Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(4): 971-977
Received: 12-05-2020
Accepted: 14-06-2020

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Ameliorative effect of trichoderma, rhizobium and mycorrhiza on internodal length, leaf area and total soluble protein in mung bean (*Vigna radiata* [L.] R. Wilazek) under drought stress

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Abstract
The present study entitled "Ameliorative Effect of Trichoderma, Rhizobium and Mycorrhiza on Internodal length, Leaf Area and Total Soluble Protein in Mung bean (*Vigna radiata* [L.] R. Wilazek) under Drought Stress". The result observed that, in comparison to T0, the exogenous application of drought and trichoderma in soil (T5) then its internodal length was increased by about 29 %, 26 % and 32% on the proposed date of the interval. Similarly, when the exogenous application of drought, trichoderma and mycorrhiza in the soil (T9) was compared to (T0) the leaf area was increased significantly with 11.6 %, 87% and 13% on the proposed dates of intervals. The average total soluble protein content was significantly enhanced with compared to (T0) about 29% and 21% at 30 and 60 DAS also it showed no difference at 80 DAS because of 0% when the soil treated with the application of drought, trichoderma and rhizobium (T8).

Keywords: Ameliorative, drought, stress, trichoderma, rhizobium, mycorrhiza

Introduction
Pulses are commonly known as food legumes, which are auxiliary to cereals in production and utilization in India. Pulses play an imperative source of dietary protein, energy, minerals and vitamins for humankind. Pulses give 25 per cent of protein requirements of the overwhelmingly vegetarian population. The World health organization (WHO) suggested the per capita utilization of pulses at 80 gram per day and the Indian council of medical research (ICMR) has suggested the least utilization of 47 gram. In 1968, the normal utilization in India was 56 gram per individual per day (Anonymous, 2004). Nevertheless, at the show, the real utilization is that as it may is much less at around 30-35 gram. The development and improvement of plants are constantly affected by environmental conditions example, stresses that are the most significant productivity decreasing variables on the earth (Dennis, 2000) [4]. Pulses are called as "Marvel of Nature". Pulses can moreover be referred to an as mini fertilizer production line, as they fix atmospheric nitrogen through symbiosis. Drought could be a problematical ecological stress factor that can occur at different intervals within the expansion and progress of crop cycle with several intensities. Drought stress could be a complex stress-influencing crop at various degrees of particular affiliation (Yordanov *et al*. 2000) [10]. Drought restricts crop development, influences crop growth and decreases the yield of the arrive, modifies and changes the morphology, physiology and anatomy of crops (Boyer, 1982) [3]. Stomata close due to water-deficient, decrease the amount of high-yielding undergrowth and reduce the vegetative growth phase by reducing the photosynthesis /leaf area (Van Loon, 1981) [9]. The consumption of chlorophyll substance is longer with expended intensity and period of water stress (Kiani *et al*. 2008) [7]. Arbuscular mycorrhizal fungi progress nutrition of plant by expanding the accessibility and transfer the different nutrients (Rouphael *et al*. 2015). AMF ameliorate the nature of the soil through affecting their surface and form that helps in plant health (Zou *et al*. 2016; Thirkell *et al*. 2017). Rhizobium species are capable of fixing atmospheric nitrogen in mung bean that are living in root nodules. Inoculation helps in increasing leaf area, plant height, dry matter production and photosynthetic rate with rhizobium in mung bean (Iqbal *et al*., 2012; Mehboob *et al*., 2012) [6, 8]. Trichoderma spp. has been characterized as plant symbiote opportunistic virulent organisms, ready to colonization in the roots of the plant as well as develop compounds which animate growth and plant protection mechanisms during problematic circumstances (Harman *et al*., 2004) [5].

