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The Effect of Plastic Mulch on Growth and Yield of Rain-fed Cowpea and Watermelon in North Kordofan State of Sudan

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Abstract A research was carried to identify the effect of plastic mulch on growth and yield of water melon (*citrullus lanatus*) and cowpea ((*Vigna unguiculata* L.Walp).), two popular crops extensively grown in Western Sudan under rain-fed condition. The experiment was conducted during rainy seasons (2014/15-2016/16) at two locations in North Kordofan of Sudan, consisted of two treatments (covered or uncovered with thin plastic sheet) laid out in a Randomized Complete Block Design (RCBD) with four replications. Plastic sheet mulching significantly increased plant height, fruit weight, fruit number and seed yield of watermelon by 30%, 70%, 17%, and 65%, respectively. In cowpea plastic sheet mulching significantly increased number of pods per plant, grain yield and 100- seed weight by 17%, 30% and 10% respectively. It can be concluded that using plastic mulch as a soil cover increased the vegetative growth and yield of watermelon and cowpea crops under marginal sandy rain-fed conditions of North Kordofan State.

Keywords: *mulching, Vigna unguiculata, citrullus lanatus, sheikan locality*

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1. Introduction

Drought events in Sudan have become more recurrent in recent decades during early to mid-1970s, mid-1980s, early 1990s and 2000s [1]. Due to the dependence on rain fall and soil moisture reserves during various stages of crop growth, agriculture and natural vegetation cover is often the first sector to be affected by drought [2]. Limitation of water resources is a cause of decreasing crop production in agricultural systems especially in arid and semiarid regions. Surface-applied mulches reduce soil water erosion, thus enhancing the potential for increasing water conservation, which is highly important for improving dry land crop production in a semi-arid region [3]. Comparative study of alternative mulching techniques indicated that clear mulches could prevent soil evaporation and increase soil surface temperature [4]. The surface energy balance of plastic mulch and its influence on the crop environment are determined by the optical properties of the plastic [5]. Reduced evaporation, which is a factor contributing to cooling, and higher microbial activity under plastic mulch were reported as factors adding to soil temperature [6]; Tarara 2000). Plastic mulching has become a valuable technique for increasing grain production in areas characterized by low air temperature and rainfall. Most crop producing areas in Sudan lie in the rain-fed areas where rainfall is either characterized by long intermittent periods of drought episodes (sabnas) or short rainy seasons. This situation emphasizes the need for using short maturing varieties and agronomic practices as adaptive mechanisms for sustainable crop production. Cowpea (Vigna unguiculta L.) is one of the important food and cash crops in Sudan. Usually it is grown as a sole crop or in intercropping in limited areas [23]. Cowpea is an important grain legumes in drier regions and marginal areas of the tropics and Sub-tropics [24]. The grain is a good source of human protein, while the haulms are valuable source of lives stock protein. The use of cowpea in Kordofan of Sudan is diversified [25]. The seed can be boiled with water and eaten as "a Ballila." They can also be cooked with meat, tomatoes and onions into 'a thick soup' eaten with pancake and fried or bread. The paste from soaked seeds can be eaten with oil as small dough nuts "Taammia," which can be eaten alone or with bread Cowpea can be used at all stages of growth as a vegetable crop [24]. The tender 'green leaves' are an important food source in Africa. Green cowpea seeds are boiled as a fresh vegetable and may be canned or frozen. Cowpea now is a broadly adapted and highly variable crop that is useful as a rotational cover crop to control erosion and to improve soil fertility It also used to intercrop with other field crops such as cereals . Highly efficient of nitrogen fixation it increased the soil fertility by 20 kg / ha. Watermelon is grown throughout the world for human

food; it is consumed as a dessert fruit, as a source of drinking water or for its edible seeds. It is also used as animal feed in some areas. Although watermelon is primarily eaten fresh, it is also eaten as cooked vegetable in Africa. In Russia, watermelon is eaten after being pickled or used for production of syrup by boiling the sugary flesh. In Sudan and Egypt the seeds are roasted, salted and eaten. Another use of watermelon is the use of the fruits as a source of drinking water during drought seasons, which is a well-known use in parts of Sudan and Nigeria. The Western part of Sudan is an important region for the diversity of watermelon where different cultivars and uses are known, especially in the Kordofan region. The objective of this study is to determine the effect of plastic mulch on yield and its attributes in Cowpea (Vigna unguiculata L.Walp) and Water melon (Citrullus l*anatus*).

