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EFFECT OF SPLIT APPLICATION OF NITROGEN ON THE GROWTH AND YIELD OF BITTER GOURD (MOMORDICA CHARANTIA)

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ABSTRACT

Plant nutrition at optimum quantity is essential for sustainable crop yield. Among all plant nutrients, nitrogen occupies a significant position. Therefore its balanced rate and timings for higher yield of crop plants needs to be investigated. The experiment was carried out to investigate the effect of split N application on the growth and yield of bitter gourd. The field trial was laid out in a three replicated Randomized Complete Block Design at the experimental field of Horticulture Department, Sindh Agriculture University Tandojam having plot size of 5.0 m x 6.0 m (30 m2). The treatments included T1= Control, T2= 150 kg ha-1 N in four splits (1/4th N as basal dose, and remaining N in 03 splits at monthly interval), T3= 150 kg ha^{-1} N in three splits (1/3rd N as basal dose, and remaining N in 02 splits at 25 days interval), T4= 150 kg ha^{-1} N in two splits (Half of N as basal dose and remaining half after 50 days of sowing and T5= 150 kg ha^{-1} N in three splits (1/3rd N after 25 days after sowing and remaining N in equal two splits at 50 and 75 days after sowing). The results revealed that all the growth and yield components of bitter gourd were significantly ($P<0.05$) influenced by increasing nitrogen doses. The nitrogen @ 150 kg ha^{-1} in three splits (1/3rd N as basal dose, and remaining N in 02 splits at 25 days interval) showed higher values and resulted 150.00 cm vine length, 21.56 cm fruit length, 89.29 g average fruit weight, 13.89 number of fruits $vine^{-1}$, 1240.2 g fruit weight $vine^{-1}$, 26.84 kg fruit yield $plot^{-1}$ and 8948 kg fruit yield ha^{-1}. The bitter gourd vines receiving 150 kg ha^{-1} N in four splits (1/4th N as basal dose, and remaining N in 03 splits at monthly interval) resulted in 146.00 cm vine length, 19.24 cm fruit length, 86.63 g average fruit weight, 13.08 number of fruits $vine^{-1}$, 1133.6 g fruit weight $vine^{-1}$, 25.63 kg fruit yield $plot^{-1}$ and 8545 kg fruit yield ha^{-1}. The results further showed that the bitter gourds raised without nitrogen application(control) showed lowest values and resulted 61.67 cm vine length, 9.80 cm fruit length, 35.64 g average fruit weight, 5.86 number of fruits $vine^{-1}$, 208.4 g fruit weight $vine^{-1}$, 6.40 kg fruit yield $plot^{-1}$ and 2136 kg fruit yield ha^{-1}. It was concluded that 150 kg ha^{-1} N in three splits (1/3rd N as basal dose, and remaining N in 02 splits at 25 days interval) was considered as an optimum level for achieving economically maximum fruit yield.

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INTRODUCTION

Bitter gourd, (*Momordica charantia*) is a delicious vegetable of Cucurbitaceae family with significant medicinal values (Miniraj *at al*. 1993). In fact, its medicinal value is more than in any of other vegetables of its class by virtue of its disease preventing and health promoting phyto chemical compounds (Grover and Yadav, 2004). The young shoots and leaves of the bitter gourd are also eaten. There are many varieties that differ substantially in the shape and bitterness of the fruit (Krawinkel and Keding, 2006). 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 (Krawinkel and Keding, 2006). The cultivation of bitter gourd is generally followed by conventional management and farmers do not give due consideration for proper nutrient management according to the crop requirement. Among these factors, balancing nutrients is of vital importance for a good crop harvest, because imbalanced nutrients application affects the crop yields adversely (Silberbush, 2002). Nitrogen is an essential nutrient elements required by the plants for their growth and vigour (Fageria and Baligar, 2005). Nitrogen is considered as an essential element of bio-molecules such as amino acids, proteins, nucleic acids, phytohormones and a number of enzymes and coenzymes. N strongly stimulates growth, expansion of the crop canopy and interception of solar radiation (Eckert, 2010). The Nitrogen fertilization needs to be adjusted because excessive fertilization is an economical loss and leads to negative environmental consequences (Mulvany *et al*., 2009).