Materials and Methods

The research work was carried out during the year 2019-20 entitled as "Ameliorative Effect of Trichoderma, Rhizobium and Mycorrhiza in Mung bean (*Vigna radiata* [L.] R. Wilazek) under Drought Stress" at School of Agriculture, Lovely Professional University (LPU), Phagwara, Punjab. The present investigation was conducted in an open environment and the laboratory of the Department of Agronomy, Lovely Professional University, Phagwara, India. Its geographical location lies between 25º 18'N latitude to 83º 03'E longitudinal and the elevation of the experimental site from the sea level is approximately 75.7 meters above the mean sea level. Phagwara falls in Northern India in "Trans-Gangetic plains Region" agro-climatic zone, it is located at the foot (lower feet) of the Himalayan range lies in the fertile plain in between Beas and Sutlej rivers area gate-way to the Himalayas, its average elevation of 234m(767feet). The average temperature is 24.1ºC on an average January is the coldest month of the year whereas, June is the hottest month of the year with an average rainfall is 686mm. The normal time for the onset of monsoon is mostly during the fourth week of June or the first week of July up to begin in the first week of September. The average annual rainfall is about 200mm.In recent times the highest temperature recorded is 38ºC in the month of June and the lowest is 0ºC in the month of January. The average relative humidity is 33% it rises to 64% from May to September. Disease-free and healthy, seeds of *Vigna radiata*, ML 818 genotype, trichoderma, rhizobium and endomycorrhiza fungi were obtained from Punjab Agriculture University, Ludhiana. The pot experiment was conducted in the polyhouse of the Lovely Professional University. Mung bean seeds were taken from Punjab Agriculture University, Ludhiana. The pot size for the experiment was in the diameter of 30 cm and 25 cm in height and each with a capacity of 14 kg soil, with a small hole at the bottom. Pots containing soil mix (Soil + FYM in 3:1) are inoculated with seeds of mung bean. According to the plan of work, Drought was induced by withholding water. Water holding was created on the 30 days after transplantation at the vegetative stage for 7 days. Plants were re-watered when 50% of the treated plants showed a sign of wilting during treatment. Trichoderma, Rhizobium and Mycorrhiza will be applied at the rate at the time of sowing of crops. The various observations were taken at three stages such as 30, 60 and 80 days after sowing (DAS) in the concerned pots. The experiment was laid out in a completely randomized design (CRD). There were thirteen treatments including control. Each treatment was replicated three times therefore, total no. of pots are 39. The treatments were T0-Control; T1- Drought; T2- Trichoderma fungi; T3- Rhizobium;T4- Endomycorrhizal fungi (AMF), *Glomus* species; T5- Drought + Trichoderma; T6- Drought + Rhizobium; T7- Drought + Mycorrhiza; T8 Drought + Trichoderma + Rhizobium; T9- Drought + Trichoderma + Mycorrhiza; T10- Drought + Rhizobium + Mycorrhiza; T11-. Drought + Trichoderma + Rhizobium + Mycorrhiza; T12- Control + Trichoderma + Rhizobium + Mycorrhiza. The recorded observations of morphological and biochemical parameters and the standard procedure adopted during the course of study are given below:

Morphological parameters

Leaf area (sq.m)

Leaf area was measured at 30, 60 and 80 days after planting by using leaf area meter and was expressed as cm^2 $plant^{-1}$.

Internodal length (cm)

Internodes are the sections of stem between nodes. The length of the internodes was recorded from one node to another node in each plant. The mean of the internodal length per plant was taken as the final internodal length of the plant. It was observed that several internodes were present in the Mung bean. So, the mean value of the internodal length was expressed as the internodal length of the plant.

Biochemical parameters

Estimation of Total Soluble Protein (mg g^{-1} fresh weight)

The method developed by *Bradford, (1976)* was followed.

Principle

The assay is based on the observation that the absorbance maximum for an acidic solution of Coomassie Brilliant Blue G-250 shifts from 465 nm to 595 nm when binding to protein occurs. Both hydrophobic and ionic interaction stabilizes the anionic form of the dye causing a visible colour change. The assay is useful since the extinction coefficient of a dye-albumin complex solution is constant over a 10-fold concentration range.

Reagents

1. Sodium phosphate buffer (pH 7.4)

Solution A: To prepare the Sodium phosphate buffer, 13.9 g of 0.1 M sodium dihydrogen phosphate (NaH_2PO_4) was dissolved in distilled water and the volume was made up to 1000 ml.

Solution B: To prepare the Sodium phosphate buffer, 26.82 g of 0.1 M disodium hydrogen phosphate (Na_2HPO_4) was dissolved in distilled water and the volume was made up to 1000 ml.

The solution A and the solution B were mixed in the ratio of 19:81 and the final pH (7.4) was adjusted with the help of pH meter.

2. Dye concentration

Dissolved 100 mg of Coomassie brilliant blue G 250 in 50 ml of 95% ethanol. Add 100 ml of concentrated ortho-phosphoric acid. Add distilled water to a final volume of 200 ml. stored in an amber bottle in the refrigerator, the solution is stable at least six months. Mixed concentrated dye solution with distilled water at the ratio of 1:4. Filter with Whatman No. 1 paper if any precipitate occurred.

