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SCREENING OF SOME EGYPTIANS BARLEY CULTIVARS FOR SPROUTED GREEN FODDER YIELD UNDER HYDROPONIC SYSTEM

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Abstract-Hydroponic fodder production is a technique for germinate seeds to sprout in free environment without chemicals (fertilizer, insecticides or fungicides) for a short growth period, the hydroponic green fodder should produced from seeds have high germination rate. Standard germination parameter of fifteen barley cultivars i.e. (Giza123,Giza124, Giza125,Giza126, Giza127, Giza 128, Giza 129, Giza130, Giza 131, Giza 132, Giza133, Gia134, Giza135, Giza136 and Giza 2000) were recorded comparing its ability for green fodder production. Significant differences among barley cv for standard germination, seedlings vigor traits and green fodder production. Barley cv Giza 136 and Giza 132 surpassed other cv for standard germination, germination rate and green fodder production. Positive and significant correlations coefficient were recorded between green fodder yield and germination %, germination index, seedling seedlings fresh weight, seedling/seed ratio, seedling length. Simple linear regression revealed that germination %, germination index and seedlings fresh weight as significantly contributing variables to variation in green fodder yield. These findings revealed that Giza 136 and Giza 132 barley cv can be considered the best choice for production of hydroponic green fodder compared with other cv.

Key words: Barley, cultivars, sprouted, green fodder, hydroponic.

1. INTRODUCTION

Irrigated agriculture is considered the most consumer of fresh water in many parts of the world, particularly in relatively arid and semiarid regions like Egypt. Reducing agricultural water use with maintaining or improving economic productivity of the agricultural sector is a major challenge. So, new technologies that can improve water use efficiency as hydroponic technique. It has been reported that hydroponic fodder production requires only about 2-3% of that water used under field conditions to produce the same amount of fodder (Al-Karaki and Al-Momani, 2011). Barley grains, which will be used for green fodder production must be of high germination percentage, seed and seedlings vigor traits. Where hydroponic sprouted fodder is produced from grains that are germinated and grown for short period of time inside special growing rooms, provided with the appropriate growing conditions (Sneath and McIntosh, 2003). A desirable nutritional changes may be occurred during sprouting period that were mainly due to the breakdown of complex compounds into a more simple form, transformation into essential constituents and breakdown transformation into essential constituents and breakdown of nutritionally undesirable constituents, sprouting of grains affected the enzyme activity, increased total protein and changes in amino acid profile, increased sugars, crude fiber, certain vitamins and minerals (Dung *et al*., 2010). Sprouting increases in the content of the amino acid Lysine by hydrolysis of prolamins and the liberated amino acids such as glutamic and proline, which are converted to limiting amino acids such as Lysine, also sprouting improves protein quality by conversion the protein into albumins and globulins (Chavan and Kadam ,1989).

The concept of putting one kilogram of grain into a hydroponic system and producing 6 to 10 kilograms fresh green sprouts, independent of weather and at any time of year (Kruglyakov, 1989). Moreover, the period between starting the production and green forage harvesting was about one week where a carpet is obtained made up with germinated seeds, their interweaved white roots and the green shoots (Pandey *et al*., 1991). It has been reported that about 1.5-2 liters of water are needed to produce 1 Kg of green fodder hydroponically in comparison to 160 liters to produce 1 Kg of green fodder of alfalfa under field conditions (Al-Karaki, 2010). Al-Hashimi, 2008 compared five forage crops (alfalfa, barley, cowpea, sorghum and wheat) for green fodder production , barley was one of the crops, which gave high fodder yield and used water efficiently, hydroponic fodder was superior to field grown forages in respect to contents of crude protein, N, P, Mg, and Zn. Gebremedhin, 2015 concluded that feeding of hydroponically grown maize and barley fodder for growing goats increased the total DM intake, feed conversion efficiency, body weight gain and economically valid. Barley cv might differ than others in the forage productivity under hydroponic conditions. Therefore, the objective of this study was to evaluate the potential of some Egyptian barley cv for green fodder production under hydroponic conditions and compare the relation between barley grain germination parameters and green fodder production.

