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Rice the staple food for more than half of the world's population and is now a commodity of strategic 8 significance driven by changing food preference in the urban and rural areas and compounded by 9 increase urbanization (Khalil et al., 2009). Water deficit has been described as the single 10 physiological and ecological factor upon which plant growth and development depends more heavily 11 than other factors (Kramer and Boyer, 1995).

A study was conducted to evaluate the effect of 12 moisture stress during the vegetative growth phase in local grown rice landraces in North Eastern 13 Nigeria. Seeds of two different local varieties namely BG doguwa, Mai-zazzabi and NERICA as 14 control were obtained from local farmers as they are the widely grown varieties in the region. There 15 were three treatments of irrigating once in a day (control), irrigating after every two days (mild) and 16 after six days (severe), respectively.

The objectives are to determine whether moisture stress has 17 effect on the growth of two local rice landraces and to determine whether moisture stress has effect 18 on the biomass of the local rice landraces. Data collection was done on the following parameters; 19 plant height, number of leaves, root length, stem diameter, and shoot biomass weight.

The present 20 study has shown that water deficit leads to a reduction in plant growth and biomass accumulation. In 21 terms of plant growth Mai-zazzabi is the most tolerant among the two varieties and is able to 22 accumulate higher biomass under soil moisture deficit condition. Rice farming is considered as one of the world's most sustainable and productive cropping system, as 26 it is adapted to wide range of environment ranging from tropical low lands to mountains and from 27 deep water

swamp to uplands.

In general, rice crop is semi aquatic and can thrive well in waterlogged soil and hence its production system relies on ample water supply. Based on the availability of water, rice can be grown in different ecological conditions such as low land rainfed, low land irrigated, deep water and upland (Hafeez et al., 2007).

In global scenario, irrigated rice is considered as productive farming system and has accounted for 55 % of total harvested area with a contribution of 75 % of total productivity. Further, annual productivity of irrigated rice is estimated to be 5 % more than that of rainfed rice (Fairhurt & Dobermann, 2002). Meanwhile, resource for irrigation has declined gradually over the past decades due to rapid urbanization and industrialization which exacerbates the problem of water scarcity (Gleick et al., 2002).

Current rice production systems rely on ample supply of water and it is estimated that on average rice require 1900 liters of water to produce 1kg of grain (FAOSTAT, 2013). Water deficit has been described as the single physiological and ecological factor upon which plant growth and development depends more heavily than other factors (Kramer and Boyer, 1995). Any shortage in water supply in relation to the requirement of plants results in water deficit hence plant become stressed.

It has been established that water deficit is a very important limiting factor at the initial phase of plant growth and establishment. It affects both elongation and expansion growth (Anjum et al., 2003). Water stress causes deceleration of cell enlargement and thus reduces stem lengths by inhibiting inter nodal elongation and also checks the tillering capacity of plants.

Different developmental stages of rice such as tillering phase, panicle initiation and heading are known to respond differently to moisture stress (Botwright Acuna et al., 2008; Kamoshita et al., 2004), however, factors such as timing, intensity and duration of stress have detrimental effect on plant growth. Liu et al., (2006) reported that reproductive stage, especially during flowering, is more vulnerable to stress and cause spikelet sterility.

Rice requires ample water to grow; rainless days for a week in upland rice growing areas and for about two weeks in shallow lowland rice growing areas can significantly reduce rice yields. Average yield reduction in rain fed, drought prone areas have ranged from 17 – 40 % insecure drought years leading to production losses and food scarcity.

With the onset of climate change, the intensity of 54 frequency of droughts, water scarcity affects more than 23 million hectares of rain fed rice production 55 area in South and South West Asia (IPCC, 2007). In Africa, recurring drought affects nearly 80 % of 56 the potential 20 million hectares of rain fed lowland rice (IFPRI, 2010).

Increasing crop tolerance to 57 water scarcity would be the most economic approach to improve the productivity and to minimize 58 agricultural use of fresh water resource. Recent studies have shown that plants have evolved various 59 morphological, physiological, biochemical and molecular mechanisms to cope up with adverse 60 climatic effect. To fulfill this objective, a deeper understanding of the possible mechanisms under 61 water stress environment is a must.

62 Though rice is affected by some environmental conditions such as Temperature, Moisture, pH., Soil 63 type etc. rice plant has shown to develop some mechanism to overcome or escape those unfavorable 64 conditions. And that's the reason why it is important to study and find out the effect of moisture on the 65 growth of such local landraces of rice.

The study was carried out at Federal College of Horticulture, Dadin Kowa nursery site situated in the 69 field. The College is situated at Dadin Kowa along Gombe to Biu/Maiduguri road in Yamaltu Deba 70 Local Government Area of Gombe State. Dadin Kowa is about 35 kilometers away from Gombe and is located in the Sudan Savannah ecological zone of Nigeria, on latitude 1000 180E, longitude 1100 71 72 310N, and on an altitude of 218 meters above sea level.

The plant was grown on a well-established 73 bed where light, CO₂ concentration and temperature conditions were controlled. Seeds of two 74 different local varieties namely BG doguwa, Mai-zazzabi and NERICA as control were obtained from 75 local farmers as they are the widely grown varieties in the region.

The soil was dug from the College 76 nursery site field, three beds of two by two meters were established with two replicate and watered to 77 field capacity for three days, and the seeds were soaked for a day prior to planting to facilitate 78 germination. Five hills of each variety with 4 seeds per hill were sown. The treatments were; irrigating 79 once in a day (control), after every two days (mild), and after six days (severe), respectively.