Procedure

The 100 mg of plant sample was taken and transferred into a mortar. The 10 ml of cold extraction was added. The mortar was kept into the ice bucket and ground with the help of pestle, till fine slurry was made. The homogenate was centrifuged at 15,000 rpm for 15 min. The supernatant was collected and used as crude protein extracted. Took 5ml diluted dye, 0.2 ml of leaf crude protein extract and 0.8 ml of distilled water; mix well and allow the colour to develop for at least five minutes but not longer than 30 minutes. The red dye turns blue when it bonded to proteins, Read the absorbance at 595 nm using a spectrophotometer.

Preparation of the Standard Curve for Estimation of Total Soluble Protein

The standard curve was prepared using 0.1-1.0 ml BSA (Bovine Serum Albumin). The standard curve was prepared by plotting the absorbance value on the y-axis against the concentration of the sugar in solution on the x-axis. The amount of total soluble protein expressed in mg/g of sample.

Results and Discussion

Internodal Length (cm)

Ameliorative effect of trichoderma, rhizobium, mycorrhiza, and their combination on Internodal length (cm) was studied

in mung bean variety ML 818 during the years 2019-20, (Table 1, Fig. 1). It was evident that the average Internodal length was significantly reduced with 12%, 42% and 16% on the proposed date of the interval when exposed to drought stress (T1) as compared to control (T0). Similarly, when the soil was treated with an application of trichoderma fungi (T2) then its Internodal length was significantly decreased with 41%, 26% and 21% at 30, 60 and 80 DAS, as compared to control (T0). Exogenous application of rhizobium in the soil (T3) then its Internodal length correspondingly decreased with 18%, 26% and 11% on the dates of 30, 60 and 80 DAS. Similarly, when the exogenous application of Endomycorrhizal fungi (AMF), *Glomus* species. in the soil (T4) was compared to T0 the Internodal length was increased significantly decreased with 47%, 42% and 16 % at 30, 60 and 80 DAS. In comparison to T0, the exogenous application of drought and trichoderma in soil (T5) then its Internodal length was increased by about 29 %, 26 % and 32% on the proposed date of the interval. The average Internodal length was significantly decreased with compared to (T0) about 12% and 11% at 30 and 60 DAS also, it was increased by about 5% at 80 DAS when the soil treated with the application of drought and rhizobium (T6). Similarly, when the soil treatment with the application of drought and mycorrhiza (T7) was compared with T0 the Internodal length was decreased significantly with 29%, 26% and 16% on the proposed date of the interval. The average Internodal length was significantly decreased with compared to (T0) about 6 % at 30 DAS also it was increased with 16% and 26% on the dates of 60 and 80 DAS when the soil treated with the application of drought, trichoderma and rhizobium (T8). Similarly, when the exogenous application of drought, trichoderma and mycorrhiza in the soil (T9) was compared to (T0) the Internodal length was increased significantly with 6%, 5% and 11% on the proposed dates of intervals. Likewise, when the soil treated with an application of drought, rhizobium and mycorrhiza (T10) then its Internodal length was significantly decreased about 53% 32% and 21% on the dates of 30, 60 and 80 DAS. The average Internodal length was significantly decreased with compared to (T0) about 24% 21% and 11% at 30, 60 and 80 DAS when the soil was treated with the application of drought, trichoderma, rhizobium and mycorrhiza (T11). In comparison to T0, the exogenous application of control, trichoderma, rhizobium and mycorrhiza in soil (T12) then its Internodal length was decreased about 47% 16% and 5% on the dates of 30, 60 and 80 DAS. When we compared the length of internodes, the maximum internodal length obtained in (T5) at 80 DAS and minimum internodal length obtained in (T10) at 30 DAS as compared to (T0).

Table 1: Internodal Length (cm) of Mung bean during *Kharif*

Treatments	30DAS	60DAS	80DAS
T0	$2.83^{abc}\pm0.76$	$3.17^{abc}\pm0.29$	$3.17^{abc}\pm0.58$
T1	$2.50^{abc}\pm0.87$	$1.83^{c}\pm0.29$	$2.67^{bc}\pm0.58$
T2	$1.67^{bc}\pm0.76$	$2.33^{bc}\pm1.15$	$2.50^{c}\pm0.87$
T3	$2.33^{abc}\pm0.76$	$2.33^{bc}\pm0.76$	$2.83^{abc}\pm1.26$
T4	$1.50^{bc}\pm0.50$	$1.83^{c}\pm0.29$	$2.67^{bc}\pm0.76$
T5	$3.67^{a}\pm1.15$	$4^{a}\pm1.0$	$4.17^{a}\pm0.76$
T6	$2.50^{abc}\pm1$	$2.83^{abc}\pm1.26$	$3.33^{abc}\pm0.58$
T7	$2^{bc}\pm1$	$2.33^{bc}\pm0.58$	$2.66^{bc}\pm0.76$
T8	$2.67^{abc}\pm0.58$	$3.67^{ab}\pm0.58$	$4^{ab}\pm0.50$
T9	$3^{ab}\pm0.2$	$3.33^{abc}\pm0.58$	$3.50^{abc}\pm9.50$
T10	$1.33^{abc}\pm1.15$	$2.17^{bc}\pm0.29$	$2.50^{c}\pm0$
T11	$2.17^{abc}\pm0.29$	$2.50^{abc}\pm0$	$2.83^{abc}\pm0.29$
T12	$1.50^{bc}\pm0.50$	$2.67^{abc}\pm1.60$	$3^{abc}\pm1.32$

