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The Effect of Different Irrigation Regimes on the Yield of Fodder Maize (Zea Mays)

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Abstract
A field study was carried out during 2013 season to investigate the effect of different irrigation intervals on fodder maize yield. Randomized complete block design (RCBD) was used, with three replicates. . Four irrigation regimes were executed T^1=3 irrigations (1st 20 Day After Sowing (DAS), 2nd 35 DAS and 3rd 50 DAS), T^2=3 irrigations (1st 20 DAS, 2nd 40 DAS and 3rd 60 DAS), T^3=3 irrigations (1st 25 DAS, 2nd 40 DAS and 3rd 55 DAS), and T^4=3 irrigations (1st 30 DAS, 2nd 45 DAS and 3rd 60 DAS). The results indicated that fodder maize yield varied significantly ($P<0.05$) under different irrigation regimes. The treatment T^1 resulted the best, plant height (185.33 cm), number of green leaves (13.42), stem width (4.46 cm), and fodder yield (30580 kg.ha^{-1}) While T^2 resulted in the best Seed germination (86.91%). Finally, T^1 irrigation regime was most effective to produce higher fodder yield in maize and the farmers may adopt this treatment to get high fodder production from maize.
Keywords: Fodder maize, Yield, Irrigation regimes

Introduction

Maize (Zea mays) is a staple food for a large part of the population especially in hilly areas and supplies raw material for the maize originated industries; also processed to manufacture corn starch, alcohol and tanning material for leather industries. Besides, its implication in the above several ways, maize is a good source of edible oil and most precious national foreign exchange is spent on the import of this important commodity every year (Anonymous, 2005). Maize is produced each year greater than any other grain in the world, and only United States produces half of the world's harvest, other top producing countries are as widespread as China, Brazil, France, Indonesia, India and South Africa, (Wikipedia, 2008). In the United States, Canada and Australia, the usual term is corn, which originally referred to any grain. Among the fodder crops grown in Sindh, maize occupies significant position and is planted almost all the year round in lower, middle and northern portions of Sindh. It is being planted as fodder crop from February to early November (Anonymous, 2007).

Maize is an important multipurpose cereal crop used as food, fodder, fuel, and in the manufacture of industrial products. The most important product of maize is the grain yield production in the world (Stephen et al., 2006). Horizontal improvement due to the expansion of population is becoming limiting. Nonetheless, effort has to make for the vertical increase in the productivity. Moreover, cost of production has to economize while optimizing inputs through proper management (Derby et al., 2005). Maize is also an important cereal crop in Pakistan and it is increasingly gaining an important position in crop husbandry because of its high yield potential and short growth duration. This crop is considering a rich source of food and fodder. Maize constitutes 6.4 % of the total grain production in Pakistan, and occupies a special position in the national economy, as it is a good source of food, and fodder (Abdullah et al., 2007).

Maize is widely adapted to climate variation and soil conditions. In view of the importance of maize as fodder crop, as well as grain, maize has picked considerable attention in the world (Ahsan and Mehdi, 2000). Fodder scarcity is considered a major limiting factor for the development of livestock industry in Pakistan and this problem was identified long time ago in the feed balance sheet (Sial and Alam, 1998). In this scenario, vertical improvement of fodder production could be achieved by maximum increasing fodder yield per unit area of fodder crops through management practices, (Bhatti, 1996).

In Pakistan maize is one of the most important cereal crops, which contributes 2.2 percent in agriculture and 0.5 percent to Grass Domestic Product. Maize was cultivated on an area of 1085 hectares in 2012-2013, less by 0.2 percent as compared with the last year (1087 hectares). However, the production witnessed 4631 tons during 2012-2013 as compared with the last year production of 4631 tons suggesting an increase of 6.8 percent more than the last year. The yield per hectare in 2012-2013 stood at 4268 kg.ha-1 posted appositive growth of 6.9 percent as compared to growth of last year 4.9 percent. The production increased due to the conversion to grow the hybrid varieties of maize that well adapted to the climate conditions, therefore enhanced maize yields (GOP, 2013).

Fodder crops play pivotal role in the agricultural economy of the developing countries, by providing cheapest source of feed for livestock. Livestock is a major sub-sector of agriculture in Pakistan and plays a key role in the economy of the country particularly in rural economy. Livestock contribution is approximately 53.2% of the agricultural value added and 11.4% to the national Grass Domestic Product (GOP, 2013).

