Pure Appl. Biol., 8(1): 50-57, March, 2019
http://dx.doi.org/10.19045/bspab.2018.700163

Research Article

Growth and yield response of bitter gourd to foliar applied urea under different irrigation levels

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Citation
Abdul Samad, Fazal Muhammad Bangulzai, Zakia Bibi, Abdul Raziq, Syed Muhammad Ishaq, Shabeer Ahmed, Shah Faisal, Lal Bakhsh and Abdul Qadir. Growth and yield response of bitter gourd to foliar applied urea under different irrigation levels. Pure and Applied Biology. Vol. 8, Issue 1, pp50-57. http://dx.doi.org/10.19045/bspab.2018.700163

Received: 07/08/2018 Revised: 02/10/2018 Accepted: 03/10/2018 Online First: 06/10/2018

Abstract

In order to examine the growth and yield response of bitter gourd to foliar applied urea at different concentrations and irrigation at various frequencies, the experiment was conducted during 2016 using 3 replicated Randomized Complete Block Design at Sindh Agriculture University Tandojam. Irrigation was applied at weekly interval (T_1), Irrigation at 10 days interval (T_2), T_2+foliar urea @ 1.5% (T_3), T_2+foliar urea @ 3% (T_4), Irrigation at 15 days interval (T_5), T_5 + foliar urea @ 1.5% (T_6), T_5 + foliar urea @ 3% (T_7). The results revealed that Irrigation at 10 days interval + foliar urea at 3.0% conc.proved to be an optimum treatmentand resulted in 144.95 cm vine length, 19.96 cm fruit length, 17.45cm diameter of fruit, 79.95 g average fruit weight, 8.95 number of fruits vine^{-1}, 739.00 g weight of fruits vine^{-1} and 9199.7 kg ha^{-1} fruit yield. The irrigation at 10 days interval + foliar application of urea (1.5%)ranked 2nd; irrigation at 15 days interval + foliar urea (3.0%)ranked 3rd; irrigation at 15 days interval + foliar urea (1.5%)ranked 4th; while weekly (control), 10 days,15 days irrigation interval without foliar applied urea ranked 5th, 6th and 7th respectively. The values for all the growth and productivity of bitter gourd were markedly increased with foliar application of urea, particularly at higher concentration. It was concluded that for acghieving desired yield performance of bittergourd the crop may be irrigted at 10 days interval + foliar application of urea at 3.0% conc.

Keyword: Bitter gourd; Irrigation; Urea conc.; Yield

Introduction

Bitter gourd, botanically named as *Momordica charantia* belongs to the Cucurbitaceae family in Momordica genus of climbing vines produce a tender, edible fruit pod [1]. The center of bitter gourd domestication likely lies in eastern Asia, possibly eastern India or southern China [2]. The bitter gourd is very useful for health by virtue of its disease preventing and health promoting phytochemical compounds. Bitter gourd is generally consumed cooked in the

green or early yellowing stage. Bitter gourd is very popular throughout South Asia. It is often prepared with potatoes and served with yogurt on the side to offset the bitterness [3]. In Pakistan and Bangladesh, bitter gourd is often cooked with onions, red chili powder, turmeric powder, salt, coriander powder, and a pinch of cumin seeds [4]. A 100 g edible portion of bitter gourd contains 93.95 g moisture, 19 Kcal energy, 4.32 g carbohydrates, 1.95 g sugars, 2 g dietary fiber, 0.18 g fat, 0.84 g protein, 6 µg Vitamin A, 68 µg beta-carotene, 1323 µg lutein zeaxanthin, 0.051 mg thiamine, 0.053 mg riboflavin, 0.28 mg niacin, 0.193 mg pantothenic acid, 0.041 mg vitamin B_6, 51 mg folate, 33 mg vitamin C, 0.14 mg vitamin E, 4.8 µg vitamin K, 9 mg calcium, 0.38 mg iron, 16 mg magnesium, 0.086 mg manganese, 36 mg phosphorus, 319 mg potassium, 6 mg sodium, 0.77 mg zinc [5].

