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Performance of concentrated cropmax on growth and yield of mungbean

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Abstract

The present study was conducted at the research field of Patuakhali Science and Technology University (PSTU), Patuakhali during the period from December 2013 to March 2014 to study on the effect of a concentrated fertilizer (Cropmax) on the growth and yield the Mung bean. It also observed the comparative growth and yield performance of foliar application Cropmax (0, 2.0, 3.0 and 5.0 ml L^{-1}) . Data were collected on plant height, leaf per plant, branches per plant, length of root, leaf area, dry weight of shoot, dry weight of root, TDM, AGR, CGR and RGR, number of pod per plant, pod length, number of seed per pod, thousand seed weight, grain yield (t ha^{-1}), straw yield (t ha^{-1}), biological yield (t ha^{-1}) and harvest index (%) etc.The experiment was laid out in a completely randomized block design (RCBD) with three replications. The collected data were analyzed statistically and means were adjudged by DMRT at 5% level of probability. The treatments Cropmax @ 3.0 ml L^{-1} as foliar application gave the highest performance in respect of all growth and yield parameters.

Key words: Performance, cropmax, growth, yield, mungbean

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Introduction

Mung bean (*Vigna radiata*) is one of the most important conventional pulses grown in Bangladesh. In Bangladesh, among pulses, Mung bean ranks fourth in acreage and production and first in market price (BBS, 2012). Being an important short–duration *kharif* grain legume, Mung bean is grown extensively in major tropical and subtropical countries of the world. Mung bean is one of the important pulse crops grown principally for its protein rich edible seeds. For developing country like Bangladesh, pulses constitute the major concentrated source of dietary proteins. As a legume Mung bean is also characterized by its ability to improve the physical, chemical and biological properties of soil. It can also increase the soil fertility through biological nitrogen fixation from atmosphere. Mung bean contributed 8.23 percent of the total pulse production in our country (BBS, 2012). Mung bean is an important source of protein and several essential micronutrients. It contains 24.5% protein and 59.9% carbohydrate. It also contains 75 mg calcium; 8.5 mg iron and 49 mg B–carotene per 100 g of split dual (Bakr *et al*., 2004).

Mung bean cultivation has been declining day by day due to low yield and less economic profit whereas it is an important pulse crop containing more protein along with good flavor supplied dal to the poor peoples in Bangladesh. The farmers of Bangladesh generally grow Mung bean with minimum tillage and without fertilizer. There is an ample scope of increasing the yield of Mung bean per unit area with improved management practices and by using proper fertilization. The farmers of our country do not use fertilizer in pulse crop due to their poor socio-economic condition which results low yield but it has great impact to increase yield. Adequate supply of chemical fertilizer or bio-fertilizer is essential for normal growth and yield of a crop.

Cropmax is a highly concentrated fertilizer supplement to be used next to a normal fertilizing program. It is natural plant nutrient supplement. It supply Micronutrient such as Cu, Mg, Mn, Zn, Fe and Organic Amino Acid, Vegetative growth stimulates etc. Cropmax is made from vegetal raw material such as soybean, sugarcane molasses and rice vinasse. It is more important, because Cropmax stimulates root growth; plants are better able to absorb the available nutrients from the soil.

Micronutrient deficiency is considered one of the major causes of declining the productivity trends in crop growing countries. Micronutrients also enhance plant productivity; leaf area and grain yield as well as enhance the enzymatic system of plants (Siddika, 2013). Among the micronutrients, zinc plays an important role in different metabolic processes in plant. Narimani *et al*. (2010) reported that microelements foliar application improve the effectiveness of microelements. Copper deficiency decreases the rate of photosynthesis and increases the rate of respiration which results in limited water availability for cell expansion and growth (Olszewska *et al*., 2008) especially under saline condition. Manganese (Mn) is an essential micronutrient in most organisms. In plants, it participates in the structure of photosynthetic proteins and enzymes. Iron (Fe) is another micronutrient that is a cofactor for approximately 140 enzymes that catalyze unique biochemical reactions. Fertilizers are indispensable for the crop production systems of modern agriculture. Among the factors that affect crop production, fertilizer is the single most important factor that plays a crucial role in yield increase, provided other factors are not too limiting. Inorganic fertilizer holds the key to the success of the crop production systems of Bangladesh agriculture, being responsible for about 50% of the total production (BARC, 2005). Higher crop yields naturally have higher requirement of nutrients due to more pressure on the land for available forms of nutrients.