Utilization of nutrients by the plants to an adequate level largely depends upon the N quantity and time of its application, because applying nitrogen according to the crop requirement at different growth stages needs to be taken into consideration (Elfstrand and Lans, 2002). Although the farmers mostly apply nitrogenous fertilizers in almost adequate amounts; but their awareness for time and quantity of nitrogen application considering the critical growth stage is not up to the mark. Due to imbalanced nitrogen application, the plant could not grow vigorously; and the crop yields are lower than the potential production. However, there is need of balancing the nitrogen application in terms of rate and time of application (Choudhari and More, 2007). The role of nitrogen is vital and cannot be tolerated and no any other nutrient can compensate its deficiency; while nitrogen deficiency is one of the key factors to influence the crop productivity adversely. The universal deficiency of N has become more severe in regions of continuous cropping (Raun and Johnson, 1999). The plant growth is mainly stimulated by N availability in the soil. Split application of N fertilizer may substantially improve N use efficiency, particularly during wet growing seasons. During early growth stages, considerable N may be lost due to denitrification and leaching, particularly if wet conditions persist (Hamid and Nasab, 2001). Suresh kumar and Karuppaiah (2008) reported that half of the total N may be applied at sowing and remaining amount of N may be adjusted in two equal splits and such N management resulted in increased number of branches, fruits and marketable yield per vine in bitter gourd. Hilli *et al.* (2009) recorded significantly more vine length, number of leaves dry matter, higher fruit and seed yield when the crop was fertilized with $1/3^{rd}$ of total N in addition to all P or K at sowing.

Parvin (2012) achieved highest fruit yield of 6.8 t ha^{-1} of bitter gourd at 80 kg ha^{-1} N in addition to recommended Phosphorous (P) and potassium (K). Prasad *et al.* (2009) indicated that application of N in three splits improved the growth and fruiting of bitter gourd. Basal application of N in addition to P and K is necessary to achieve good crop stand. Harris and Clarke (2012) reported that N may be divided into various doses and under drought conditions one split application at critical growth stage is necessary. Thriveni *et al.* (2015) found that split N application through urea had a beneficial effect on bitter gourd vine length, branches $vine^{-1}$, fruits $plant^{-1}$, fruit weight, fruit girth, fruit yield as compared to conventional nutrient management. Considering the importance of split application of N on the yield potential of bitter gourd, the proposal study is aimed at examining the impact of split application of nitrogen on the growth and production of bitter gourd under field conditions.

MATERIALS AND METHODS

The experiment was carried out to investigate the effect of split N application on the growth and yield of bitter gourd. The field trial was laid out in a three replicated Randomized Complete Block Design at the experimental field of Horticulture Department, Sindh Agriculture University Tandojam having plot size of 5.0 m x 6.0 m (30 m^2). The treatments included T_1= Control, T_2= 150 kg ha^{-1} N in four splits ($1/4^{th}$ N as basal dose, and remaining N in 03 splits at monthly interval), T_3= 150 kg ha^{-1} N in three splits ($1/3^{rd}$ N as basal dose, and remaining N in 02 splits at 25 days interval), T_4= 150 kg ha^{-1} N in two splits (Half of N as basal dose and remaining half after 50 days of sowing and T_5= 150 kg ha^{-1} N in three splits ($1/3^{rd}$ N after 25 days after sowing and remaining N in equal two splits at 50 and 75 days after sowing). The N was given in the form of Urea as per the treatment plan; while 75 kg P (Single Super Phosphate) and 50 kg K (Sulphate of Potash) was also applied to maintain the experimental soil for nutrient status. All the cultural practices were operated as per the recommendations in all the plots uniformly. The observations were recorded on the basis of five selected vines in each plot. The traits of economic importance were measured which included vine length (cm), fruit length (cm), single fruit weight (g), number of fruits $vine^{-1}$, weight of fruits $vine^{-1}$ (g), fruits yield $plot^{-1}$ (kg) and fruit yield ha^{-1} (kg).