2. MATERIALS AND METHODS

This Study was carried out at the Laboratory of Seed Technology Research Unit, Mansoura, Egypt, in 2015 season, two times to evaluate fifteen Egyptian barley cv for production sprouted fodder under hydroponic system. Barley cv were Giza123, Giza124, Giza125, Giza126, Giza127, Giza128, Giza129, Giza130, Giza131, Giza132,Giza133,Gia134,Giza135,Giza136 and Giza 2000 and they were obtained from Barley Research Department, Field Crops Research Institute. Barley seed were immersed in 5 % NaOCl (sodium hypochloride solution) for 5 min. to avoid fungal invasion.

Germination tests were performed according to ISTA, 1999, while 400 seeds from each cv were sown in four replicates at 20º C±2 in sterilized Perti dishes (15 × 1.5 cm) covered at the bottom with two sheets of Whatman filter paper that had been autoclaved and germination parameters were performed daily to study the following characters:-

- 1-Germination percentage: It was defined as the total number of normal seedlings at the end of the test after seven days.
- 2- Germination rate: It was defined according to Bartlett, (1937).
- 3- Germination index (GI): It was calculated as described in the Association of Official Seed Analysis (AOSA, 1983).
- 4 Seedlings fresh weight (gm).Ten normal seedlings from each replicate were selected randomly and weighted (g).
- 5- Seedling length (cm): It was measured for ten normal seedlings at the end of the test.
- 6- Seedlings dry weight (gm): Selected ten normal seedlings were dried in hot-air oven at 85^{o} C for 12 hours to obtain the seedlings dry weight (g), according to Krishnasamy and Seshu 1990.
- 7-Seedling/seed ratio. It was calculated by dividing ten wet seedling weight on ten dry barley seed weight.

2.1 Green Fodder Production

Steel trays with dimensions (30 cm × 40 cm × 4 cm) were used for growing barley seeds to produce green fodder. These trays were obtained from the local market. Seeds of all barley cv were cleaned from dust and any inert materials, then sterilized by sodium hypochloride 5%, for 5 minutes, then it washed well before soaking in tap water overnight before planting. The seeding rate was about 480 g / tray (equivalent to about 4.0 Kg/ m^2) according to **Al Hashmi, 2008.** Seeds were spread on trays, trays were stacked on shelves of the germinator. Temperature inside the germinator was 20°C and the relative humidity adjusted about 70%. Trays were irrigated twice a day.

These traits were recorded after 7 days as follows.

- Dry matter % : First ,dry matter weight was calculated as mentioned in seedlings dry weight (g) character. Then, dry matter % was calculated by dividing dry matter weight on green fodder yield weight multiple by 100.
- Green fodder yield (Kg/m^2). The trays contained green fodder was removed. Total fresh and dry fodder yields as well as yield/seed ratio were estimated after 7 days.
- Yield/seed ratio: It was calculated by dividing green fodder yield (Kg/m^2) on barley seed rate / m^2.

All obtained data were subjected to the statistical analysis according to the technique of analysis of variance (ANOVA) of completely randomized design, as described by Gomez and Gomez, 1984. The results of green fodder yield (Kg/m^2) and germination characters under study were subjected to simple correlation and simple linear regression analysis techniques (Draper and Smith, 1966)

RESULTS

Germination %, germination index and seedlings fresh weight (g) of barley cv under study are presented in Fig 1. Significant differences among tested barley cv were found in germination %, germination index and seedlings fresh weight (g). Giza 136 cv was superior compared with other cv under study, which recorded the highest values of these parameters. Giza 132 cv came in the second rank without significant differences with Giza 136 cv in germination % , germination index and germination rate parameters. While, the lowest values of same parameters were obtained by Giza 123 ,Giza 125, Giza 126 and Giza 133 barley cv.

