 2016). According to Smith et al. (2001) organic mulches including sawdust, dry grass (lawn clippings), maize cobs, rice and wheat straw, water hyacinth etc., have been very effective for vegetable growth and yield by improving moisture content of soil, heat energy and add some of the organic nitrogen and other mineral to improve nutrient status of the soil (Saeed and Ahmad, 2009). Mulching has been used to obtain good vegetable growth and yield in crops like sweet potato, potato, tomato and pepper (Awodoyin and Ogunyemi, 2005; Rahman *et al.*, 2006). Iles and Dosmann (1999) indicated that the number of branches of red maple trees was improved remarkably when neem leaves and seaweed mulches attributed to enhanced soil temperature, moisture, and pH. Ferrini *et al.* (2008) also found that mulching with neem leaves and seaweeds significantly improved trunk diameter of ornamental trees. This was attributed to the increase in physiological activities due to improved soil physico-chemical properties. Holloway (1992) also found that five woody plant species grew better after sea weed mulch and neem leaf treatments than after other mulch treatments. The increase in leaf area could be attributed to the interaction between the increased soil water content and soil temperature. He also found that five woody plant species had more leaves following use of neem leaves and seaweeds as organic mulch, attributed to the high nutrient composition in the organic material which is released during decomposition.

Wood shaving mulch had higher increase in chlorophyll content and 50% days to flowering (Table 1). In both sites, Wood shavings treatments had the highest leaf chlorophyll content with a 90% and 98.6% increase in site 1 and 2 respectively. This was followed by neem leaves, cashew nut leaves and sea weeds which increased by 54.1%, 35.3%, 32.4% and 55.4%, 36.0% and 33.1% respectively in site 1 and 2 but were not significantly different from the control. In both sites, wood shaving had the highest number of days to 50% flowering with an increase of 155% and 158% in site 1 and 2 respectively. This was followed by sea weed, cashew nut leaves and neem leaves treatments with an increase of 122%, 105%, 98.8%; and 125%, 107.6%, 96.7% respectively for site 1 and 2. Control treatments had the lowest days to 50% flowering. Ndiso et al (2018) reported that mulching with organic materials increased soil moisture content and

groundcover, chlorophyll content, growth parameters, yield and yield components of maize plants. Organic materials increase soil fertility directly improving vegetative growth of crops (Scharenbroch and Lloyd, 2006). Mulching is an effective method of manipulating crop growing environment to increase yield and improve product quality by controlling weed growth, ameliorating soil temperature, conserving soil moisture, reducing soil erosion, improving soil structure and enhancing organic matter content (Awodoyin and Ogunyemi, 2005).

Effect of Organic Mulch on Amaranthus Yield Fresh weight of amaranthus was significantly affected by organic mulch. Neem leaves, cashew nut leaves and wood shavings had a higher increase in fresh weight in both Pwani and Jaribuni sites (Figure 1). Neem leaves with amaranthus had the highest fresh weight with a 35.2% increase in Pwani and 25.5% in Jaribuni. But not different from wood shavings with amaranthus (30.7%) and cashew nut leaves with amaranthus (30.7%) in site 1 and from wood shavings with amaranthus (21.3%) and cashew nut leaves with amaranthus (21.4%) in site 2. The lowest fresh weight content in both sites was obtained from control with amaranthus, which had no difference from sea weeds with amaranthus. Ferrini *et al.* (2008) found that mulching neem leaves significantly improved fresh weight of ornamental trees. Previous studies have also shown that organic materials increase soil organic matter by directly improving soil properties (Scharenbroch and Lloyd, 2006), increasing photosynthesis, and by having an impact on above ground C allocation (Scharenbroch, 2009).

Dry matter of amaranthus was significantly affected by organic mulch. Neem leaves, cashew nut leaves and wood shavings had a higher increase in dry matter in both sites. Neem leaves with amaranthus had the highest increase in dry matter by 8.4%, in site 1 and 8.6% in site 2 but not significantly different from wood shavings with amaranthus (4.9%) and cashew nut leaves with amaranthus (4.9%) in site 2. Sea weeds with amaranthus had the lowest dry matter content with a 2.4% reduction but had no difference with control treatment in site 1. While in site 2 neem leaves was not different from wood shavings with amaranthus and cashew nut leaves with amaranthus. This finding is consistent with that of Ferrini *et al.* (2008), who suggested that neem mulch increased crop yield by improving soil physico-chemical properties.

Table 1: Effect of organic mulch type on growth of amaranthus in Jaribuni and Pwani