However, from the above discussion, the present study was carried out on the aspect of growth and yield of Mung bean regarding to various levels of foliar spraying of Cropmax (Cropmax is a combinations micronutrients such as Cu, Zn, Mg, Mn and Fe, and Organic Amino Acid, Vegetative growth stimulates).

Materials and Methods

The experiment on mungbean was carried out in the rabi season of 2014 at the Research Farm of Patuakhali Science and Technology University, Dumki, Patuakhali. The research farm is located at $22^{0}37'$ N latitude and $89^{0}10'$ E longitudes. The maximum area is covered by Gangetic Tidal Floodplains and falls under Agroecological Zone “AEZ– 13”. The area lies at 0.9 to 2.1 meter above mean sea level (Iftekhar and Islam, 2004). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Three different concentrations of Cropmax as foliar application was used for the present study as level T_1: Control (without Cropmax), T_2: 2.0 ml L^{-1} $plot^{-1}$, T_3: 3.0 ml L^{-1} $plot^{-1}$ and T_4: 5.0 ml L^{-1} $plot^{-1}$. Prepared Cropmax treatments were sprayed at 3 times from 10 days after sowing (DAS) while recommended dose of NPK fertilizers were used as basal soil application according to Fertilizer Recommendation Guide (FRG 2012). All fertilizers were applied to the respective plots during land preparation. The applied fertilizers were mixed properly with the soil in the plot using a spade. The seed of Mung bean were sown in the research field on January 02, 2014. Seed were sown in rows by hand plough. The distances between row to row and seed to seeds were 30 and 10 cm, respectively and seeds to seed distance 10 cm and 2–3 cm depth from the soil surface. Morphological characters such as Plant height, Number of leaves per plant, Number of Branch $plant^{-1}$, Length of root, Dry weight of root (g), Dry weight of shoot (g), Leaf area plant^{-1}, Growth characters such as Total dry matter (TDM), Absolute Growth Rate (AGR), Crop Growth Rate (CGR), Relative Growth Rate (RGR) and Yield and yield contributing characters such as No. of pods plant^{-1}, Number of seed pod^{-1}, Pod length (cm), 1000–grains weight, Grain yield (t ha^{-1}), Straw yield (t ha^{-1}), Biological yield, Harvest index (%) and Estimation of chlorophyll was recorded.

The crop growth rate values at different growth stages were calculated using the following formula–

$$\text{Absolute Growth Rate (AGR)}=\frac{W_2 - W_1}{T_2 - T_1}\ \text{g cm}^{-2}\text{day}^{-1},$$

$$\text{Crop Growth Rate (CGR)}=\frac{1}{GA}\times\frac{W_2 - W_1}{T_2 - T_1}\ \text{g m}^{-2}\text{day}^{-1},$$

$$\text{Relative growth rate (RGR)}=\frac{\text{Log}_e W_2 - \text{Log}_e W_1}{T_2 - T_1}$$

g cm^{-2}day^{-1},

Biological yield=Grain yield+Straw yield,

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}}\times 100.$$

Where,W_1= Total dry matter production at previous sampling date, W_2= Total dry matter production at current sampling date, T_1= Date of previous sampling, T_2= Date of current sampling, GA= Ground area (m^2), Log_e= Natural logarithm.

The data obtained from experiment on various parameters were statistically analyzed in MSTAT–C computer program (Russel, 1986). The mean values for all the parameters were calculate and the analysis of variance for the characters was accomplished by Duncan's Multiple Range Test (DMRT) and the significance of difference between pair of means was tested by the Least Significant Differences (LSD) test at 5 % levels of probability (Gomez and Gomez, 1984).

Results and Discussion

Responses of cropmax on the morphological characters of mungbean

Plant height: The data on plant height of the present study had statistically significant due to various treatments of Cropmax as foliar application to the plant (Table 1). Among the treatments, foliar application Cropmax @ 3.0 ml L^{-1} produces the tallest plant (16.2, 22.2, 41.5 and 55.5 cm) at 15, 30, 45 and 60 DAS, respectively, which was significantly different from and superior to all other treatments at all stage of growth .Most of the treatments recorded significantly higher plant height over control. The shortest plant at every data recording stages of 15, 30, 45 and 60 DAS (11.0, 13.8, 31.6 and 38.7 cm) was found in control treatment.