Results in Fig. 2 showed significant differences among barley cv under study in seedling length (cm), seedlings dry weight (g) and seedling/seed ratio parameters. The tallest length and heaviest seedlings dry weight of seedling were obtained with Giza 136 barley cv and it was followed by Giza 132 cv without any significant differences between them. On contrast, the shortest seedling length and slight seedlings dry weight were obtained with Giza 123 and Giza 2000 cv without any significant differences between them in seedling length parameters. The highest seedling/seed ratio was obtained with Giza 129,Giza 135 and Giza 136 barley cv.

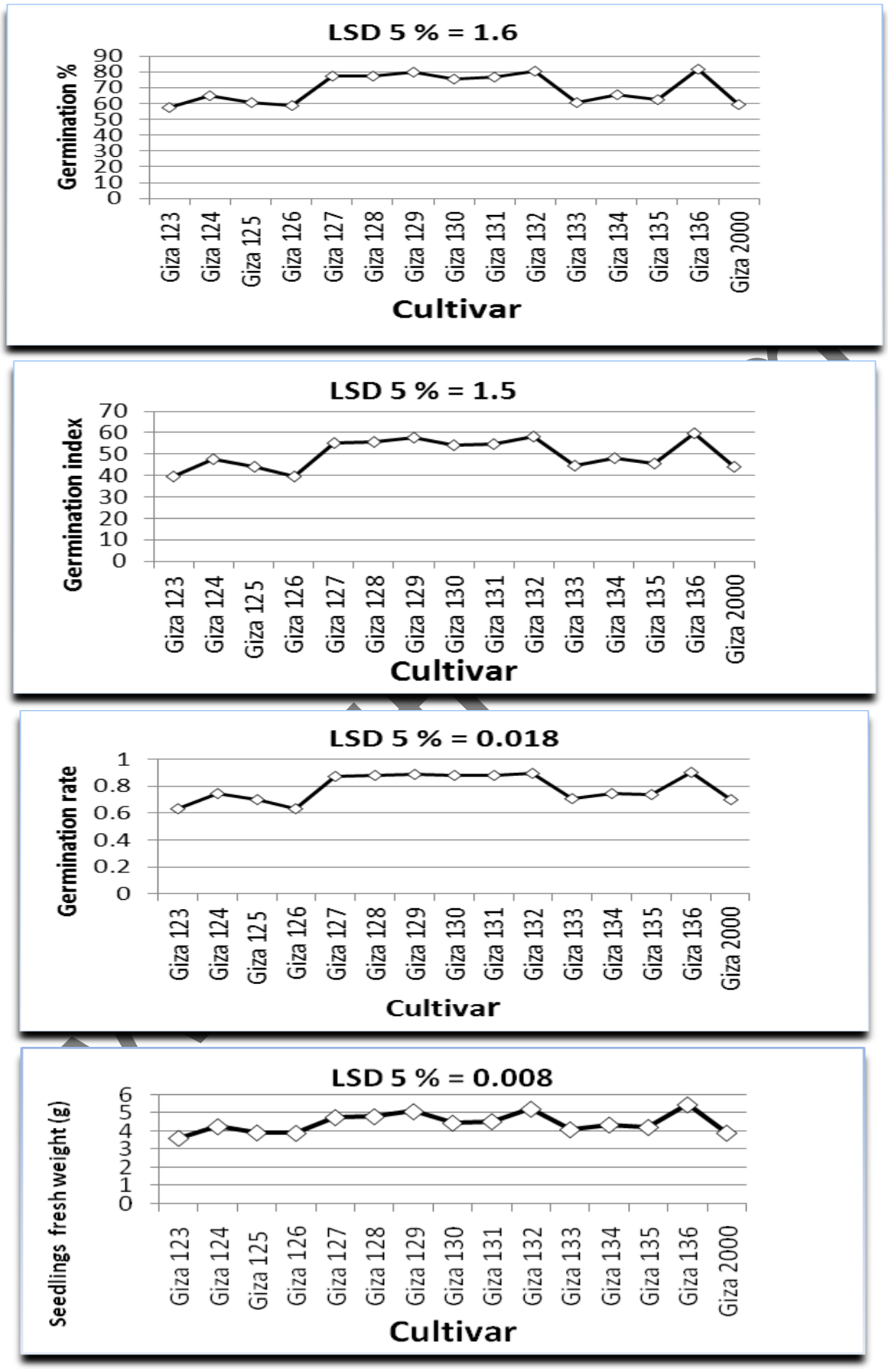


Fig.1Germination % , Germination index , Germination Rate and Seedlings Fresh Weight (g) as Affected by Barely CV