Maize responds well to the management practices like irrigation, nitrogen, and other agriculture practices. Proper time and supplemental irrigation should be realized in irrigation scheduling for the most effective use of available water to optimize maize production. Water deficit has little effect on timing of emergence, number of leaves per plant, but delays tasseling initiation and silking, therefore reduces plant height and vegetation growth of maize (Singh et al., 2007).

Deficit irrigation is the scheduling method where irrigation is purposefully carried out not to fully meet water requirements of the crop, and plants are allowed to extract soil moisture beyond readily available water in the plant root zone (Bekele and Tilahun, 2007). Deficit irrigation is needed where essential resources such as water, capital, energy and labour are limited. Under deficit irrigation, crops are deliberately allowed to sustain some water deficit and yield reduction. The irrigator aims to increase water use efficiency (WUE) by reducing the amount of water at irrigation or by increasing the irrigation interval. The present study was carried out during season 2013 to investigate the effect of different irrigation intervals on fodder maize yield

Material and Methods

Use of irrigation water helps to economically maximize the crop productivity and optimize the actual crop water requirement. The present study was carried out during 2013 season to investigate the fodder yield of maize under the effect of different irrigation intervals. The experiment was conducted at Agriculture Research District Washuk, Balochistan.The experiment was laid out in a three replicates in Randomized Complete Block Design (RCBD), keeping plot size of 6m x 5m (30m^2). The land was prepared by giving two dry plowings followed by precision land leveling. After soaking dose, when soil came in condition two plowings with crosswise cultivator followed by planking was applied to achieve the fine seed bed. The variety "Akbar" was sown by means of single coulter hand drill at the row distance of 30 cm. Nitrogen fertilization (N) was applied in the form of urea, Phosphor (P) in the form of single super phosphate (SSP), and potassium (K) in the form of sulphate of potash (SOP). The crop was irrigated as planned. 1/3 of N (as urea) along with all P and K were applied at the time of sowing and remaining N was applied in two splits, the first split at first irrigation and the 2nd split after 25 days of first one.

Data recorded:

I. Before harvest:

Seed germination (%): was worked out on the basis of seedlings emerged in each plot from an approximate total number of seeds sown in the certain plot area.

II. After harvest

Five plants in each plot were selected at random and labeled. The observations were recorded as follow:

Plant height (cm): was measured by measuring tape from bottom to the top of the labeled plants in each plot.

Number of green leaves plant^{-1}: The green leaves on the labeled plants in each plot were counted

Stem width (cm): The stem width of each labeled plant in each plot was measured by means of Vernier Caliper in centimeters. The stem width was measured from bottom, middle and upper part of stem and averaged.

Fodder yield (kg ha-^{1}): was calculated on the basis of fodder yield per plot in kilograms using the following formula:

Seed yield (kg. ha-^{1}) = Fodder yield plot-1 (kg) x 10000 m^2

Plot size (m^2)