| Site | Plant height (cm) | | Leaf area (cm ²) | | Stem girth (mm) | | Branch number (no./plant) | | Leaf number (no./plant) | | Chlorophyll content (CCI) | | 50% flowering (days) | |
|---------------------|-------------------|---------------|------------------------------|-------------|-----------------|-------------|---------------------------|-------------|-------------------------|--------------|---------------------------|--------------|----------------------|--------------|
| | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| Wood shavings | 38.4bc | 30.0bc | 8.6b | 5.2b | 5.9b | 4.5b | 2.5b | 1.8b | 4.8bc | 3.7bc | 35.2a | 29.1a | 28.9a | 23.8a |
| Neem leaves | 49.9a | 39.6a | 10.3a | 6.6a | 7.5a | 5.8a | 3.1a | 2.3a | 6.0ab | 4.7ab | 26.2b | 21.6b | 21.9b | 18.0b |
| Cashew nut leaves | 38.6bc | 30.2bc | 8.6b | 5.2b | 6.2b | 4.7b | 2.5b | 1.8b | 5.2bc | 4.1bc | 23.0b | 18.9b | 23.2b | 19.1b |
| Sea weeds | 42.2ab | 33.2ab | 10.4a | 6.7a | 7.7a | 6.0a | 3.5a | 2.7a | 6.8a | 5.4a | 22.5bc | 18.5bc | 25.1b | 20.7b |
| Control | 29.4c | 22.5c | 7.9b | 4.6b | 5.7b | 4.3b | 2.2b | 1.6b | 4.2c | 3.2c | 17.0c | 13.9c | 11.3c | 9.2c |
| Mean | 39.7 | 31.1 | 9.1 | 5.6 | 6.6 | 5.1 | 2.8 | 2.1 | 5.4 | 4.2 | 24.8 | 20.4 | 22.1 | 18.2 |
| P value | 0.0045 | 0.0032 | 0.0005 | 0.0004 | 0.0001 | 0.0001 | <0.0001 | <0.0001 | 0.0085 | 0.0003 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| LSD _{0.05} | 9.5728 | 6.2456 | 1.1631 | 0.2458 | 0.8601 | 0.3 | 0.4242 | 0.1 | 1.4395 | 0.9 | 5.754 | 4.5 | 3.5731 | 2.7 |
| CV (%) | 20.1 | 14.7 | 10.6 | 8.4 | 10.9 | 8.7 | 12.8 | 10.4 | 22.3 | 18.3 | 19.4 | 15.9 | 13.5 | 11.0 |

Site 1- Jaribuni and Site 2 – Pwani University

Means followed by the same letter are not significantly different according to LSD test (5%).

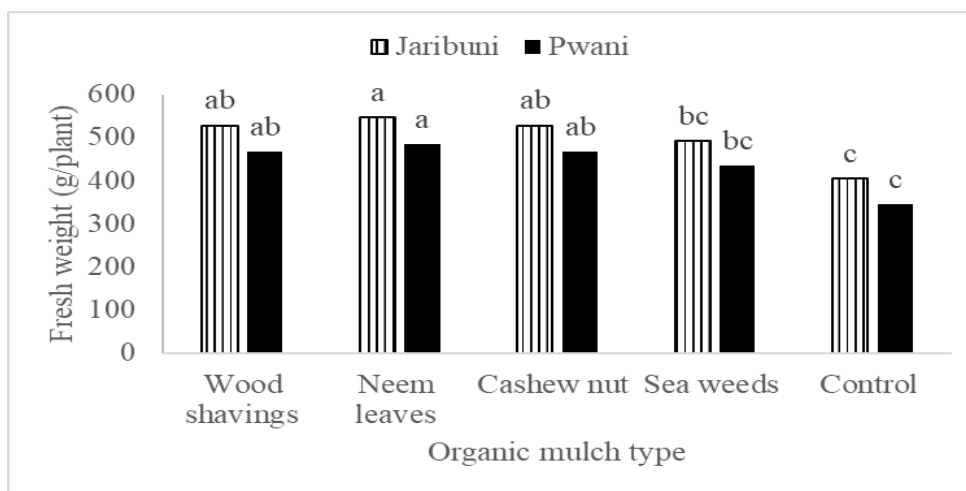


Figure 1: Effect of organic mulch on fresh weight during amaranthus production in Jaribuni and Pwani. Means followed by the same letter within a site are not significantly different according to LSD test (5%).

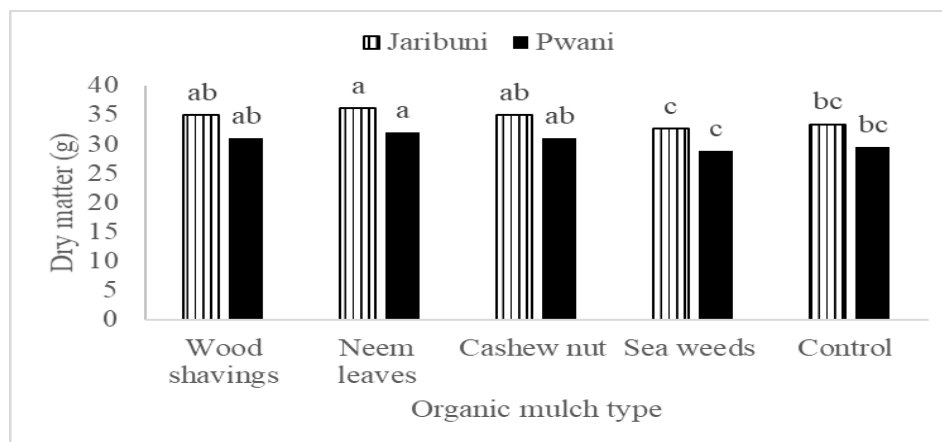


Figure 2: Effect of organic mulch on dry matter content during amaranthus production in Jaribuni and Pwani. Means followed by the same letter within a site are not significantly different according to LSD test (5%).

3. CONCLUSION

Neem leaves mulch can be used to increase morphological traits like plant height, leaf area, stem girth and number of branches, fresh weight and dry matter leading to improved growth and yield of amaranths. Seaweed mulches can also be used to increase leaf number, chlorophyll, leaf area, stem girth and number of branches which contribute to the growth of amaranths. A clear indication that effects of mulches depends on the mulching material. Organic mulches such as neem leaves, seaweeds and wood shavings can be used to enhance growth and yield of amaranthus in the region. Similar work should be done to determine the effect of these organic mulches on cereals such as maize and sorghum; and legumes such as cowpeas and green grams in the region. There is need to study other organic mulches to increase the variety of organic mulches so that farmers can have variety of mulches to use depending on circumstances.

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