Statistical analysis

The recorded data were subjected to statistical analysis using computer software Statistix (2006). The analysis of variance was employed to examine the significance of each character for overall treatments, while the Least Significant Difference (LSD) test at 0.05 % probability level was employed to compare the treatment means.

RESULTS AND DISCUSSION

Vine length (cm): The data in regards to vine length of bitter gourd as affected by varying nitrogen doses are presented in Figure-1. The analysis of variance demonstrated that there was a significant ($P<0.05$) and linear impact of varying nitrogen levels on the bitter gourd vine length. The bitter gourd vines (creeping on soil surface on ridges) supplied with nitrogen at the rate of 150 kg ha^{-1} in three splits ($1/3^{rd}$ N as basal dose, and remaining N in 02 splits at 25 days interval) demonstrated maximum length of 150.00 cm, while the bitter gourd vines receiving nitrogen at the rate of 150 kg ha^{-1} in four splits ($1/4^{th}$ N as basal dose, and remaining N in 03 splits at monthly interval) and 150 kg ha^{-1} N in two splits (Half of N as basal dose and remaining half after 50 days of sowing with average vine length of 146.00 cm and 143.00 cm, respectively. The nitrogen @ 150 kg ha^{-1} N in three splits ($1/3^{rd}$ N after 25 days after sowing and remaining N in equal two splits at 50 and 75 days after sowing) demonstrated a simultaneous reduction in vine length up to 137.00 cm, respectively. However, the plots receiving no nitrogen (control) resulted in a minimum vine length of 61.67 cm. The least significant difference (LSD) test suggested that statistically the differences among all the treatments as well as control were significant (P<0.05). The increases in vine length under higher N application rates might be due to the increase in photosynthetic and other metabolic activities that caused better cell division and its elongation, resultantly plants with better vine length were produced (Firoz, 2009). The findings of Heidari and Mohammad (2012) also endorse the results of present investigation who also found beneficial effect of N on vine length.

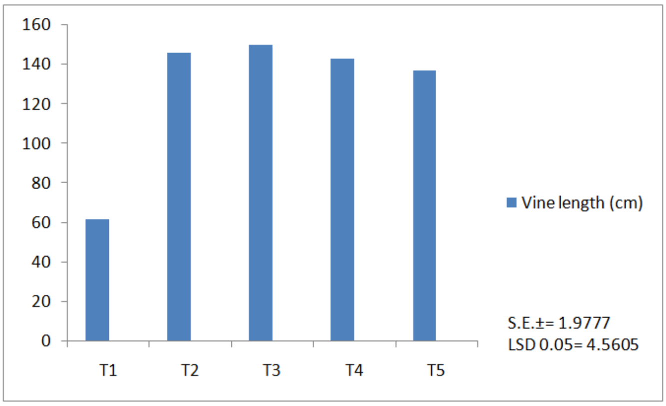

Figure 1. Vine length (cm) of bitter gourd as affected by different N levels

Fruit length (cm)