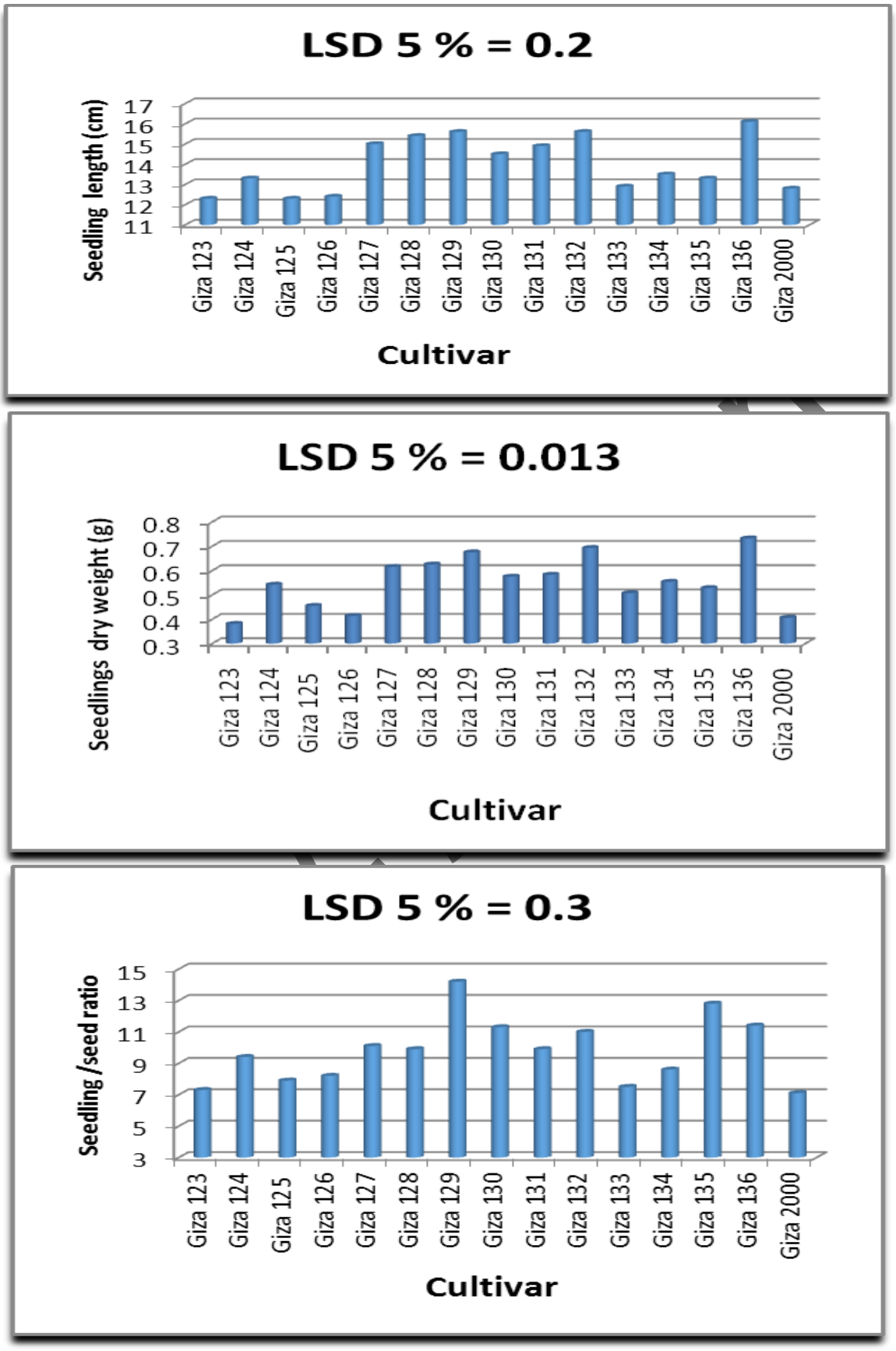


Fig.2 Seedlings Dry Weight (g), Seedling Length (cm) and Seedling/Seed Ratio as Affected by Barely CV

