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# Effect of straw mulch and irrigation frequency on yield and yield components of mung bean [*Vigna radiata* (L.) Wilczek]

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**ABSTRACT**

A field experiment was conducted at agricultural research farm of Agriculture faculty of Ghazni University in 2022. It was laid out in Factorial Randomized Complete Block Design with three levels of irrigation frequency as, irrigation interval at 5 (I05), 10 (I10) and 15 (I15) days; with straw mulch (SM) and non-straw mulch (NM) in three replications. The highest amount of grain yield (1102 kg $ha^{-1}$) was obtained from 10-day irrigation interval with straw mulch (SMI10) followed by SMI15 (1064 kg $ha^{-1}$) and SMI05 (1081 kg $ha^{-1}$) treatments, respectively. While NMI15 treatment significantly ($P<0.05$) reduced number of leaves (18 leaves per plant), leaf area (22 $cm^2$), number of pods (15 pods per plant), 1000-seed weight (48 g), and grain yield (531 kg $ha^{-1}$) than other treatments. In SMI10, SMI05, and SMI15 treatments, the crop water stress coefficient ($K_s$) values were recorded as 0.93, 0.91, and 0.90, respectively. In conclusion, the highest mung bean performance was achieved under SMI10 and SMI15 treatments, and for achieving suitable yield of mung bean, 15-day irrigation interval with straw mulch is recommended.

**Key words:** Irrigation frequency, mulch, mung bean, yield, yield components

## INTRODUCTION

Mung bean (*Vigna radiata* L.) is a short-season grain legume crop that grows in summer predominantly indry conditions throughout tropical and subtropical (Robertson et al., 2004). This crop is rich in protein (25%) with high quality lysine (460 mg $g^{-1}$) and tryptophan (60 mg $g^{-1}$). Its seed has significant amount of ascorbic acid when sprouted, as well as riboflavin (0.21 mg 100 $g^{-1}$) and minerals (Praveena et al., 2018) specifically K, Fe, P and Ca with higher digestibility (Mahato et al., 2015). Due to its ability to fix atmospheric nitrogen in the soil (Mahunta et al., 2018), mung bean plays a major role in crop rotation (Sadiq et al., 2018). In case of drought stress, Allahmoradi et al. (2011) reported the adverse effects of drought stress during vegetative growth than in reproductive stage. There for in areas with limited water availability and high soil temperature, straw mulch may be beneficial for growth and yield of mung bean (Chaudhary et al., 1985). The contribution of crops residue uses as mulch on conservation of soil fertility for long time reported by Martin and Belfield (2007). The use of an appropriate Ks method having the potential to improve irrigation time table in better management of stress and ensuring optimum yield under limited irrigation water supply (Kullberg et al., 2017). Therefore, the aim of this experiment was the evaluation of mulch and irrigation frequency on yield and yield components of mung bean for efficient use of irrigation water under irrigated conditions with limited water supply.

## MATERIALS AND METHODS

### Experimental site

This experiment wa scarried out at agricultural research farm of the Ghazni University (lat. 33° 31' 58" N, long. 68° 28' 52" E, altitude 2204 m above MSL). Ghazni province is in the area with cold and snowy winter (October to March the fourth quarter of the Persian year) in which the most parts of precipitations occur and hot summer (Hemat et al., 2017).

### Experimental design

This experimental design was laid out in Factorial Randomized Complete Block Design with three irrigation frequency and with and without straw mulch which consist of six treatments viz. NMI05, NMI10, NMI15, SMI05, SMI10, and SMI15 (Table 1) in three replications

**Table 1.** Description of the treatments

| No. | Treatments description | Group abbreviation |
|---|---|---|
| 1 | Irrigation after 5 days interval (I05) with no-straw mulch (NM) | NMI05 |
| 2 | Irrigation after 10 days interval (I10) with no-straw mulch (NM) | NMI10 |
| 3 | Irrigation after 15 days interval (I15) with no-straw mulch (NM) | NMI15 |
| 4 | Irrigation after 5 days interval (I05) with straw mulch (SM) | SMI05 |
| 5 | Irrigation after 10 days interval (I10) with straw mulch (SM) | SMI10 |
| 6 | Irrigation after 15 days interval (I15) with straw mulch (SM) | SMI15 |