The availability of irrigation water is the fundamental requirement for crop production and the availability or judicious use of irrigation water Scarcity of water resources is a worldwide issue due to the increasing demand [6]. The pressure on water resources is expected to increase as the requirements for food production and industrial needs go up in parallel with rapidly growing population [7]. Water resources are limited worldwide and there is an urgent need to identify and adopt efficient irrigation management strategies since irrigation of agricultural lands accounts for over 85% of worldwide water usage [8, 9] indicate that crop water use efficiency can be increased either by improving the irrigation scheduling and the crops may be saved from water stress at its critical growth stages. At leaf level, the increase in transpiration efficiency may result both from an increase in photosynthetic rate and a decrease in stomatal conductance [10]. Irregular and inadequate water supply affects the growth, yield and fruit quality in vegetables; and irrigated vegetables produce good yields every year, but the response to irrigation may vary greatly from one year to the next depending upon the amount and distribution of rainfall during the growing season. A thorough soaking every four to five days on light, sandy soils and every seven to ten days on heavy soils is a good general guide for irrigating if no enough rains. Early watering in the day to cut down on evaporation losses and to give the foliage plenty of time to dry out is suggestible [11].

Foliar application of urea is low cost and gives rapid plant response. The foliar application of urea can not only optimize the nitrogen supply to the plant, but the plant also withstand under water stress and drought conditions [12] found that once foliar applied urea is absorbed by the leaves it converted to ammonia. Foliar applied urea is found to be highly effective on and if major portion of nutrients is taken up through the foliage, it would not contribute greatly to denitrification [13]. The studies indicated that nitrogen through soil or in foliar form improves plant growth and yield [14, 15] and foliar form of nitrogen application is more effective, particularly in water shortage and drought conditions [16]. However, soil application of nutrients is essential [17]. The conjunctive use of nutrients through soil and foliar method produce better impact on crop growth and fruit yield than using any single method of nutrient application [18]. The proposed experiment was carried out to examine the yield response of bitter gourd to different irrigation levels and foliar applied urea under field conditions.

Materials and methods

The experiment was laid out in three replicated Randomized Complete Block Design at the experimental field of the Orchard, Department of Horticulture, Sindh Agriculture University Tandojam having net plot size of 3.5 m x 5.0 m (17.5 m^2). The crop was fertilized with different levels of foliar applied urea. Apart from the foliar applied

urea, the crop was treated with recommended dose of NPK (100-75-50 kg ha^{-1}). All P and K along with ½ Nitrogen was applied at the time of sowing. The remaining Nitrogen was divided into two equal splits and was applied at flowering and fruiting stages, respectively. The irrigations was applied as per treatment plan and 1.5 to 3.0 gram urea was dissolved in 100 liter water to prepare solution for foliar application. The soil applied NPK fertilizers was applied at the recommended rates of 100-75-50 kg ha^{-1} in the form of Urea, Single Super Phosphate and Sulphate of Potash, respectively. All the cultural practices were operated as per the recommendations in all the plots uniformly. The observations was recorded on the basis of five selected vines in each plot.

The analysis of variance was employed to examine the significance for each character for overall treatments, while the L.S.D. (Least Significant Differences) test was employed to compare the treatment means, following the statistical methods suggested **[19]**.

Results

Vine length (cm)

Vine length of bitter gourd is an important growth trait and it influences the yield parameters. The results related to bitter gourd as affected by different irrigation frequencies are given in (Table1). There was a significant increase ($P<0.05$) in vine length for different irrigation frequencies. The maximum vine length (144.95 cm) was noted when bitter gourd was irrigated at 10 days interval + foliar application of urea at 3.0% conc., followed by vine length of 143.50, 142.00 and 139.50 cm in bitter gourd when crop was irrigated at 10 days interval + foliar application of urea at 1.5% conc., 15 days interval + foliar application of urea at 3.0% conc. and 15 days interval + foliar application of urea at 1.5% conc., respectively. The vine length (134.50 and 124.50 cm) was noted when bitter gourd was irrigated at Control (irrigation at weekly interval) and Irrigation at 10 days interval. The lowest vine length (120.50 cm) was noted when bitter gorud irrigated at 15 days interval. It was observed that bitter gourd fruit produced highest vine length when irrigated at 10 days interval + foliar application of urea at 3.0% conc. The LSD test demostrated signifcant ($P<0.05$) in vine length between all irrigation levels.

Fruit length (cm)

Fruit length (cm) in bitter gourd is an important growth trait and it influences the yield parameters. The results related to bitter gourd as affected by different irrigation frequencies are given in (Table1). There was significant increase ($P<0.05$) in fruit length for different irrigation frequencies. The maximum fruit length (19.96 cm) was noted when bitter gourd was irrigated at 10 days interval + foliar application of urea at 3.0% conc., followed by fruit length of 17.98, 17.10 and 16.04 cm in bitter gourd when irrigated at 10 days interval + foliar application of urea at 1.5% conc.,15 days interval + foliar application of urea at 1.5% conc. and irrigated at Control (irrigation at weekly interval), respectively. The minimum fruit length (15.61 and 12.67 cm) was noted when bitter gourd was irrigated at 10 days interval and 15 days interval + foliar application of urea at 1.5% conc. The lowest fruit length (11.96 cm) was noted when bitter gorud was irrigated at 15 days interval. It was observed that bitter gourd produced highest fruit length when irrigated at 10 days interval + foliar application of urea at 3.0% conc. The LSD test demostrated signifcant ($P<0.05$) difference in fruit length between all irrigation levels.