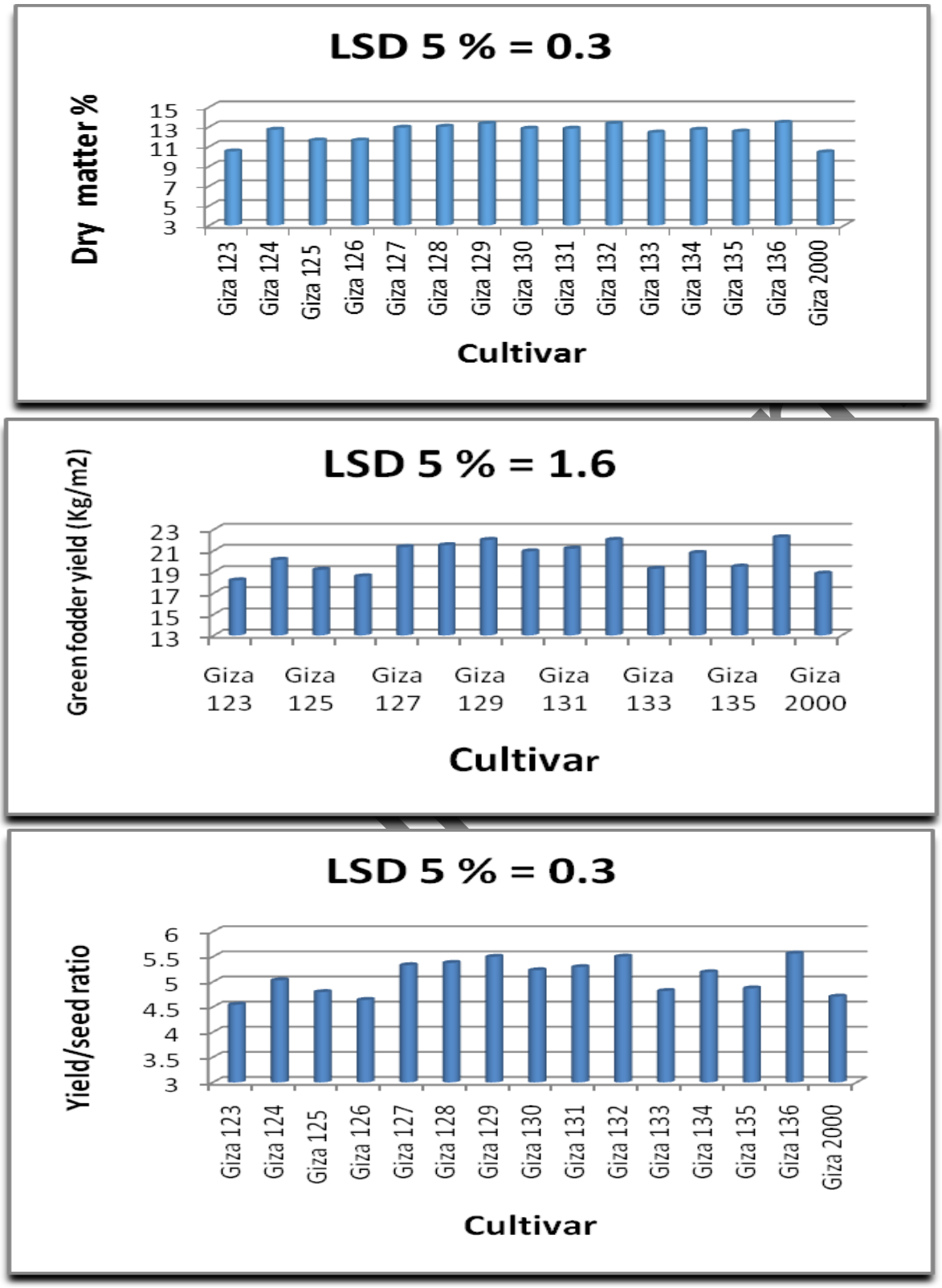


Fig.3 Dry Matter % , Green Fodder Yield (Kg/m2) and Yield/Seed Ratio as Affected by Barely CV

On the other hand, Giza 2000 barley cv recorded the lowest value of seedling/seed ratio.

Fig. 3 shows dry matter % , green fodder yield (Kg/m^2) and yield/seed ratio as affected by barely cv under study. Similar behavior was exhibited by these cv on theses parameters of Fig 3. Giza 136 and Giza 132 cv significantly exceeded the other studied cv in dry matter % , green fodder yield (Kg/m^2) and yield/seed ratio without significant differences between them. On the other hand, the lowest values of dry matter % and green fodder yield (Kg/m^2) were obtained by Giza 123 and Giza 2000 barley cv without significant differences between them. Simple correlation for the germination %, germination index, seedlings fresh weight (g),