The results pertaining to fruit length of bitter gourd as affected by varying nitrogen doses are shown in Figure-2. The analysis of variance illustrated that the fruit length of bitter gourd was significantly influenced (P<0.05) due to application of nitrogen at varying levels. The bitter gourd vines fertilized with nitrogen at the rate of 150 kg ha^{-1} in three splits (1/3rd N as basal dose, and remaining N in 02 splits at 25 days interval) resulted in highest fruit length of 21.56 cm, while the vines receiving nitrogen at the rate of 150 kg ha^{-1} N in four splits (1/4th N as basal dose, and remaining N in 03 splits at monthly interval) and 150 kg ha^{-1} N in two splits (Half of N as basal dose and remaining half after 50 days of sowing with average fruit length of 19.24 cm and 16.63 cm, respectively. The crop under nitrogen dose 150 kg ha^{-1} N in three splits (1/3rd N after 25 days after sowing and remaining N in equal two splits at 50 and 75 days after sowing) followed an adverse impact on fruit length with 14.73 cm length of fruits, respectively. However, the bitter gourd plantation left untreated for nitrogen (control) produced minimum fruit length of 9.80 cm. Fruit length is most important yield component and this character vitally contributes to final fruit yield. The greater fruit length reflects that available nutrients especially N has been better sink and transported by axillary branches to the fruits that leads to healthier fruits with better length. The findings of the current study are in consonance with Ahmed et al. (2007) who reported that application of higher rates of N showed beneficial effects on fruit length of cucumber.

Single fruit weight (g)

The data in relation to individual fruit weight of bitter gourd as influenced by varying nitrogen doses are presented in Figure-3. The analysis of variance indicated that the application of nitrogen at varying levels had significant (P<0.05) effect on individual fruit weight of bitter gourd. The average fruit weight was significantly highest (89.29 g) in plots fertilized with nitrogen at the rate of 150 kg ha^{-1} in three splits (1/3rd N as basal dose, and remaining N in 02 splits at 25 days interval), followed by average fruit weight of 86.63 and 83.42 g, recorded in plots fertilized with nitrogen at the dose of 125 kg ha^{-1} and 100 kg ha^{-1}, respectively. The bitter gourd given nitrogen doses at the rates of 150 kg ha^{-1} N in three splits (1/3rd N after 25 days after sowing and remaining N in equal two splits at 50 and 75 days after sowing) resulted in lower average fruit weight of 77.47 g, respectively. However, the lowest average fruit weight (35.64 g) was obtained in control plots, where nitrogen was not applied. The higher average fruit weight under higher nitrogen doses was linearly contributed by increased fruit length, and these parameters are directly and positively influenced by the soil applied nitrogen at higher doses; because in control plots, the average fruit weight was significantly lowest. The data also indicated the average fruit weight was increased significantly when nitrogen was applied up to 150 kg ha^{-1} N in three splits (1/3rd N as basal dose, and remaining N in 02 splits at 25 days interval). These results reflects that N should be applied in split doses because during early growth stages, substantial N may be lost due to denitrification and leaching, particularly under wet conditions (Hamid and Nasab, 2001).