Diameter of fruit (cm)

Diameter of fruit of bitter gourd is an important growth trait and it influences the yield parameters. The results related to bitter gourd as affected by different irrigation frequencies are given in (Table1). There was significant increase ($P<0.05$) in fruit diameter

for different irrigation frequencies. The maximum diameter of fruit (17.45cm) was noted when bitter gourd was irrigated at 10 days interval + foliar application of urea at 3.0% conc., followed by diameter of fruit of 16.63, 16.27 and 15.55cm in bitter gourd when irrigated at 10 days interval + foliar application of urea at 1.5% conc.,15 days interval + foliar application of urea at 3.0% conc. and 15 days interval + foliar application of urea at 1.5% conc., respectively. The diameter of fruit (15.27 and 15.70cm) was noted when bitter gourd was irrigated at Control (irrigation at weekly interval) and irrigation at 10 days interval. The lowest diameter of fruit (12.43cm) was noted when bitter gorud was irrigated at 15 days interval. It was observed that bitter gourd fruit produced highest diameter of fruit when irrigated at 10 days interval + foliar application of urea at 3.0% conc. The LSD test demostrated signifcant increase ($P<0.05$) in diameter for fruit between all irrigation levels.

Table 1. Effect of various combinations of irrigation frequencies and foliar application of urea in different conc. on Vine length (cm), Fruits length (cm), Diameter of fruit (cm) and Average fruit weight (g) of bitter gourd

Treatments	Vine length (cm)	Fruit length (cm)	Diameter of fruit (cm)	Average fruit weight (g)
Control (irrigation at weekly interval)	134.50 e	16.04 d	15.27 c	67.86 e
Irrigation at 10 days interval	124.50 f	15.61 e	15.70 bc	62.00 f
Irrigation at 10 days interval + foliar application of urea at 1.5% conc.	143.50 b	17.98 b	16.63 ab	77.47 b
Irrigation at 10 days interval + foliar application of urea at 3.0% conc.	144.95 a	19.96 a	17.45 a	79.95 a
Irrigation at 15 days interval	120.50 g	11.96 g	12.43 d	52.00 g
Irrigation at 15 days interval + foliar application of urea at 0.5% conc.	139.50 d	17.10 c	15.55 bc	71.83 d
Irrigation at 15 days interval + foliar application of urea at 3.0% conc.	142.00 c	12.67 f	16.27abc	75.50 c
SE ±	0.4645	0.1036	0.5816	0.5087
LSD 0.05	1.0120	0.2216	1.2672	1.1083
CV (%)	0.42	2.06	4.56	0.90

Average fruit weight (g)

Average fruit weight (g) of bitter gourd is an important growth trait and it influences the yield parameters. The results related to bitter gourd as affected by different irrigation frequencies are given in (Table1). There was significant increase ($P<0.05$) in average fruit weight for different irrigation frequencies.

The maximum average fruit weight (79.95 g) was noted when bitter gourd was irrigated at 10 days interval + foliar application of urea at 3.0% conc., followed by average fruit weight of 77.47, 75.50 and 71.83 g in bitter gourd when irrigated at 10 days interval + foliar application of urea at 1.5% conc., 15 days interval + foliar application of urea at 3.0% conc. and 15 days interval + foliar application of urea at 1.5% conc., respectively. The average fruit weight (67.86 and 62.00 g) was noted when bitter gourd was irrigated at Control (irrigation at weekly interval) and Irrigation at 10 days interval. The lowest average fruit weight (52.00 g) was noted when bitter gorud was irrigated at 15 days interval. It was observed that bitter gourd fruit produced highest average fruit weight when irrigated at 10 days interval + foliar application of urea at 3.0% conc. The LSD test demostrated signifcant increase ($P<0.05$) in average fruit weight (g) among all irrigation levels.