For the 80 first three weeks the plants were subjected to daily irrigation with the same amount of water per bed. 81 The beds were kept weed free by handpicking the weeds and also weeding with hoe. Plant height (cm): Measurement commenced twenty (21) days after planting and subsequent 84 measurements were taken after every 7 days.

85 Number of leaves: This was done by counting the number of leaves on each individual plant. 86 Stem diameter (cm): The stem diameter was measured using a thread which is tied to the stem of 87 the plant and then placed on a meter rule to take the measurement. 88 Wet shoot weight (kg): This was determined immediately after harvesting using an electronic 89 weighing balance.

90 Dry shoot biomass weight (kg): The shoots were harvested and then placed in paper bags and dried at 80091 C to constant weight in an oven, the shoots were then weighed. 92 Root length (cm): The plants were uprooted and soaked in water to wash off soil particles. The 93 length of the root was determined by using a meter rule. Measurements were taken from the stem 94 base to the longest root tip of the tap root.

95 Dry root biomass weight (kg): The roots were harvested and then placed in paper bags and dried at 80096 C to constant weight in an oven, the roots were then weighed. Data collected were subjected to analysis of variance (ANOVA) using 100 Minitab(c) V. 17 (State College PA) 101 variety mean were separated using the Turkey Pairwise Comparisons.

102 Results presented are from the fifth week after germination as 103 were observed before then on all parameters measured. 104 There was a general decline in plant height with increasing water deficit (figure 1). There was a 105 significant difference ($P=0.05$) in plant height among the watering regimes in W6 and W7 but not in 106 W8 and the first and third regimes has the tallest plants (107 the plant has developed tolerant mechanism and that's why the growth in height continued.

The 108 reduction in plant height with increased water deficit was more pronounced in BG doguwa and 109 NERICA as shown in (figure 1). Root length noticeably reduced with increased water deficit (figure 3) 152 recorded higher root lengths than plants of treatment 2 153 stress) respectively. The more pronounced reduction occurred 154 reduction in the stem diameter and biomass (kg) with the increase in water deficit (figure 3).

Plants 155 that were watered daily (Control) had higher stem diameters(cm) and biomass(kg) accumulation than 156 plants of the other watering regimes. The general reduction in plant height with increase in water deficit (Figure-1) in rice agrees with 171 results of Siddique et al. (2000) in wheat. Growth involves both cell growth and development which is 172 a process consisting of cell division, cell enlargement and differentiation and these processes are very 173 sensitive to water deficit because of their dependence upon turgor (Jones and Lazenby, 1988).

The 174 inhibition of cell expansion is usually followed closely by a reduction in cell wall synthesis (Salisbury 175 and Ross, 1992). This may have affected plant height of the rice. This study has shown that Mai 176 zazzabi were generally taller than BG doguwa and Nerica at severe moisture deficit conditions.

This 177 implies that Mai zazzabi can withstand higher levels of dehydration. In terms of plant height, Mai 178 zazzabi is the most tolerant variety among the three varieties. The number of leaves decrease with 179 increase in water deficit (figure 2).

Water deficit might, inhibit photosynthesis and produce less 180 assimilates which resulted in lower number of leaves this result agrees with the work of Hossain 181 (2001). The shoot plant dry weights decreased with increased water deficit. Similar results were 182 obtained by Willumsen (1993). The reduction in shoot dry weight could be associated with reduced 183 rate of leaf production hence low number of leaves.

Reduction in leaf growth may also have been 184 contributed by lower rates of cell division and cell extension in the leaves. Reduction in leaf growth 185 leads to less photosynthesis hence retarded overall plant growth as the resources required for growth 186 processes become limited in supply (Mwai, 2002). Plants show increased root: shoot ratio during soil 187 moisture deficit (Boyer, 1985).

Similar results have also been obtained in mango rootstock seedlings 188 (Luvaha, 2005). The differential sensitivity of roots and shoots (with root growth being less sensitive to 189 water deficits) leads to large increases in the root to shoot ratio in drought (Sharp and Davies, 1985).

190 This may be an adaptation of Mai zazzabi rice varieties for survival under drought conditions since 191 increased root surface area allows more water to be absorbed from the soil. A reduction in shoot 192 growth coupled with continued root growth would result in an improved plant water status under 193 extreme water deficit conditions.

In maize seedlings, root growth continues at very low water 194 potentials which are completely inhibitory to shoot growth (Boyer, 1985). The three varieties may 195 possess mechanisms of biomass accumulation under moisture deficit conditions. In this study Mai 196 zazzabi exhibits superior tolerance to water deficit in terms of biomass accumulation.

Whole plant dry 197 weight significantly declined with moisture deficit. This finding is in agreement with the results 198 reported by Emmam et al. (2010). Water deficit may

have influenced the height and leaf area per 199 plant which ultimately influenced the shoot dry matter of plants. A reduction of photosynthetic surface 200 by water deficit decreases the ability of plant to produce dry matter.

The present study has shown that water deficit leads to a reduction in plant growth and biomass 203 accumulation. In terms of plant growth Mai zazzabi is the most tolerant among the three varieties and 204 is able to accumulate higher biomass under soil moisture deficit conditions. Mai zazzabi can be suggested to farmers as the variety which is more tolerant to 205 moisture stresses 206 especially those in the northern part of the country where there is low annual rainfall.

And also 207 recommend that more research should be carried out on rice so as to come up with improve variety 208 that will be more tolerant to other environmental conditions not necessarily moisture so as to increase 209 productivity and yield to meet up with the increasing population growth and demand worldwide.

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