2. Materials and Methods

Field experiments were conducted at two locations (Faris and Eldomokia, Sheikan locality, in North Kordofan State during 2014-2016 rainy seasons. These locations were chosen to represent southern and eastern areas of the locality. The experiments were conducted on sandy soil. The average rainfall was 387 and 356.4 mm in the first and second season respectively in Faris and in Eldomokia 178.9 and 163.5 mm for first and second season. The two crop varieties Ein elgazal (cowpea), and Chashier improved (watermelon) and the two treatments (covered or uncovered with thin plastic sheet) were arranged in a Randomized Complete Block Design (RCBD) with four replications. Plot size was 5m×3m and sowing was carried out on flat. Spacing was 2 mx 1 m for water melon and 50 cm x 30 cm for cowpea. For cowpea, a recommended NPK (15:15:15) fertilizer micro-dose of 0.6 grams/hole was applied with the seeds at planting.

Planting was done on 15th of July after sufficient rainfall moisture availability in the soil was attained. First weeding and thinning to two plants per hole were carried out after two weeks from planting. The second weeding was done after a month from the first one

The collected data:-

Soil moisture content was measured at three soil depth during dry spells using gravimetric method [8]. Gravimetric moisture content (g g^{-1}) of the soil samples was calculated on oven dry weight basis, then converted into volumetric moisture content (cm3 cm-3) expressed as profile water Content at 0-10-20-30 cm soil depths.

Parameters measured for water melon included plant height (cm) which was measured from ground surface to the tip of the main stem for a random sample of five plants per plot, days to 50% flowering as the number of days from sowing to the time when 50 percent of the plants within the plot bear at least one flower each, total fruit number per plot (nu), total fruit weight (yield per unit area (kg), total dry seeds weight (g), total fresh seeds weight (kg), and 100- seeds weight (g) which was determined by weighing a sample of 100- seeds from each plot.

Parameters measured for cowpea included plant height (cm) which was measured from ground surface to the tip of the main stem for a random sample of five plants per plot. , days to 50%flowering calculated as the number of days from sowing to the time when 50 percent of the plants within the plot bear at least one flower each, number of pods per plant (nu calculated by counting the pods from random five plants taken from each plot, pod height (cm), number of seeds per pod determined by counting the seeds of pods of five random plants taken from each plot, 100 – seeds weight (g) which was determined weighing 100-seeds from each plot, and seed yield (kg determined by weighing the seed yield of each plot.

All the recorded data were compiled and analyzed using MSTAT-C package. Single and combined analysis of variance for each location, as described by Gomez and Gomez [7] for the Randomized Complete Block Design.

3. Results and Discussion

The non-mulched plots had lower soil moisture content than clear plastic mulched. Higher soil moisture content was observed during dry spells (sabnas) when rains stopped about one week or ten days in plots covered with clear plastic mulch as compared to non-mulched plots (bare soil). In the first season in (faris) soil moisture retained 34.43% in case of mulching and 22.97% in case of no mulching and 19. 63% in case of mulching and 11. 70% in case of no mulching in second season. In Aldomokia differences were significant in soil moisture retention of 29.46% of mulching and 21.70% of no mulching in first season and 22.9% of mulching and 16.84% in no mulching in second season. The better performance of parameters under plastic mulching treatment for the studied crops might be due to sufficient soil moisture Content at 5% level (SMC) is greatly retained under the clear plastic mulch. Tolk, *et al* [9] and Liu *et al* [10] concluded that mulching increases soil moisture and nutrients availability to plant roots, in turn, leading to higher grain yield.