Statistical Analysis

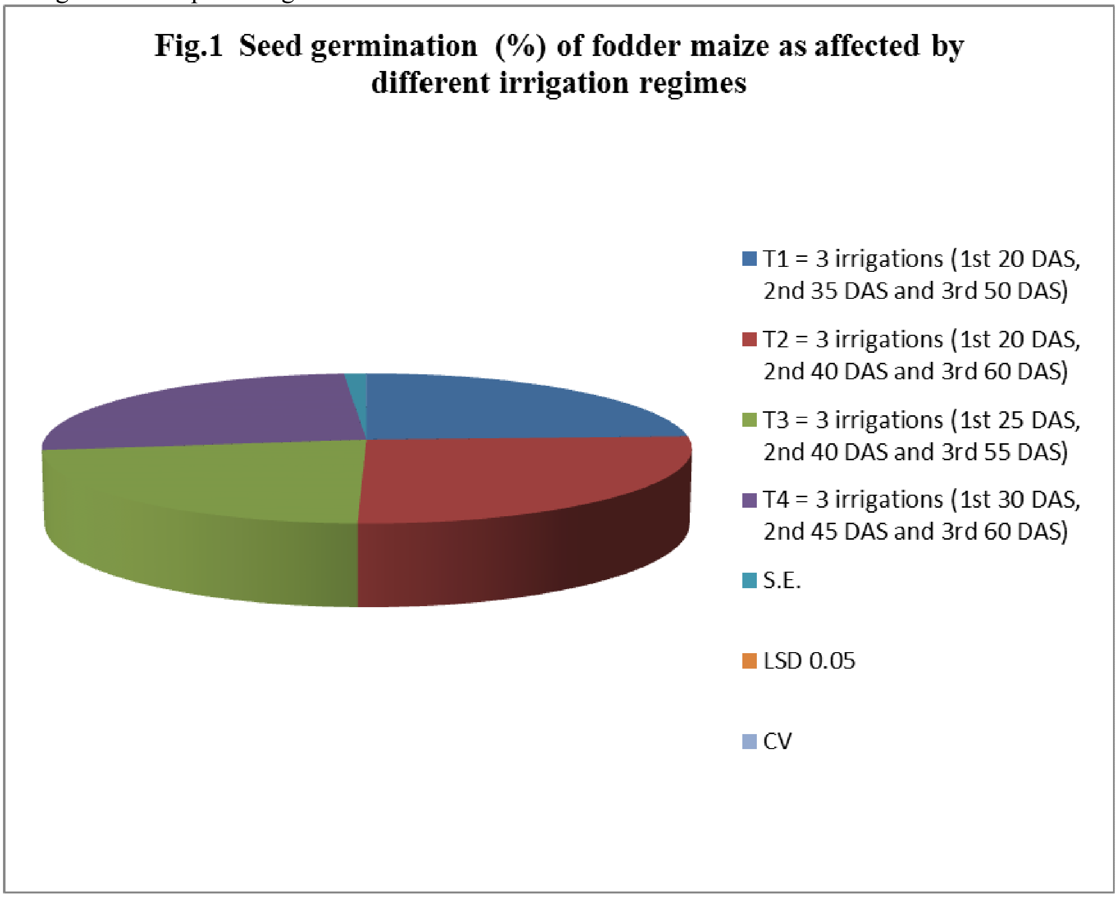
The analysis of variance of the data collected were interpreted using the statistical software MSTATC, Treatment means were compared by using L.S.D at 5% level of probability according to Waller and Duncan (1969).

Results

Seed germination (%)

Seed germination is the key factor in a crop raised for fodder production, because potential crop stand can only be achieved if seed germination is up to the desired criterion. The data in regards to seed germination percentage of fodder maize as influenced by different irrigation an interval is given in Fig.1 and analysis of variance as Table 1. The analysis of variance suggested non-significant ($P>0.05$) effect of various irrigation intervals on seed germination percentage of fodder maize. It is apparent from the results (Fig.1) that relatively higher seed germination percentage (86.91%) on average was recorded in T2, when the crop was given three irrigations (1st irrigation at 20 days after sowing, 2nd at 40 days and 3rd after 60 days after sowing); while the treatment T^3 55 resulted average seed germination of 83.60 percent. Similarly, T^4 treatment resulted average seed germination of

83.16 percent. However, the seed germination was lowest (80.48%) in T^4 treatment. It was observed that the treatment T^2 proved to be an effective irrigation regime, while delayed first irrigation resulted in a reduction in seed germination percentage

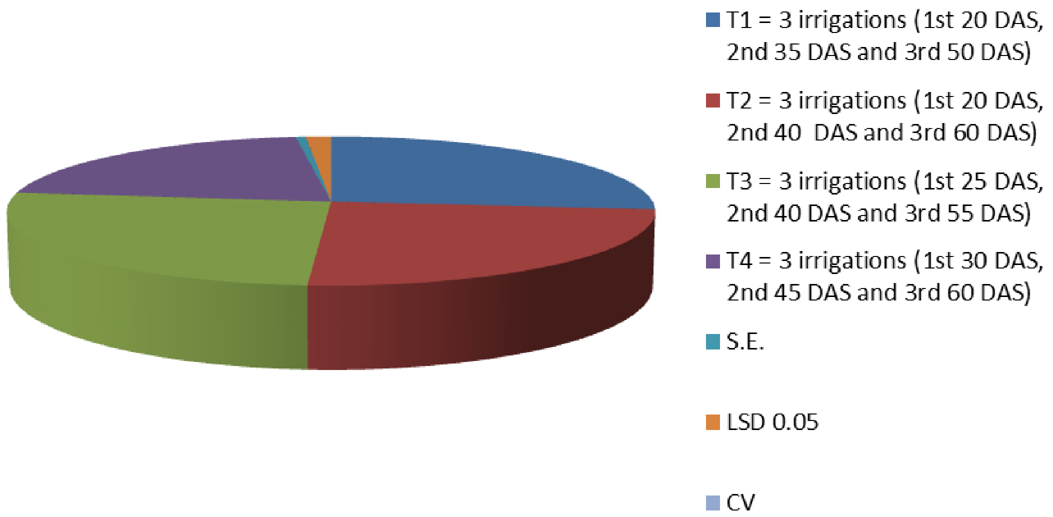


Plant height (cm)