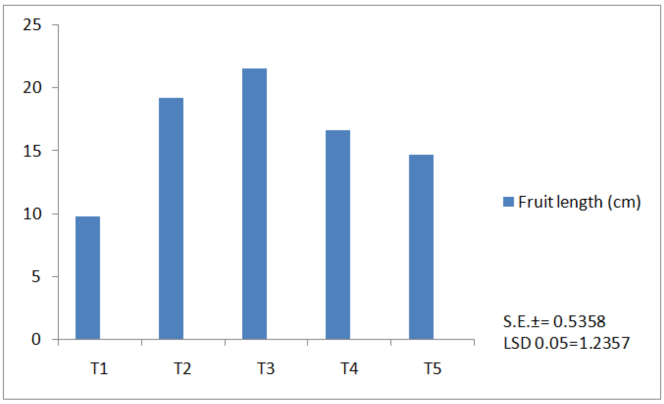

Figure 2. Fruit length (cm) of bitter gourd as affected by different N levels

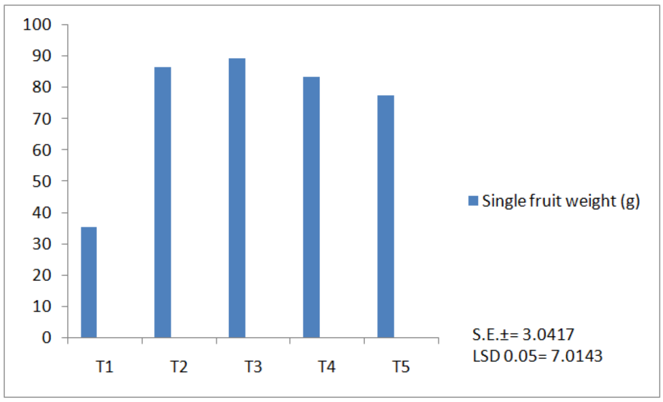

Figure 3. Single fruit weight (g) of bitter gourd as affected by different N levels

Number of fruits vine^{-1}

The results pertaining to number of fruits plant $^{-1}$ of bitter gourd as influenced by varying nitrogen doses are presented in Figure-4. The analysis of variance illustrated that different doses of nitrogen fertilizer had significant (P<0.05) effect on the number of fruits vine^{-1} of bitter gourd. The number of fruits vine^{-1} was significantly highest (13.89) in plots fertilized with highest nitrogen dose of 150 kg ha^{-1} N in three splits (1/3rd N as basal dose, and remaining N in 02 splits at 25 days interval), followed by 13.08 and 12.02 fruits vine^{-1} recorded in plots fertilized with nitrogen doses of 150 kg ha^{-1} N in four splits (1/4th N as basal dose, and remaining N in 03 splits at monthly interval) and 150 kg ha^{-1} N in two splits (Half of N as basal dose and remaining half after 50 days of sowing, respectively. The number of fruits in bitter gourd fertilized with nitrogen doses of 150 kg ha^{-1} N in three splits (1/3rd N after 25 days after sowing and remaining N in equal two splits at 50 and 75 days after sowing) followed a declining trend with 10.75 fruits vine^{-1}, respectively. However, the minimum number of fruits (5.86) vine^{-1} was observed in plots left untreated for nitrogen (control). The increase in the number of fruits vine^{-1} was significant (P<0.05) when nitrogen was applied @ 150 kg ha^{-1} N in three splits (1/3rd N as basal dose, and remaining N in 02 splits at 25 days interval). These results demonstrated that N is equally important at all growth stages of the plants. The findings of Prasad *et al.* (2009) also supports the results of current investigation who also demonstrated that supplying of N in three split doses enhanced the vegetative and fruit characters of bitter gourd.

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

The data in regards to weight of fruits vine^{-1} of bitter gourd as affected by varying doses of nitrogen fertilizer are given in Figuree-5. The analysis of variance indicated that different doses of nitrogen fertilizer had significant (P<0.05) influence on the weight of fruits vine^{-1}. The maximum weight of fruits (1240.2 g) vine^{-1} was achieved from the bitter gourd plots given nitrogen @ 150 kg ha^{-1} in three splits (1/3rd N as basal dose, and remaining N in 02 splits at 25 days interval), followed by 1133.6 and 1003.5 g average weight of fruits vine^{-1} obtained from the plots fertilized with nitrogen doses of 150 kg ha^{-1} N in four splits (1/4th N as basal dose, and remaining N in 03 splits at monthly interval) and 150 kg ha^{-1} N in two splits (Half of N as basal dose and remaining half after 50 days of sowing, respectively. The weight of fruits in bitter gourd fertilized with nitrogen dose of 150 kg ha^{-1} N in three splits (1/3rd N after 25 days after sowing and remaining N in equal two splits at 50 and 75 days after sowing) pursued a diminishing trend with 834.4 g average weight of fruits vine^{-1}, respectively. The minimum weight of fruits (208.4 g) vine^{-1} was observed in plots kept without nitrogen (control). These results highly suggested the importance of N in split doses. Moreover, the current findings also suggest that bitter gourd plants have different N requirements at vegetative and reproductive growth stages. In the present study, the application of N at adequate quantity might have fulfilled the nutritional requirements of plants resultantly healthier plants with better fruit weight were produced. These results are in consonance with the findings of Heidari and Mohammad, 2012 who also suggested that split application of N at 150 N kg ha^{-1} revealed positive and beneficial effects on growth and yield characters.