Where, DAS: Days after sowing, Data are in the form of Mean±SD at $p<0.05$,

T0-Control; T1- Drought; T2- Trichoderma fungi; T3- Rhizobium;T4- Endomycorrhizal fungi (AMF), *Glomus* species; T5- Drought + Trichoderma; T6- Drought + Rhizobium; T7- Drought + Mycorrhiza; T8 Drought + Trichoderma + Rhizobium; T9- Drought + Trichoderma + Mycorrhiza; T10- Drought + Rhizobium + Mycorrhiza; T11-. Drought + Trichoderma + Rhizobium + Mycorrhiza; T12- Control + Trichoderma + Rhizobium + Mycorrhiza.

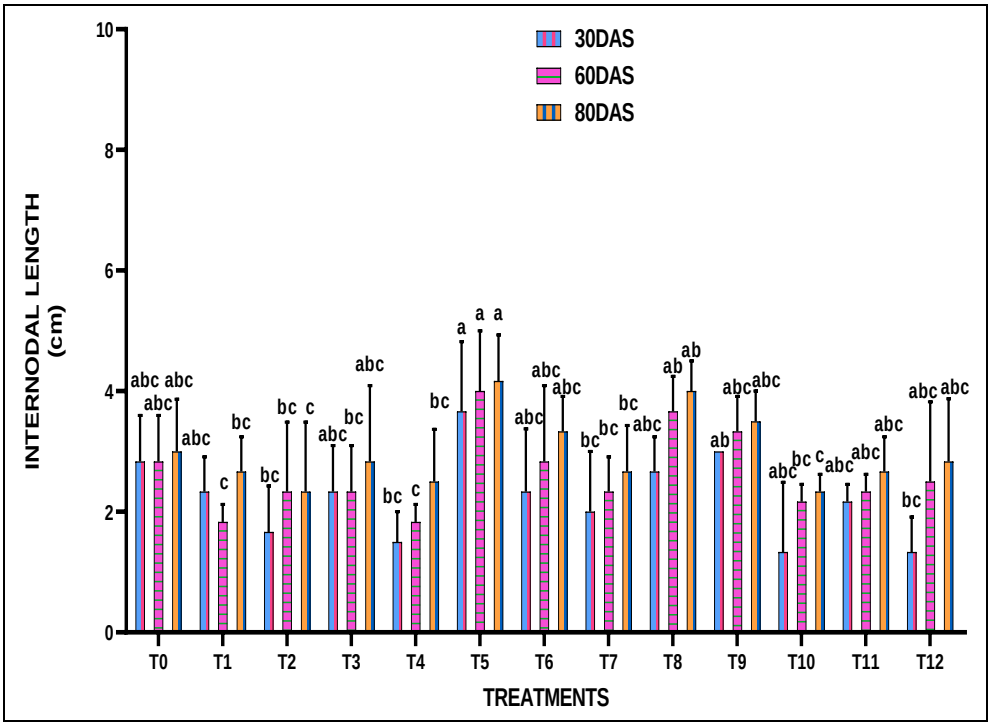

Fig 1: Internodal Length (cm) of Mung bean during *Kharif* 2019-20

Where, DAS: Days after sowing, Data are in the form of Mean±SD at $p<0.05$, T0-Control; T1- Drought; T2- Trichoderma fungi; T3- Rhizobium;T4- Endomycorrhizal fungi (AMF), *Glomus* species; T5- Drought + Trichoderma; T6- Drought + Rhizobium; T7- Drought + Mycorrhiza; T8 Drought + Trichoderma + Rhizobium; T9- Drought + Trichoderma + Mycorrhiza; T10- Drought + Rhizobium + Mycorrhiza; T11-. Drought + Trichoderma + Rhizobium + Mycorrhiza; T12- Control + Trichoderma + Rhizobium + Mycorrhiza.