In maize crop for fodder production, plant height plays elementary role to decide the validity of a treatment; and maize varieties with shorter height seldom used for fodder production. The results pertaining to plant height of fodder maize as affected by different irrigation intervals are presented in Fig.2. The analysis of variance Table 2 demonstrated significant ($P \leq 0.05$) impact of various irrigation intervals on plant height of fodder maize.

It is evident from the results (Fig.2) that significantly maximum plant height (185.33 cm) on average was recorded in T^1 treatment when the crop was given 1st irrigation at 20 days after sowing, 2nd at 35 days and 3rd after 50 days of sowing (T^1); while the plant height slightly reduced (182.00 cm) in (T^3). Maize crop recorded the minimum plant height (157.33 cm) in (T^4) treatment. The differences in plant height between T^1 (1st irrigation at 20 days after sowing, 2nd at 35 days and 3rd after 50 days of sowing) and T^3 (1st irrigation at 25 days after sowing, 2nd at 40 days and 3rd after 55 days of sowing) were non-significant . We concluded that delayed 1st irrigation up to 30 days after sowing impacted the plant height adversely

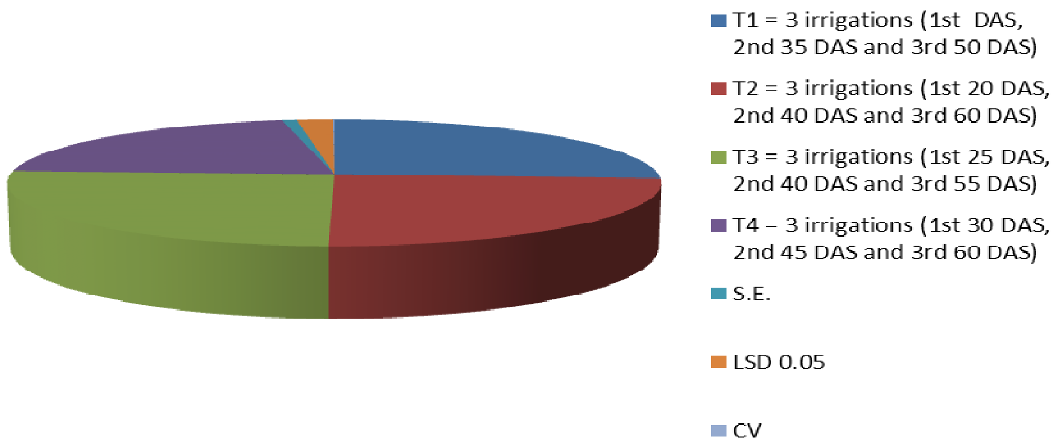
Fig 2. Plant height (cm) of fodder maize as affected by different irrigation regimes



Number of green leaves per plant:

Number of green leaves in maize for fodder production is a quantity parameter; but this trait is generally influenced by level of input application. The results in regards to the number of green leave plant-1 of fodder maize as influenced by different irrigation intervals are shown in Fig.3. The analysis of variance Table 3 indicated significant ($P \leq 0.05$) impact of various irrigation intervals on the number of green leaves plant^{-1} of fodder maize. The results showed (Fig.3) that maximum number of green leaves plant-1 (13.42) on average was achieved in crop given 1st irrigation at 20 days after sowing, 2nd at 35 days and 3rd after 50 days of sowing (T^1); by the delay in the first irrigation the number of green leaves plant^{-1} slightly decreased to (12.70) and (11.10) in T^3 and T^4 treatments, respectively.

Fig3. Green leaves plant^{-1} of fodder maize as affected by different irrigation regimes



Stem width (cm)

Results in relation to stem width of fodder maize as affected by different irrigation intervals are presented in

Fig.4. The analysis of variance Table 4 suggested significant ($P \leq 0.05$) effect of various irrigation intervals on the stem width of fodder maize. The results (Fig.4) showed that maximum stem width (4.46 cm) on average was recorded in plants given 1^{st} irrigation at 20 days after sowing, 2^{nd} at 35 days and 3^{rd} after 50 days of sowing (T^1); while the lowest stem width (3.69 cm) was recorded in crop given 1^{st} irrigation after 30 days of sowing, 2^{nd} after 45 days and 3rd after 60 days of sowing (T^4). The LSD test suggested that statistically the differences in the stem width of maize between T^1 and T^3 were non-significant. This indicates that T^1 and T^3 irrigation regimes resulted the best traits.