Number of leaf plant^{-1}: Significant variation was found on leaf production due to various treatments of Cropmax as foliar application in this study (Table 1). Among the different types of treatments, 3.0 ml L^{-1} of Cropmax as foliar application had produces highly significant for obtaining the more leaves plant^{-1} (7.1, 19.7, 24.3 and 27.7) comparatively than that of other foliar treatments at 15, 45, 30 and 60 DAS, respectively. From the table 3 it was also found the without Cropmax (control treatment) obtained the minimum leaves plant^{-1} (4.8, 12.9, 15.7 and 17.9).

Number of branch plant^{-1}: Significant variation was found on number of branch plant $^{-1}$ production due to various treatments of Cropmax as foliar application in this study in Table 2. Among the different types of treatments, 3.0 ml L^{-1} of Cropmax as foliar application had produces highly significant for obtaining the more number of branch plant $^{-1}$ (6.5, 14.9,18.0 and 19.9) comparatively than that of other foliar treatments at 15, 30, 45 and 60 DAT, respectively. It was also found the without Cropmax (control treatment) obtained the minimum number of branch plant^{-1} (4.6, 8.2, 10.8 and 13.1) at 15, 45, 30 and 60 DAS, respectively.

***Root length*:** Root length of plant increased continuously up to 60 DAS. Root length of plant increased significantly through the application of Cropmax. The results of root length of plant at 15, 30, 45 and 60 days after sowings have been presented in (Table 2). At 15, 30, 45 and 60 DAS the maximum root length of plant (6.9, 10,9, 16.6 and 21.6 cm) was found in Cropmax 3.0ml L^{-1} which was significantly different from and superior to all other treatments and lowest root length of plant (3.6,5.5, 9.8 and 12.9 cm) was found in control treatment.

Table 1. Effect of foliar application of cropmax on plant height and number of leaf plant $^{-1}$ of mungbean.

Treatment	Plant height (cm) at different DAS				Number of leaf plant^{-1} at different DAS			
	15	30	45	60	15	30	45	60
T_1: control	11.0c	13.8d	31.6d	38.6d	4.8d	12.9d	15.7d	17.9d
T_2: 2.0 ml L^{-1} Cropmax	14.6b	16.9c	36.5c	45.9c	5.4c	15.5c	21.2c	24.5c
T_3: 3.0 ml L^{-1} Cropmax	16.2a	22.2a	41.5a	55.5a	7.0a	19.7a	24.3a	27.7a
T_4: 5.0 ml L^{-1} Cropmax	14.8b	19.5b	39.9b	52.4b	6.3b	18.5b	23.1b	26.6b
CV%	4.26	3.57	4.52	3.29	3.19	4.60	3.12	2.56
Sig. level	**	**	**	**	*	**	**	*

**= significant at 1% level of probability and *= significant at 5% level of probability, Figures followed by same letter(s) are statistically similar as per DMRT at 5%.

Table 2. Effect of foliar application of cropmax on number of branch plant $^{-1}$ and of mungbean.

Treatment	Number of branch plant $^{-1}$ at different DAS				Root length (cm) at different DAS			
	15	30	45	60	15	30	45	60
T_1: control	4.6c	8.2c	10.8d	13.1d	3.6d	5.5d	9.8d	12.9d
T_2: 2.0 ml L^{-1} Cropmax	5.5b	12.6b	14.8c	17.5 c	5.9c	8.9c	13.8c	18.0c
T_3: 3.0 ml L^{-1} Cropmax	6.5a	14.9a	18.0a	19.9a	6.9a	10.9a	16.6	21.6a
T_4: 5.0 ml L^{-1} Cropmax	5.6b	14.0b	16.5b	18.5b	6.5b	10.0b	15.7b	20.2b
CV%	3.71	2.71	4.32	5.22	3.52	5.49	3.79	2.9
Sig. level	**	**	**	**	**	*	**	**

**= significant at 1% level of probability and *= significant at 5% level of probability, Figures followed by same letter(s) are statistically similar as per DMRT at 5%.