Fruits yield plot^{-1} (kg)

The results in relation to fruit yield plot^{-1} of bitter gourd as influenced by varying doses of nitrogen fertilizer are shown in Figure-6. The analysis of variance demonstrated significant (P<0.05) effect of varying nitrogen levels on the fruit yield plot^{-1}. It is apparent from the results that the maximum fruit yield plot^{-1} (26.84 kg) was obtained from the bitter gourd plantation receiving highest nitrogen @ 150 kg ha^{-1} N in three splits (1/3rd N as basal dose, and remaining N in 02 splits at 25 days interval), followed by average fruit yield of 25.63 kg and 24.05 kg plot^{-1} noted from the plots fertilized with nitrogen doses of 150 kg ha^{-1} N in four splits (1/4th N as basal dose and 150 kg ha^{-1} N in two splits (Half of N as basal dose and remaining half after 50 days of sowing, respectively. The fruit yield in plots fertilized with 150 kg ha^{-1} N in three splits (1/3rd N after 25 days after sowing and remaining N in equal two splits at 50 and 75 days after sowing) revealed a declining trend with average fruit yield of 19.39 kg plot^{-1}, respectively. The lowest fruit yield (6.40 kg) plot^{-1} was recorded in control plots where nitrogen was not applied.

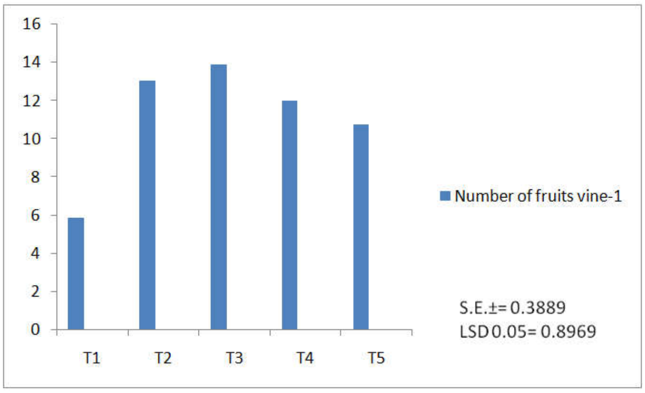

Figure 4. Number of fruits vine^{-1} of bitter gourd as affected by different N levels

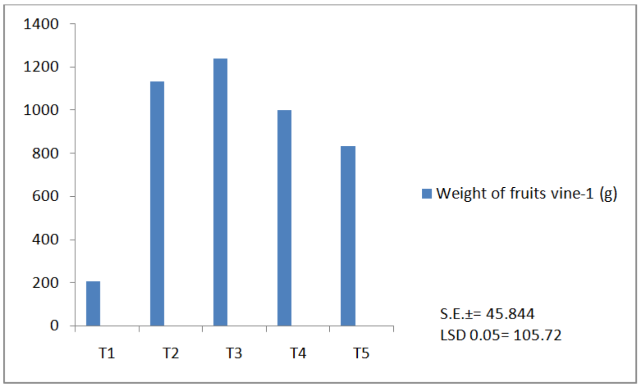

Figure 5. Weight of fruits vine^{-1} (g) of bitter gourd as affected by different N levels