The Cowpea results (Figure 1) indicated that plant height, number of pods per plant and seed yield (Figure 2) were significant (p= 5% level). Similar responses were reported by Opara [16] and Polthanee [17] on cowpea.

This ensures better plant growth as expressed in vigorous plant growth during early and mid-season. Also, it might have positive effect on seedling emergence and flowering. The results of the present study agreed with the finding of Abdul-Baki and Spence [18], Igbal *et al*. [19], Wang *et al*. [20], Rashidi *et al*. [21] and Parmar *et al*. [22] who indicated that plants under polyethylene mulch produce larger fruit and have higher fruit yield per plant because of the better plant growth due to favorable hydro-thermal regime of soil and complete weed free environment. Furthermore, they mentioned that the extended retention of moisture and availability of moisture also lead to a higher uptake of nutrient for proper growth and development of plants. In water melon, significant differences were observed between mulching treatments (figure. 3) for the studied traits (Figure 4) except plant length, number of fruits per plot, fruit weight and seed yield (Figure 5). The increase in growth parameters was attributed to sufficient soil moisture near root zone and minimized evaporation loss due to mulching. Similar findings have also been obtained by Dean Ban et al. [11], Ansary and Roy [12] in wateremelon, Al-Majali and

Kasrawi [13] in muskmelon, Hallidri [14] in cucumber, Alemayehu-Ambaye and Joseph [15] in melon.

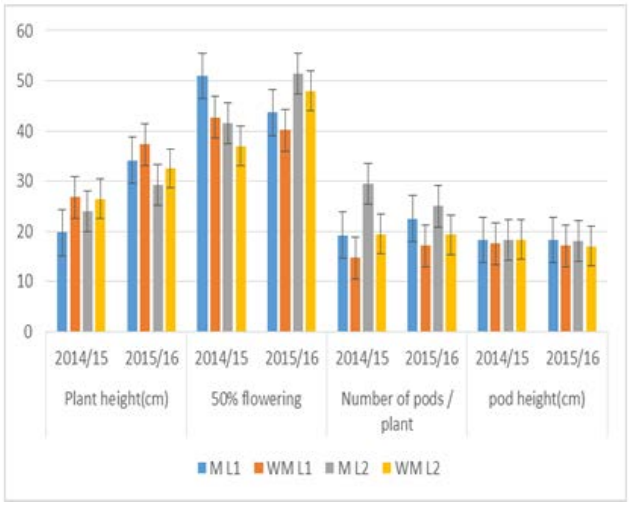

Figure 1. Effect of mulching on the plant height, 50%flowering, number of pods per plant and pod height of Cowpea grown during 2014/15 and 2015/16 rainy season

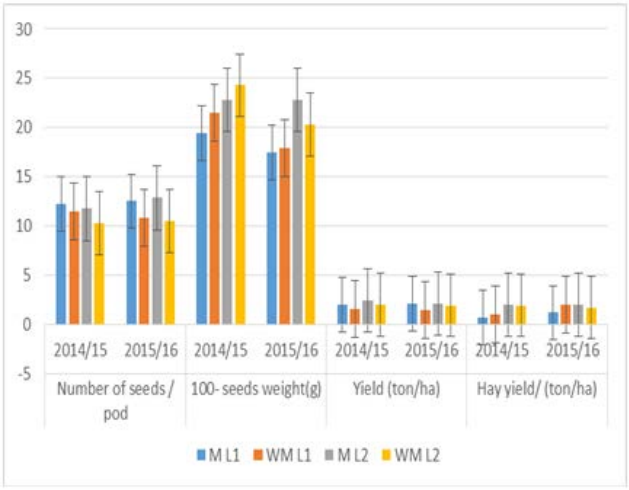

Figure 2. Effect of mulching on number of seeds per pod, 100-seed weight, seed yield (ton/ha) and hay yield (ton/ha) of Cowpea grown during 2014/15 and 2015/16 rainy season