seedling/seed ratio, seedling length (cm) and green fodder yield (Kg/m^2) are presented in Table (1). Positive and significant correlation coefficient were recorded between green fodder yield (Kg/m^2) and germination % , germination index, seedling fresh weight (g), seedling/seed ratio, seedling length (cm) and correlation coefficient were (0.871, 0.865,0.825, 0.611 and 0.860) for parameters (Table 1), respectively.

Table-1Simple Correlation for Germination %, Germination Index, Seedling Fresh Weight (g), Seedling/Seed Ratio, Seedling Length (cm) and Green Fodder Yield (Kg/m2).

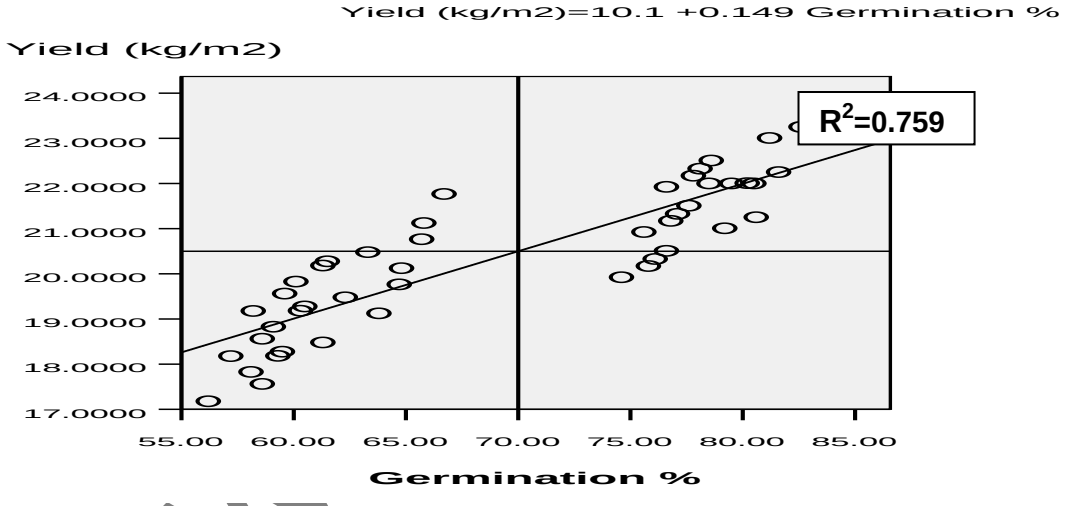
Parameters	Germination %	*Germination index*	Seedlings fresh weight (g)	Seedling /seed ratio	Seedling length (cm)
Green fodder yield (Kg/m^2)	**0.871 ****	**0.865 ****	**0.825 ****	**0.611****	**0.860****