Leaf Area (sq.m)

Ameliorative effect of trichoderma, rhizobium and mycorrhiza and their combination on leaf area (sq.m) was studied in mung bean variety ML 818 during the years 2019-20, under the drought stress. Data were recorded at 30, 60 and 80 days after sowing (DAS) (Table 2, Fig. 2). It was evident that the average leaf area was significantly increased with 3.3%, 27% and 1% on the proposed date of the interval when exposed to drought stress (T1) as compared to control (T0). Similarly, when the soil was treated with an application of trichoderma fungi (T2) then its leaf area was significantly increased with 4% and 33% at 30 and 60 DAS also it was reduced with 13% at 80 DAS as compared to control (T0). Exogenous application of rhizobium in the soil (T3) then its leaf area correspondingly decreased with 0.3% at 30 DAS and it was increased by about 32% and 30% on the dates of 60 and 80 DAS. Similarly, when the exogenous application of Endomycorrhizal fungi (AMF), *Glomus* species. in the soil (T4) was compared to T0 the leaf area was increased significantly with 3.3% and 38% at 30 and 60 DAS and it was reduced by about 14% at 80 DAS. In comparison to T0, the exogenous application of drought and trichoderma in soil (T5) then its leaf area was reduced by about 0.8 %, 1% and 23% on the proposed date of the interval. The average leaf area was significantly decreased with compared to (T0) about 2.1% and 21% at 30 and 80 DAS also; it was increased by about 10% at 60 DAS when the soil treated with the application of drought and rhizobium (T6). Similarly, when the soil treatment with the application of drought and mycorrhiza (T7) was compared with T0 the leaf area was increased significantly with 1%, 20% and 6% on the proposed date of the interval. The average leaf area was significantly decreased with compared to (T0) about 1.3 % at 30 DAS also it was increased with 5% and 13% on the dates of 60 and 80 DAS when the soil treated with the application of drought, trichoderma and rhizobium (T8). Similarly, when the exogenous application of drought, trichoderma and mycorrhiza in the soil (T9) was compared to (T0) the leaf area was increased significantly with 11.6 %, 87% and 13% on the proposed dates of intervals. Likewise, when the soil treated with an application of drought, rhizobium and mycorrhiza (T10) then its leaf area was significantly increased by about 1.8% and 32% at 30 and 60 DAS also it was decreased with 16% at 80 DAS, as compared to control (T0). The average leaf area was significantly decreased with compared to (T0) about 1.6% at 30 DAS also it was increased about 91% and 36% at 60 and 80 DAS, when the soil was treated with the application of drought, trichoderma, rhizobium and mycorrhiza (T11). In comparison to T0, the exogenous application of control, trichoderma, rhizobium and mycorrhiza in soil (T12) then its leaf area was increased with 6.4% and 29% at 30 and 60 DAS also it was reduced by about 8% on the dates of 80 DAS. When we compared the leaf area, the maximum leaf area obtained in (T11) at 60 DAS and minimum leaf area obtained in (T6) at 30 DAS as compared to (T0).

Table 2: Leaf Area (sq.m) of Mung bean during *Kharif* 2019-20

Treatments	30DAS	60DAS	80DAS
T0	5.37^{bc}±1.10	11.20^{b}±1.82	21.33^{abc}±4.33
T1	7.50^{bc}±3.97	14.27^{ab}±7.30	21.63^{abc}±8.28
T2	7.97^{bc}±4.80	14.90^{ab}±5.12	18.60^{abc}±6.01
T3	5.17^{bc}±0.76	14.73^{ab}±2.39	27.80^{ab}±1.35
T4	7.50^{bc}±2.29	15.43^{ab}±5	18.27^{bc}±6.55
T5	4.83^{bc}±1.04	11.13^{b}±0.55	16.50^{c}±2.95
T6	4^{c}± 0.3	12.33^{b}±0.90	16.80^{abc}±2.88
T7	6^{bc}± 0.3	13.40^{b}±0.61	22.53^{abc}±4.66
T8	4.50^{c}± 0.2	11.77^{b}±2.63	24.00^{abc}±8.92
T9	12.83^{a}±0.76	20.97^{a}±2.14	24.07^{abc}±4.86
T10	6.50^{bc}±3.91	14.80^{ab}±6.06	17.90^{bc}±6.61
T11	4.33^{c}±0.29	21.40^{b}±0.4	29^{a}±0.92
T12	9.50^{bc}±4.50	14.47^{ab}±5.55	19.60^{abc}±5.1

Where, DAS: Days after sowing, Data are in the form of Mean±SD at $p<0.05$, T0-Control; T1- Drought; T2- Trichoderma fungi; T3- Rhizobium;T4- Endomycorrhizal fungi (AMF), *Glomus* species; T5- Drought + Trichoderma; T6- Drought + Rhizobium; T7- Drought + Mycorrhiza; T8 Drought + Trichoderma + Rhizobium; T9- Drought + Trichoderma + Mycorrhiza; T10- Drought + Rhizobium + Mycorrhiza; T11-. Drought + Trichoderma + Rhizobium + Mycorrhiza; T12- Control + Trichoderma + Rhizobium + Mycorrhiza.