Number of fruits vine^{-1}

Number of fruits vine^{-1} in bitter gourd is an important growth trait and it influences the yield parameters. The results related to bitter gourd as affected by different irrigation frequencies are given in Table-2. There was significant increase ($P<0.05$) in number of fruits vine^{-1} for different irrigation frequencies. The maximum number of fruits vine^{-1} (8.95) was noted when bitter gourd was irrigated at 10 days interval + foliar application of urea at 3.0% conc., followed by number of fruits vine^{-1} of 8.55, 8.11 and 7.85 in bitter gourd when irrigated at 10 days interval + foliar application of urea at 1.5% conc.,15 days interval + foliar application of urea at 3.0% conc. and 15 days interval + foliar application of urea at 1.5% conc., respectively. The number of fruits vine^{-1} (7.18 and 6.65) was noted when bitter gourd was irrigated at Control (irrigation at weekly interval) and Irrigation at 10 days interval. The lowest number of fruits vine^{-1} (5.15) was noted when bitter gorud was irrigated at 15 days interval. It was observed that bitter gourd fruit produced highest number of fruits vine^{-1}when irrigated at 10 days interval + foliar application of urea at 3.0% conc. The LSD test demostrated signifcant increase ($P<0.05$) in number of fruits vine^{-1}amongall irrigation levels.

Weight of fruits vine^{-1} (g)

The weight of fruits vine^{-1} (g) in bitter gourd is an important yield trait and it influences the yield parameters. The results related to bitter gourd as affected by different irrigation frequencies are given in (Table2). There was significant increase ($P<0.05$) in weight of fruits vine^{-1} for different irrigation frequencies. The maximum weight of fruits vine^{-1} (739.00 g) was noted when bitter gourd was irrigated at 10 days interval + foliar application of urea at 3.0% conc., followed by weight of fruits vine^{-1}of 710.00, 678.33 and 645.00g in bitter gourd when irrigated at 10 days interval + foliar application of urea at 1.5% conc.,15 days interval + foliar application of urea at 3.0% conc. and 15 days interval + foliar application of urea at 1.5% conc., respectively. The weight of fruits vine^{-1} (595.00 and 520.00 g) was noted when bitter gourd was irrigated at Control (irrigation at weekly interval) and Irrigation at 10 days interval. The lowest weight of fruits vine^{-1} (418.33 g) was noted when bitter gorud irrigated at 15 days interval. It was observed that bitter gourd fruit produced highest weight of fruits vine^{-1}when irrigated at 10 days interval + foliar application of urea at 3.0% conc. The LSD test demostrated signifcant increase ($P<0.05$) in weight of fruits vine^{-1} (g) amongall irrigation levels.

Fruit yield (kg) ha^{-1}

The fruit yield (kg ha^{-1}) in bitter gourd is an important yield trait and it represents final yield. The results related to bitter gourd as affected by different irrigation frequencies are given in (Table2). There was significant increase ($P<0.05$) in fruit yield (kg ha^{-1}) for

different irrigation frequencies. The maximum fruit yield ha^{-1} (9199.7 kg) was noted when bitter gourd was irrigated at 10 days interval + foliar application of urea at 3.0% conc., followed by fruit yield ha^{-1}of 9145.0,7940.0 and 8320.0kg in bitter gourd when irrigated at 10 days interval + foliar application of urea at 1.5% conc.,15 days interval + foliar application of urea at 3.0% conc. and 15 days interval + foliar application of urea at 1.5% conc., respectively. The fruit yield ha^{-1} (7876.7 and 7305.0 kg) was noted when bitter gourd was irrigated at Control (irrigation at weekly interval) and Irrigation at 10 days interval. The lowest fruit yield ha^{-1} (6323.3 kg) was noted when bitter gorud was irrigated at 15 days interval. It was observed that bitter gourd fruit produced highest fruit yield (kg ha^{-1})when irrigated at 10 days interval + foliar application of urea at 3.0% conc. The LSD test demostrated signifcant increase (P<0.05) in fruit yield (kg ha^{-1}) amongall irrigation levels.

Table 2.Effect of various combinations of irrigation frequencies and foliar application of urea in different conc. on Number of fruits vine^{-1}, Weight of fruits vine^{-1} (g) and Fruit yield (kg ha^{-1}) of bitter gourd

Treatments	Number of fruits vine^{-1}	Weight of fruits vine^{-1} (g)	Fruit yield(kg ha-^{1})
Control (irrigation at weekly interval)	7.18 e	595.00 e	7876.7 b
Irrigation at 10 days interval	6.65 f	520.00 f	7305.0 bc
Irrigation at 10 days interval + foliar application of urea at 1.5% conc.	8.55 b	710.00 b	9145.0 a
Irrigation at 10 days interval + foliar application of urea at 3.0% conc.	8.95 a	739.00 a	9199.7 a
Irrigation at 15 days interval	5.15 g	418.33 g	6323.3 c
Irrigation at 15 days interval + foliar application of urea at 1.5% conc.	7.85 d	645.00 d	8320.0 ab
Irrigation at 15 days interval + foliar application of urea at 3.0% conc.	8.11 c	678.33 c	7940.0 b
SE ±	0.1200	4.6876	534.22
LSD 0.05	0.2614	10.213	1164.0
CV (%)	1.96	0.93	8.16