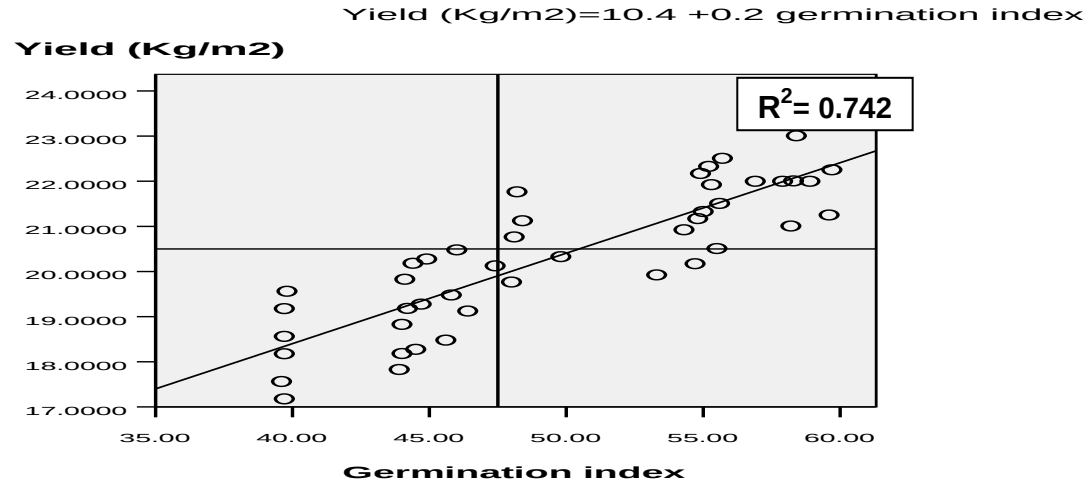
Simple linear regression for the germination %, germination index, seedlings fresh weight (g) and green fodder yield (Kg/m^2) are shown in Fig (4).The coefficient of determination for germination % , germination index and seedlings fresh weight (g) towards green fodder yield (Kg/m^2) were 75.9 , 74.2, 68.2 %, respectively. Results in Fig (4) revealed that germination %, germination index and seedlings fresh weight (g) as significantly contributing variables to variation in green fodder yield (Kg/m^2) . The prediction equations for green fodder yield (Kg/m^2) was computed as follows:

Green fodder yield (Kg/m^2) = 10.1 +0.149 germination %.

Green fodder yield (Kg/m^2) = 10.4 +0.2 germination index.

Green fodder yield (Kg/m^2) = 9.5 + 2.4 seedlings fresh weight (g)