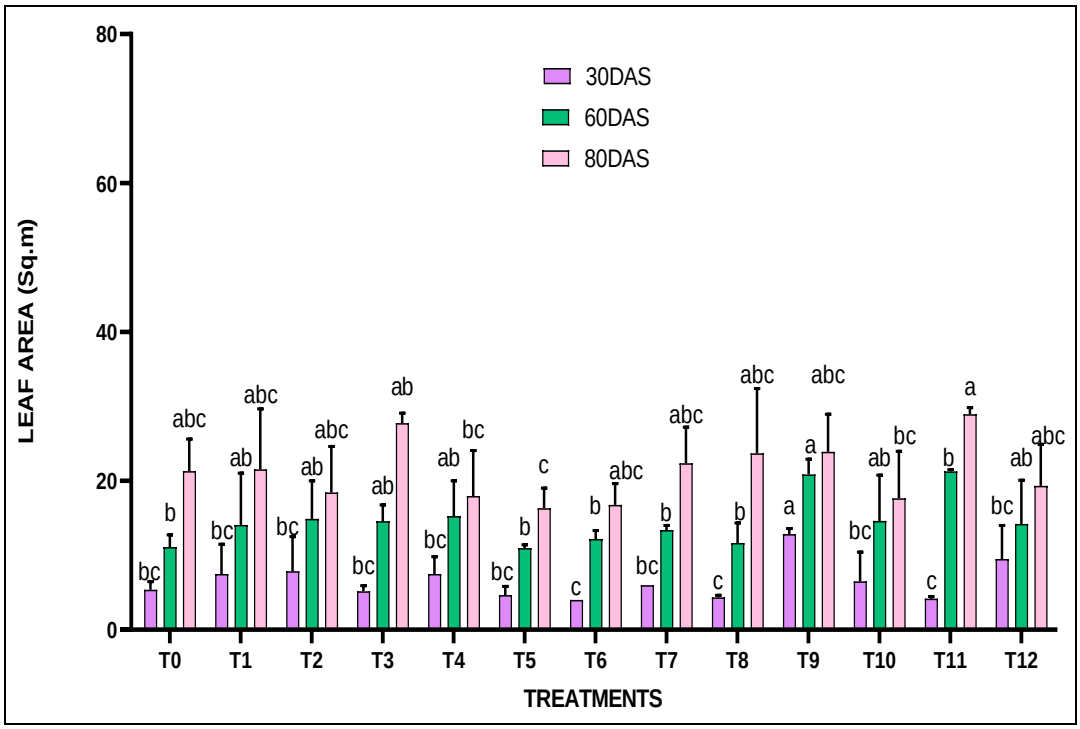

Fig 2: Leaf Area (sq.) of Mung bean during *Kharif* 2019-20

Where, DAS: Days after sowing, Data are in the form of Mean±SEM at $p<0.05$, T0-Control; T1- Drought; T2- Trichoderma fungi; T3- Rhizobium;T4- Endomycorrhizal fungi (AMF), *Glomus* species; T5- Drought + Trichoderma; T6- Drought + Rhizobium; T7- Drought + Mycorrhiza; T8 Drought + Trichoderma + Rhizobium; T9- Drought + Trichoderma + Mycorrhiza; T10- Drought + Rhizobium + Mycorrhiza; T11-. Drought + Trichoderma + Rhizobium + Mycorrhiza; T12- Control + Trichoderma + Rhizobium + Mycorrhiza

Total soluble protein (mg g^{-1} fresh weight)