### Data collection and parameters

### Growth and yield attributes

The plant growth parameters were directly measured from the row length of each treatment and recorded. A representative sample of 10 plants was used to represent the treatment and replication for determination of numbers of pods per plant, seeds per pod, 1000-seed weight and yield, and individual leaf are a measured as below:

$$LA = LL \times LW \times A \quad (1)$$

Where, LL and LW are leaf length and leaf width and A is constant (A=0.75), respectively, and total leaf area per plant was calculated by summation of individual leaf areas per plant.The leaf area index (LAI) was calculated from multiplying of leaf area per plant with number of plants per unit of land (Greaves and Wang, 2017) based on bellow equation:

$$LAI = LA/Plant \times No.\ Plant/m^2 \quad (2)$$

### Crop water stress coefficient ($K_s$)

Crop water stress coefficient ($K_s$) shows the amount of water which received by plant during the growing season and calculated from relative yield reduction to maximum yield of crop. It ranges from 0-1 where the number 1 shows when crop received 100% of water and lower than 1 indicates the degree of stress. It is calculated by the following equation (Wahaj et al., 2007):

$$K_s=1-1/K_y\,[1-Y_a/Y_m] \quad (3)$$

Where, $K_s$ is crop water stress coefficient, $Y_a$= actual yield (kg $ha^{-1}$), $Y_m$= the maximum yield (kg $ha^{-1}$).

The SPSS software was used for analyzing of variance and Duncan test was used for determination of the significant differences between each treatment.

## RESULTS AND DISCUSSION

### Growth parameters

According to the research results, all the growth parameters, viz. plant height, number of leaves per plant, leaf area, leaf area index, and number of branchesper plant increased with increasein irrigation frequency under no mulch treatments (Table 2). The highest value of plant height (34 cm) was observed in SMI05 and with SMI10 (30 cm) and SMI15 (28 cm) but there was no significant *($p<0.05$)* difference between all the treatments. Also, no significant difference was found in leaf area index and number of branches per plant among the treatments. The treatment of SMI10 had higher number of leaves per plant (36) than the remaining treatments except NMI10 and NMI15 which were significant. In case of leaf area, there were statistically no significant differences among all the treatments except NMI15 which had significantly the lowest leaf area (22 $cm^2$) than other treatments.

**Table 2.** Effects of irrigation frequencies and straw mulch on growth attributing characteristics of mung bean

| Treatments | Plant height (cm) | Leaves per plant | Leaf area ($cm^2$) | Leaf area index | Branches per plant |
|---|---|---|---|---|---|
| NMI05 | 26 | $29^{cd}$ | $31^{ab}$ | 1.15 | 5 |
| NMI10 | 26 | $26^{de}$ | $28^{bc}$ | 0.90 | 5 |
| NMI15 | 20 | $18^{f}$ | $22^{d}$ | 0.52 | 5 |
| SMI05 | 34 | $35^{ab}$ | $34^{a}$ | 1.48 | 6 |
| SMI10 | 30 | $36^{a}$ | $31^{ab}$ | 1.40 | 6 |
| SMI15 | 28 | $32^{bc}$ | $31^{ab}$ | 1.26 | 6 |
| LSD | NS | * | * | NS | NS |
| CV% | 16 | 22 | 13 | 13 | 11 |

*Represent the significant difference ($P<0.05$), NS = no significant difference, LSD=least significant deviation, CV=coefficient of variation.

The result of this experiment is in conformity with the finding of Patel et al. (2020) who opioned that the plant growth depends on photosynthetic net produces, nutrient and water absorption from the soil, hence the proper and timely use of irrigation frequencies with reduction in water losses from plant rhizosphere causes cell turgidity resulting in higher meristematic activity, photosynthetic rate, and improves morphological parameters and ultimately enhance plant development (Yadav et al., 2021).

### Yield and yield components of mung bean

The yield components of mung bean in response to irrigation frequency varied from the highest to the lowest, where as no significant reduction were found among the treatments under straw mulch. Significantly the highest values in number of pods per plant (23, 22, and 22) and 1000-seed weight (59, 58, and 60 g) were recorded from SMI15, SMI10 and SMI05, respectively, compared to the remaining treatments (Table 3). Itwas in conformity with Haqqani and Pandey (1994) finding who reported the suffering of mung bean due to water stress resulted in reduction of seed yield, number of seeds per pod and 1000-seed weight. The similar result was reported by Bunkar et al. (2013) who recorded significantly higher values in all growth and yield parameters as well as yields under weed and straw mulches.