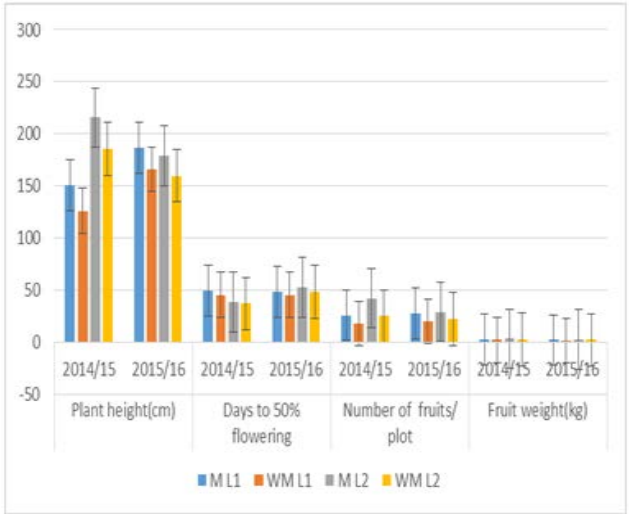

Figure 3. Effect of mulching on plant height, 50%flowering, number of fruits per plot and fruit weight of Watermelon grown during 2014/15 and 2015/16 rainy season

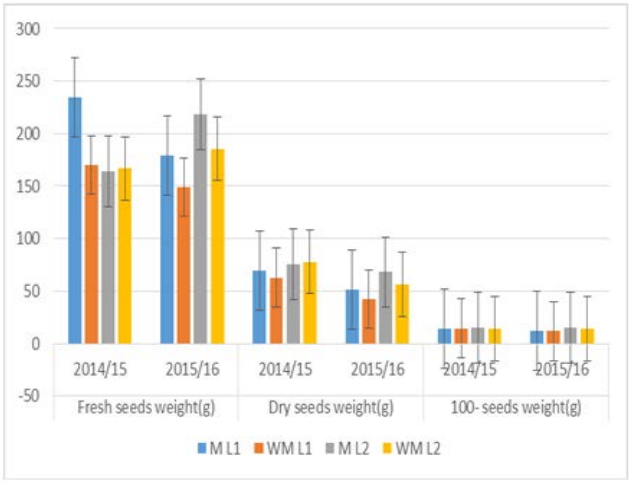

Figure 4. Effect of mulching on fresh seeds weight, dry seeds weight and 100- seeds weight of Watermelon growing during 2014/15 and 2015/16 rainy season

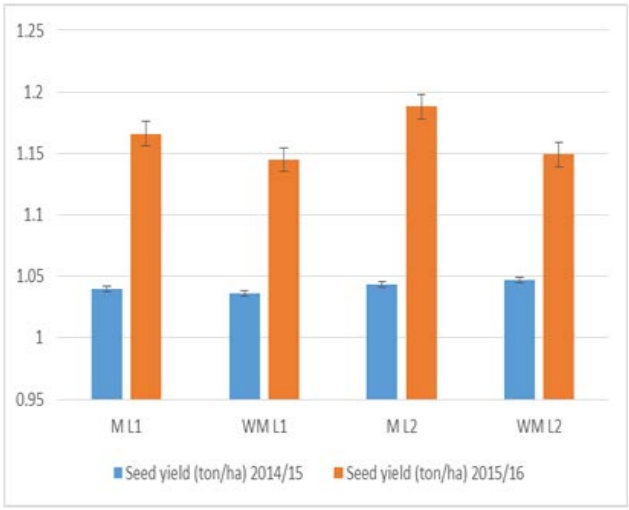

Figure 5. Effect of mulching on seed yield (ton/ha) of Watermelon growing during 2014/15 and 2015/16 rainy season

4. Conclusion

The results indicated that using plastic mulch as a soil cover increased the vegetative growth and yield of watermelon and cowpea crops under marginal sandy rain-fed conditions of North Kordofan State (Sudan). So as a result plastic mulching in watermelon and cowpea crops is recommended for similar conditions and environment with this study.

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