Ameliorative effect of trichoderma, rhizobium, mycorrhiza, and their combination on total soluble protein content (cm) was studied in mung bean variety ML 818 during the years 2019-20, under the drought stress. Data were recorded at 30, 60 and 80 days after sowing (DAS) (Table 3 & Fig. 3). It was evident that the average total soluble protein content was significantly increased with 3% and 13% at 30 and 60 DAS also it was decreased with 54% on the dates of 80 DAS when exposed to drought stress (T1) as compared to control (T0). Similarly, when the soil was treated with an application of trichoderma fungi (T2) then its total soluble protein content was significantly increased with 12% and 6% at 30 and 60 DAS also it was reduced with 47% at 80 DAS, as compared to control (T0). Exogenous application of rhizobium in the soil (T3) than its total soluble protein content correspondingly increased with 10% and 7% at 30 and 60 DAS also it was reduced by about 52% at 80 DAS. Similarly, when the exogenous application of Endomycorrhizal fungi (AMF), Glomus species. in the soil (T4) was compared to T0 the total soluble protein content was increased significantly with 5% and 1% at 30 and 60 DAS also it was decreased with 44% at 80 DAS. In comparison to T0, the exogenous application of drought and trichoderma in soil (T5) then its total soluble protein content was increased with 7% and 21% at 30 and 60 DAS also it was reduced by about 1% at 80 DAS. The average total soluble protein content was significantly increased with compared to (T0) about 9% and 14% at 30 and 60 DAS also it was reduced by about 32% on the dates of 80 DAS when the soil treated with the application of drought and rhizobium (T6). Similarly, when the soil treatment with the application of drought and mycorrhiza (T7) was compared with T0 the total soluble protein content was increased significantly with 1% and 7% at 30 and 60 DAS also it was reduced by about 26% on the dates of 80 DAS. The average total soluble protein content was significantly increased with compared to (T0) about 29% and 21% at 30 and 60 DAS also it showed no difference at 80 DAS because of 0% when the soil treated with the application of drought, trichoderma and rhizobium (T8). Similarly, when the exogenous application of drought, trichoderma and mycorrhiza in the soil (T9) was compared to (T0) the total soluble protein content was increased significantly with 10% and 7% on the dates of 30 and 60 DAS also it was reduced by about 31% on the dates of 80 DAS. Likewise, when the soil treated with an application of drought, rhizobium and mycorrhiza (T10) then its total soluble protein content was significantly increased with 11% and 14% at 30 and 60 DAS also it was reduced by about 15% at 80 DAS, as compared to control (T0). The average total soluble protein content was significantly increased with compared to (T0) about 24% and 18% at 30 and 60 DAS also it was reduced by about 13% on the dates of 80 DAS when the soil was treated with the application of drought, trichoderma, rhizobium and mycorrhiza (T11). In comparison to T0, the exogenous application of control, trichoderma, rhizobium and mycorrhiza in soil (T12) then its total soluble protein content was increased with 6% and 20% on the dates of 30 and 60 DAS also it was reduced by about 34% at 80 DAS. When we compared the content of total soluble protein, the maximum total soluble protein content obtained in (T8) at 30 DAS and minimum total soluble protein content obtained in (T1) at 80 DAS as compared to (T0).

Table 3: Total soluble protein (mg g^{-1} fresh weight) of Mung bean during *Kharif*

Treatments	30DAS	60DAS	80DAS
T0	$5.67^{l}\pm0.38$	$3.97^{e}\pm0.38$	$8.14^{a}\pm0.13$
T1	$9.63^{j}\pm0.21$	$11.36^{c}\pm0.35$	$3.75^{f}\pm0.08$
T2	$19.78^{c}\pm0.17$	$7.39^{d}\pm0.43$	$4.33^{e}\pm0.17$
T3	$17.72^{e}\pm0.50$	$7.83^{d}\pm0.33$	$3.89^{f}\pm0.13$
T4	$12.11^{i}\pm0.21$	$4.52^{e}\pm0.13$	$4.53^{e}\pm0.21$
T5	$14.39^{g}\pm0.25$	$15.44^{a}\pm0.39$	$8.06^{a}\pm0.13$
T6	$16.11^{f}\pm0.21$	$11.50^{c}\pm0.38$	$5.53^{d}\pm0.13$
T7	$6.83^{k}\pm0.25$	$8^{d}\pm0.14$	$6.06^{c}\pm0.17$
T8	$40.44^{a}\pm0.83$	$15.39^{a}\pm0.38$	$8.14^{a}\pm0.13$
T9	$17.50^{e}\pm0.42$	$8^{d}\pm0.17$	$5.61^{d}\pm0.13$
T10	$18.89^{d}\pm0.60$	$11.61^{c}\pm0.29$	$6.94^{b}\pm0.17$
T11	$33.97^{b}\pm0.51$	$13.81^{b}\pm0.50$	$7.06^{b}\pm0.13$
T12	$13.06^{h}\pm0.50$	$15.28^{a}\pm0.29$	$5.39^{d}\pm0.13$

Where, DAS: Days after sowing, Data are in the form of Mean±SD at $p<0.05$, T0-Control; T1- Drought; T2- Trichoderma fungi; T3- Rhizobium;T4- Endomycorrhizal fungi (AMF), *Glomus* species; T5- Drought + Trichoderma; T6- Drought + Rhizobium; T7- Drought + Mycorrhiza; T8 Drought + Trichoderma + Rhizobium; T9- Drought + Trichoderma + Mycorrhiza; T10- Drought + Rhizobium + Mycorrhiza; T11-. Drought + Trichoderma + Rhizobium + Mycorrhiza; T12- Control + Trichoderma + Rhizobium + Mycorrhiza.