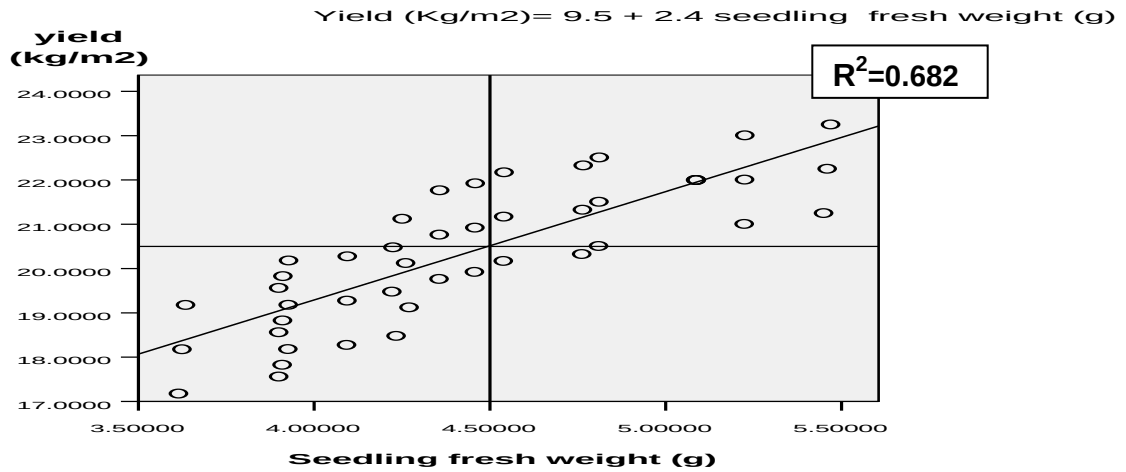


Fig. 4 Slope of Linear Relationship Between Green Fodder Yields (Kg/m2) and (Germination %, Germination Index, Seedlings Fresh Weight)

DISCUSSION

Hydroponic fodder production involves supplying cereal grain with necessary moisture and nutrients, to enable germination and plant growth in the absence of a solid growing medium.

There are several features of barley sprouted green fodder that can kept in mind ,sprouting of grains affected the enzyme activity, increased total protein and changes in amino acid profile, increased sugars, crude fibre, certain vitamins and minerals, the period between starting the production and green forage harvesting was about one week where a carpet is obtained made up with germinated seeds, their interweaved white roots and the green shoots, production of fresh green sprouts, independent of weather and at any time of year (Kruglyakov *et al*.,1989)

In present study, fifteen barley cv were evaluated for green fodder production under hydroponic system. Whereas, (Giza 129,Giza 130,Giza 131 , Giza 135 and Giza 136) are hulles barley cv and (Giza 123-Giza 124,Giza 125, Giza 126, Giza 127 , Giza 128, Giza 2000,Giza 132,Giza 133 and Giza 134) are hulled barley cv. The results showed Giza 136 as a superior barley cv for green fodder yield under hydroponic system, it is due to the highest values of germination %, germination index and seedlings fresh weight (g), which were obtained with Giza 136 barley cv and significantly correlated with green fodder yield, specially germination % parameter, which recorded the highest correlation coefficient (0.871) with green fodder yield (Kg/m^2). The variation among barley cv under study for germination parameters, it might be due to the genetically factors and heredity variation among the fifteen barley cv under study, which caused differed in germination parameters. Also, varietal differences among barley cv, which were related to ecotype , hull, pericarp and endosperm characters caused variation in water uptake % and osmotic potential (**Lee *et al*., 2002**).

Al-Hashmi (2008) obtained values regarding to the seedling length of hydroponic barley green fodder; which ranged between 18 and 20 cm. But in our study, for Giza 136 barley cv, which was the best compared with other cv, the seedling length was close to 17 cm and did not exceed, this could be because we did not use any fertilizer and nutrient solutions but we only had a water for irrigation. **Al-Karaki (2010)** reported that yield/seed ratio reached up to 8 times in barley green fodder produced hydroponically. While, in our study yield/seed ratio reached 5.6 with Giza 136 cv as a highest value, This decline in value of yield/seed ratio is due to no fertilizer and nutrient solution were added. Yield/seed ratio parameter was controlled by many factors, such as germination % , seedlings fresh weight (g) and number of seed / 1 Kg barley seed , the barley seeds of cv under study were different in seed weight and size. Also, we can predict green fodder yield Kg/m^2 through predictive equation by knowing the characteristics of germination%, germination index and seedlings fresh weight (g). The results of this study agreed with **Gebremedhin (2015)** who concluded that barley cv might differ than others in the forage productivity under hydroponic conditions. Ultimately, it can be concluded from this study that Giza 136 and Giza 132 barley varieties can be considered the best choice for production of hydroponic green fodder.

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