**Table 3.** Effects of irrigation frequencies and straw mulch on yield and yield components of mung bean

| Treatments | Pods per plant | Seeds per pod | 1000-seed weight (g) | Yield (kg $ha^{-1}$) |
|---|---|---|---|---|
| NMI05 | $20^{bc}$ | 8 | $56^{cd}$ | $972^{cd}$ |
| NMI10 | $20^{bc}$ | 8 | $54^{de}$ | $784^{e}$ |
| NMI15 | $15^{d}$ | 8 | $48^{f}$ | $531^{f}$ |
| SMI05 | $22^{ab}$ | 9 | $60^{a}$ | $1081^{ab}$ |
| SMI10 | $22^{ab}$ | 8 | $58^{bc}$ | $1102^{a}$ |
| SMI15 | $23^{a}$ | 9 | $59^{ab}$ | $1064^{bc}$ |
| LSD | * | NS | * | * |
| CV% | 13 | 6 | 8 | 24 |

*Represent the significant difference ($P<0.05$), NS = no significant difference, LSD=least significant deviation, CV=coefficient of variation.

The yield of mung bean due to irrigation frequency and straw mulch differed from NMI05 to SMI15. The grain yield of mung bean (1102 kg $ha^{-1}$) was recorded from the SMI10 treatment, that was not significantly different than SMI05, SMI15, and NMI05 treatments, except NMI10 and NMI15 treatments that was significantly different (Table 3). The similar findings reported by Swain et al. (2007) who stated that the greater up take of nutrients and moisture by plant under straw mulching by conserving moisture and mulching benefits yield by improving soil physical conditions including improved stability in the top soil (de Silva and Cook, 2003).

**Crop water stress coefficient ($K_s$)**

On the basis of the research results, the performances of mung bean to various irrigation frequency and straw mulch from NMI05 to SMI15 were dissimilar. The treatments (SMI10, SMI05, SMI15 and NMI05) whose $K_s$ values were recorded 0.93, 0.91, 0.90, and 0.83, respectively, indicating very less waterstress. However, the treatments of NMI10 and NMI15 whose $K_s$ values (0.70 and 0.51, respectively) had decreased significantly ($P<0.05$) indicating the sensitivity of the mung bean to water stress (Fig. 1).

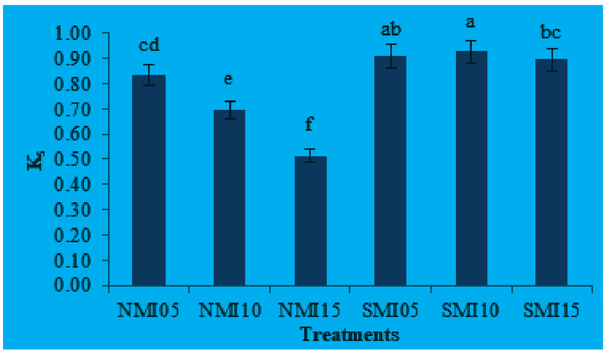
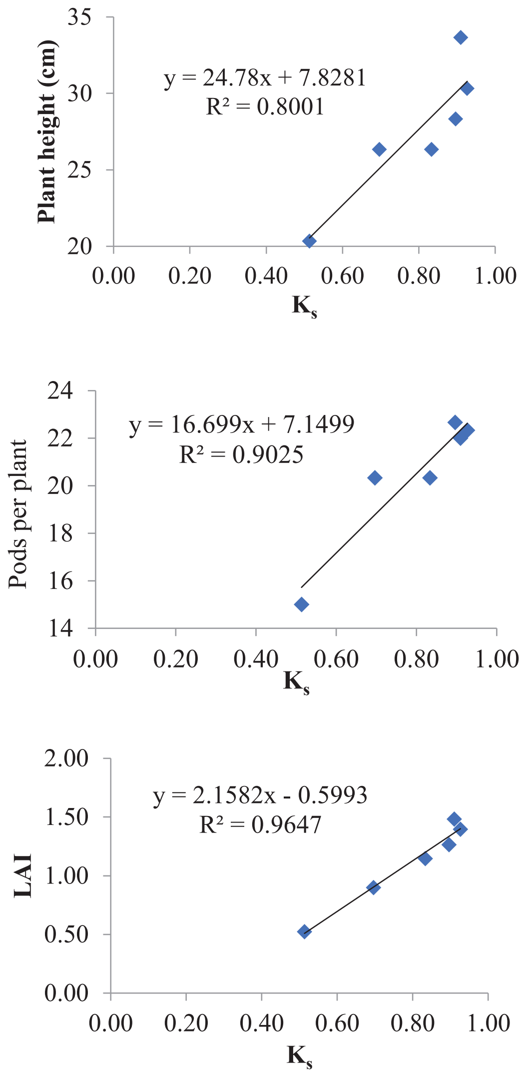