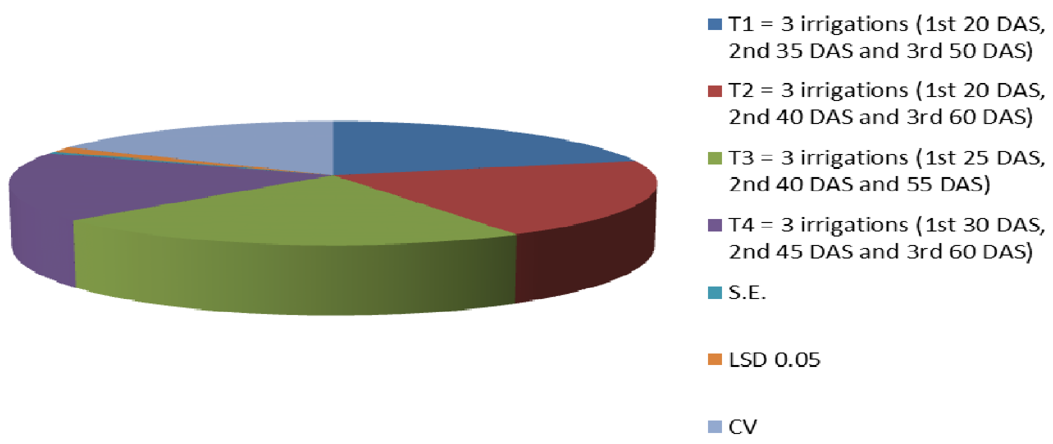


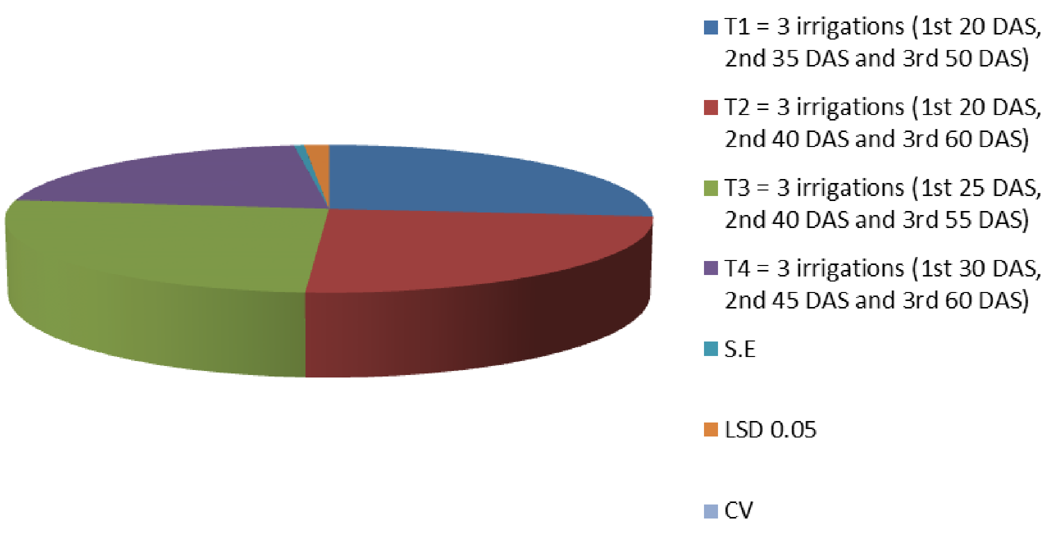
Fig4. Stem girth (cm) of fodder maize as affected by different irrigation regimes

Fodder yield (kg. ha^{-1})

Fodder yield is a multiple trait composition and varieties differ in potential, while the effect of inputs and environmental conditions on fodder yield is well recognized. The results in regards to fodder yield Kg.ha^{-1} of fodder maize as influenced by different irrigation intervals are shown in Fig.5. The analysis of variance Table 5 showed significant ($P \leq 0.05$) effect of various irrigation intervals on the fodder yield Kg. ha^{-1} of maize.