Discussion

The current study was performed to evaluate the growth and yield response of bitter gourd to foliar applied urea under different irrigation levels. The irrigation frequencies at 10 days interval + foliar application of urea at 3.0% conc. resulted 144.95 cm vine length, 19.96 cm fruit length, 17.45cm diameter of fruit, 79.95 g average fruit weight, 8.95 number of fruits vine^{-1}, 739.00kg weight of fruits vine^{-1}and 9199.7kg ha^{-1} fruit yield. The irrigation frequencies at 10 days interval + foliar application of urea at 1.5% conc. resulted 143.50 cm vine length, 17.98 cm fruit length, 16.63cm diameter of fruit, 77.47 g average fruit weight, 8.55 number of fruits vine^{-1}, 710.00 g weight of fruits vine^{-1}and 9145.0kg ha^{-1}fruit yield. The bitter gourd fruit received irrigation frequencies at 15 days interval + foliar application of urea at 3.0% conc. resulted 142.00 cm vine length, 17.10 cm fruit length, 16.27cm diameter of fruit, 75.50 g average fruit weight, 8.11 number of fruits vine^{-1}, 678.33 g weight of fruits vine^{-1}and 7940.0kg ha^{-1} fruit yield. Irrigation frequencies at 15 days interval + foliar application of urea at 1.5% conc. resulted 139.50 cm vine length, 17.10 cm fruit length,

15.55cm diameter of fruit, 71.83 g average fruit weight, 7.85 number of fruits vine^{-1}, 645.00 g weight of fruits vine^{-1}and 8320.0kg ha^{-1} fruit yield. The bitter gourd irrigated at control (irrigation at weekly interval) resulted 134.50 cm vine length, 16.04 cm fruit length, 15.27cm diameter of fruit, 67.86 g average fruit weight, 7.18 number of fruits vine^{-1}, 595.00 g weight of fruits vine^{-1}and 7876.7kg ha^{-1} fruit yield. The irrigation frequencies at 10 days interval resulted 124.50 cm vine length, 15.61 cm fruit length, 15.70cm diameter of fruit, 62.00 g average fruit weight, 6.65 number of fruits vine^{-1}, 520.00kg weight of fruits vine^{-1}and 7305.0kg ha^{-1} fruit yield. The bitter gourd irrigated at 15 days interval resulted 120.50 cm vine length, 11.96 cm fruit length, 12.43cm diameter of fruit, 52.00 g average fruit weight, 5.15 number of fruits vine^{-1}, 418.33 g weight of fruits vine^{-1}and 6323.3kg ha^{-1} fruit yield.The values for all the growth and productivity of bitter gourd were markedly increased when crop irrigated at 10 days interval + foliar application of urea at 3.0% conc. These agree results with the finds of Asoegwu **[20]** who observed a decrease in the number of leaves with increase in irrigation interval. Similar findings were reported Channabasavanna and Setty **[21]** for sweet pepper. In their research findings showed an increase in growth and yield parameters with increasing organic and inorganic fertilizers up to a point, after which the parameters start decreasing. For example Olaniyi and Odedere **[22]** observed that although the application of 6 tha^{-1} compost gave the highest growth and yield parameters of fluted pumpkin, there was no significant difference between the values obtained at 4.5 and 6 tha^{-1}. However Polat *et al*. **[23]** found that there were statistically significant differences among different levels of spent mushroom compost applied, in terms of total yield of lettuce, as 2 and 4 tha^{-1} gave the best result. In the case of cucumber grown in green houses with drip irrigation also observed that the highest total fruit yield under similar dose rate.

Conclusions

It is concluded that the values for all the growth and yield traits of bitter gourd were markedly increased when irrigted at 10 days interval + foliar application of urea at 3.0% conc.It is suggested that for better growth and productivity, Bitter gourd may be irrigated at 10 days interval + foliar application of urea at 3.0 % concentration.

Authors' contributions

Conceived and designed the experiments: FM Bangulzaiand & A Samad, Performed the experiments: A Samad & FM Bangulzai, Analyzed the data: N Ahmed, Contributed reagents/materials/analysis tools: Z Bibi, L Bakhsh, A Raziq &SM Ishaq, Wrote the paper: FM Bangulzai & A Samad.

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