**Fig. 1.** Crop stress coefficient under various irrigation frequencies and straw mulch

Furthermore, the relationships of $K_s$ with growth, yield and yield components are presented in Fig. 2. The significant correlations ($R^2 = 0.9$) showed among growth, yield, and yield components with $K_s$. The growth, yield, and yield components values were decreased whenever the mung bean exposed to water shortage. The essentiality of maximizing water use efficiency through crop water stresse valuation was advocated by Kokkotos et al. (2020) and use of appropriate $K_s$ method to manage limited irrigation water supply for ensuring optimum yield are already expressed and confirm the result of our study in case of $K_s$. Like wise, our result is similar with findings of Terán-Chaves et al. (2022) who concluded that various water levels affect ryegrass by water depletion in the soil, resulting in reduction of biomass production by 76% at stress levels between 50% and 90% of total available water.



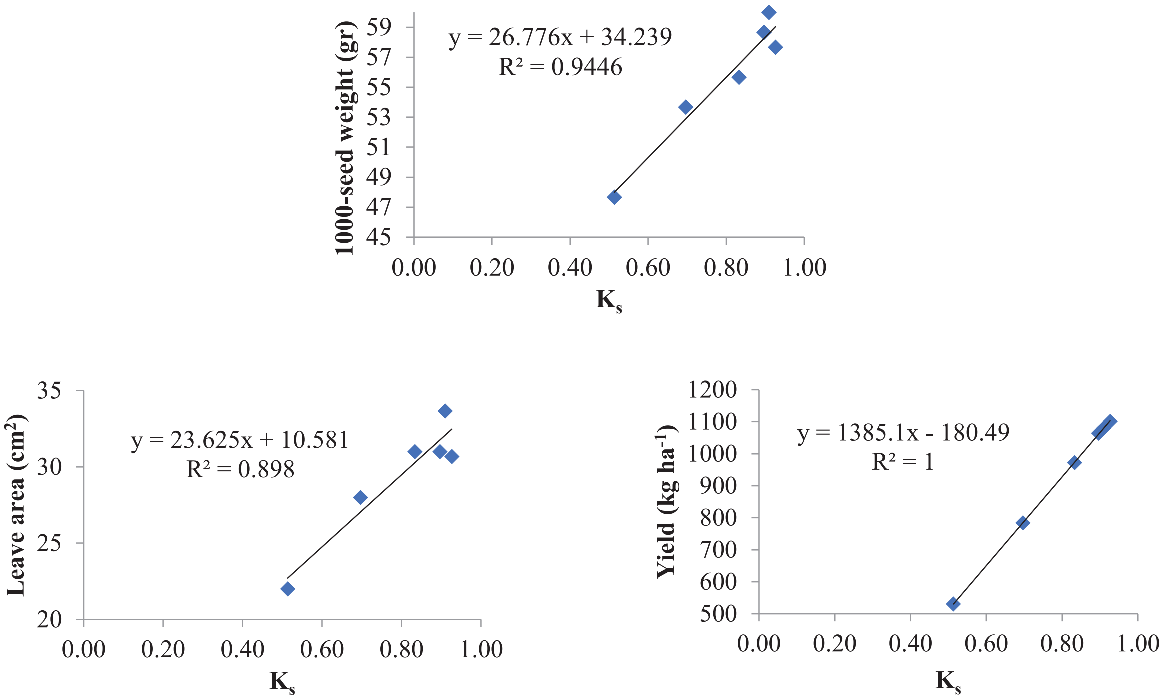



**Fig. 2.** Relationship of crop water stress coefficient with yield and yield components of mung bean

## CONCLUSION

Mung bean crop showed dissimilar performances to various irrigation frequencies and mulch. Although its response was better in 5-day and 10-day irrigation frequency with or without mulch cover, in addition SMI15 had satisfactory performance with respect to water in adequacy and scarcity. Therefore, mulching can be a better option for water saving and is recommended to be used between rows of cultivated crops.

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