It is obvious from the results (Fig.5) that highest fodder yield Kg.ha-^{1} (30580 kg) was produced by the crop given 1^{st} irrigation at 20 days after sowing, 2^{nd} at 35 days and 3^{rd} after 50 days of sowing (T^1); while the lowest fodder yield (25960 kg. ha^{-1}) was recorded in crop given 1^{st} irrigation after 30 days of sowing, 2^{nd} after 45 days and 3rd after 60 days of sowing (T^4). The LSD test indicated that statistically the differences in fodder yield Kg. ha^{-1} of maize between T^1 (1st irrigation after 20 days of sowing, 2^{nd} after 35 days and 3^{rd} after 50 days of sowing) and T^3 (1^{st} irrigation after 25 days of sowing, 2^{nd} after 40 days and 3^{rd} after 55 days of sowing) were non-significant ($P > 0.05$). This indicates that T^1 and T^3 irrigation regimes were most effective to produce higher fodder yield in maize

Fig.5 Fodder yield (kg ha^{-1}) of fodder maize as affected by different irrigation regimes



Discussion

Water availability in the root-zone limits crop production and the competition for fresh water increasing. However, the canal water availability for agriculture in Pakistan is limiting with the time. Thus, it is imperative to plan sound basis to improve water use efficiency and judicious use of water may be ensured. The present study was carried out to investigate the fodder yield of maize under the influence of varying irrigation intervals. The present study showed that fodder yield of maize varied significantly ($P \leq 0.05$) under the influence of varying irrigation intervals. T^1=3 irrigations (1^{st} 20 DAS, 2^{nd} 35 DAS and 3^{rd} 50 DAS) resulted in 80.48 % seed germination, 185.33 cm plant height, 13.42 number of green leaves plant-1, 4.46 cm stem width and 30580 kg ha^{-1} fodder yield. T^2=3 irrigations (1^{st} 20 DAS, 2^{nd} 40 DAS and 3^{rd} 60 DAS) resulted in 86.91% seed germination, 174.00 cm plant height, 12.25 number of green leaves plant-1, 4.07 cm stem width and 28710 kg ha^{-1}fodder yield. T^3=3 irrigations (1^{st} 25 DAS, 2^{nd} 40 DAS and 3^{rd} 55 DAS) produced 83.60% seed germination, 182.00 cm plant height, 12.70 number of green leaves plant-1, 4.22 cm stem width and 30030 kg f ha^{-1}odder yield ; while T^4=3 irrigations (1^{st} 30 DAS, 2^{nd} 45 DAS and 3^{rd} 60 DAS) resulted in 83.16% seed germination, 157.33 cm plant height, 11.10 number of green leaves $plant^{-1}$, 3.59 cm stem width and 25960 kg ha^{-1}fodder yield. These results are in agreement with those of Milani and Neishabouri (2001) who reported that irrigation interval may be decided in such a way to avoid excessive use of water to optimize the irrigation water requirement of maize. Abid Niaz et al., (2004) reported that 11 and 12 days irrigation proved to more effective than 13 days interval for achieving higher maize fodder yield. However, these suggestions could not be used for all the agriculture soils. In another investigation El-Tantawy et al. (2007) and Igbadun et al. (2008) concluded that crop water use efficiency and Irrigation water use efficiency (IWUE) were strongly influenced by the number of growth stages in which deficit irrigations were applied and how critical the growth stages were to moisture stress rather than the amount of irrigation water applied. While maximum water use efficiency was obtained under full irrigation, maximum was obtained in the deficit irrigation treatment at vegetative growth stage, suggested that IWUE may be improved upon by practicing deficit irrigation at the vegetative growth stage of the maize crop. Tariq and Usman (2009) found that there was significant effect of irrigation depths on grain yield. Maqsood (2010) reported that six irrigations improved all the physiological traits over five and four irrigations in maize. Asim and Mohamed (2011) indicated that maximum plant population and field water use efficiency were obtained at irrigation water amount of 50% ETc in both seasons. Also, 10 days irrigation interval gave the highest values of plant height, cob length, 100-seed weight, grain yield, Stover yield, and field water use efficiency. Khatun et al., (2012) concluded that application of two irrigations would be better for growth and maximizing the yield of maize. Rusere et al., (2012) concluded that deficit irrigation results in a significant decline in silage maize yield and an increase in water use efficiency.

Conclusion

It was concluded that T^1 and T^3 irrigation regimes were most effective to produce higher fodder yield in maize and the farmers may adopt these treatments to get higher fodder production in District Washuk, Balochistan region, using Akbar variety.

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