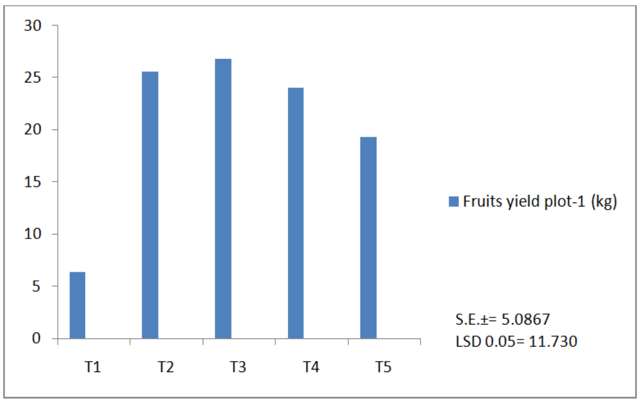

Figure 6. Fruits yield plot^{-1} (kg) of bitter gourd as affected by different N levels

Fruit yield ha^{-1} (kg)

The data pertaining to fruit yield ha^{-1} of bitter gourd as affected by different doses of nitrogen fertilizer are presented in Figure-7.

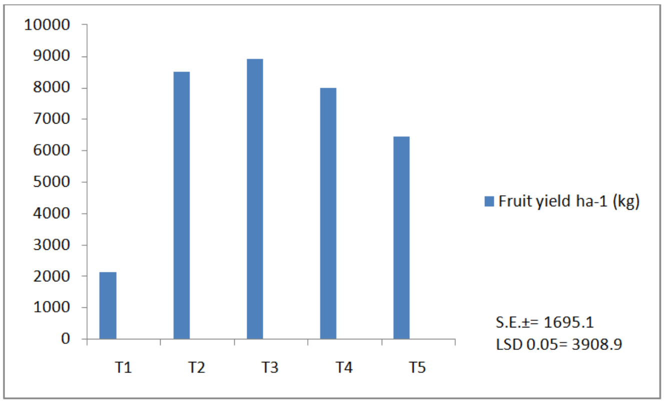

Figure 7. Fruit yield ha^{-1} (kg) of bitter gourd as affected by different N levels

The analysis of variance illustrated that the fruit yield ha^{-1} was significantly ($P<0.05$) influenced by varying nitrogen levels. The highest fruit yield of 8948 kg ha^{-1} was achieved from the plots supplied with 150 kg ha^{-1} N in three splits (1/3rd N as basal dose, and remaining N in 02 splits at 25 days interval), closely followed by fruit yield of 8545 and 8018 kg ha^{-1} realized from the plots fertilized with 150 kg ha^{-1} N in four splits (1/4th N as basal dose, and remaining N in 03 splits at monthly interval) and 150 kg ha^{-1} N in two splits (Half of N as basal dose and remaining half after 50 days of sowing , respectively. The fruit yield in plots fertilized with 150 kg ha^{-1} N in three splits (1/3rd N after 25 days after sowing and remaining N in equal two splits at 50 and 75 days after sowing) with average fruit yield of 6465 kg ha^{-1}, respectively. The minimum fruit yield of 2136 kg ha^{-1} was observed in control plots where nitrogen was not given to the plants. It is evident from the results that higher fruit yield ha^{-1} was mainly contributed by improved vine length, length of fruits, weight of fruit vine^{-1}, number of fruits vine^{-1} and average fruit weight vine^{-1}. Moreover, these results also suggests that under high N nutrition plants have got capacity to absorb nutrients efficiently that leads to better photosynthetic and other metabolic activities resultantly higher yield was obtained. These findings are in accord with the results of Heidari and Mohammad, (2012), Nasreen et al. (2013) who also described that N is very essential for better yield of bitter gourd.

Conclusions

In the light of findings of the current investigation, it is suggested that balanced application of N nutrition is prerequisite for achieving desired yield results in bitter gourd. However, supply of N in split doses also plays a vital to meet the N requirements of bitter gourd. It is concluded that 150 kg ha^{-1} N in three splits (1/3rd N as basal dose, and remaining N in 02 splits at 25 days interval) was considered as an optimum level for achieving economically maximum fruit yield. However, further study needs to be carried out in other regions and diverse climatic conditions to optimize the N requirements of bitter gourd.

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