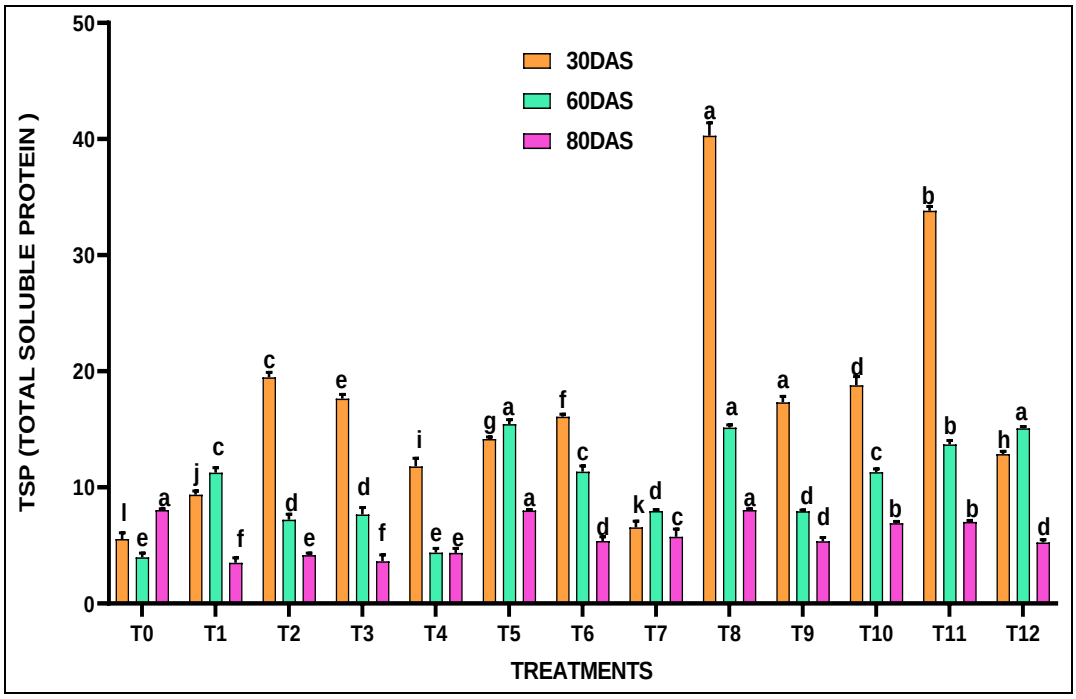

Fig 3: Total soluble protein (mg g^{-1} fresh weight) of Mung bean during *Kharif* 2019-20

Where, DAS: Days after sowing, Data are in the form of Mean±SD at $p<0.05$, T0-Control; T1- Drought; T2- Trichoderma fungi; T3- Rhizobium;T4- Endomycorrhizal fungi (AMF), *Glomus* species; T5- Drought + Trichoderma; T6- Drought + Rhizobium; T7- Drought + Mycorrhiza; T8 Drought + Trichoderma + Rhizobium; T9- Drought + Trichoderma + Mycorrhiza; T10- Drought + Rhizobium + Mycorrhiza; T11-. Drought + Trichoderma + Rhizobium + Mycorrhiza; T12- Control + Trichoderma + Rhizobium + Mycorrhiza.

Conclusion

The development and improvement of plants are constantly affected by environmental conditions example, stresses that are the most significant productivity decreasing variables on the earth. Drought could be a problematical ecological stress factor that can occur at different intervals within the expansion and progress of crop cycle with several intensities. Drought stress could be complex stress influencing crop at various degrees of particular affiliation. Drought restricts crop development, influences crop growth and decreases the yield of the arrive, modifies and changes the morphology, physiology and anatomy of crops. The Internodal length was increased by the treatment of drought and trichoderma. Leaf area was enhanced by the treatment of drought, trichoderma and mycorrhiza. TSP content was increased by the treatment of drought, trichoderma and rhizobium.

Acknowledgement

P.K. and S.K. gratefully acknowledge the support provided by Lovely Professional University.

Author Contributions

The contribution of the authors in paper writing was equal.

Conflict of Interest Statement

The authors state that they have no interest in conflict.

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