***Leaf area (cm^2)*:** Significant variation was found on leaf area production due to various treatments of Cropmax as foliar application in this study in (Table 3). Among the different types of treatments, 3.0 ml L^{-1} of Cropmax as foliar application had produces highly significant for obtaining the more leaf area (19.36, 28.36, 35.93 and 37.95 cm^2) comparatively than that of other foliar treatments at 15, 30, 45 and 60 DAS, respectively. It was also found the without Cropmax (control treatment) obtained the minimum leaf area (10.99, 19.65, 23.43 and 25.17 cm^2) at 15, 45, 30 and 60 DAS, respectively.

Table 3. Effect of foliar application of cropmax on leaf area of mungbean

Treatment	Number of branch plant $^{-1}$ at different DAS			
	15	30	45	60
T_1: control	10.99d	19.65d	23.43c	25.17d
T_2: 2.0 ml L^{-1} Cropmax	14.86c	24.00c	26.54b	34.60c
T_3: 3.0 ml L^{-1} Cropmax	19.36a	28.36a	35.93a	37.95a
T_4: 5.0 ml L^{-1} Cropmax	18.18b	26.49b	28.43b	36.57b
CV%	3.65	3.56	5.66	6.35
Sig. level	**	**	*	*

**=Significant at 1% level of probability and *= significant at 5% level of probability. Figures followed by same letter(s) are statistically similar as per DMRT at 5%.

***Dry shoots weight (g)*:** Foliar application of Cropmax on the dry shoot weight of Mung bean was statistically significant in (Table 4). At 30 DAS, foliar application of Cropmax @ 3.0 ml L^{-1} recorded the more dry weight of shoot (2.9g, 4.8g, 5.9g and 7.1g, respectively) at 15, 30, 45 and 60 DAS after sowing. Among other treatments of the study, the lowest dry weight of shoot (2.3 g, 3.5g, 4.6 g and 5.2 g) was recorded in those plants which were not treated by any treatments of the study.

Dry weight of root (g): Dry weight of root of Mung bean influenced significantly by the foliar application of different levels of Cropmax at particular days after sowing. The results of dry weight of root at 15, 30, 45 and 60 DAS have been presented in (Table 4). Most of the treatments recorded significantly higher plant height over control. The highest dry weight of root at 15 days (0.32 g), at 30 DAS stage the highest dry weight of root (0.45 g), at 45 DAS stage the highest dry weight of root (0.57 g) and at 60 DAS stage the highest dry weight of root (0.71 g) was found in 3.0 ml L^{-1} Cropmax which was significantly different from and superior to all other treatments and all stage of growth. The lowest dry weight of root at every data recording stages of 15, 30, 45 and 60 DAS (0.15 g , 0.21g, 0.37 g and 0.42 g) was found in control treatment .

***Total dry matter (g plant^{-1})*:** Significant variation due to foliar application of Cropmax was also obtained in respect of total dry matter (TDM) at all the data recording stages except 15 DAT in (Table 5). At 15 DAS highest TDM was found in Cropmax @ 3.0 ml L^{-1} and lowest TDM was received in control. The highest TDM (33.403, 52.157and 61.238 g plant^{-1}) was obtained from the @ 3.0 ml L^{-1} foliar application Cropmax and the lowest TDM (27.568, 44.630, and 51,551 g plant^{-1}) was observed in control at 30, 45 and 60 DAS, respectively.

***Absolute growth rate (AGR)*:** A significant variation was obtained in respect of absolute growth rate (AGR) due to the effect of different level of Cropmax at 15-30, 30-45 and 45-60 DAS growth stages (Table 5). It was further observed that the AGR had higher between 15–30 DAS and then declined at both stages viz. 30–45 DAS and 45-60 DAS; in that case the lower AGR was recorded between 45-60 DAS. Foliar application of Cropmax showed significant variation in relation to AGR at all the data recording stages .However, foliar application @ 3.0 ml L^{-1} also produced the higher AGR (1.382, 1.155 and 0.998 g cm^{-2} day^{-1}) and the lower AGR (1.172 , 0.948 and 0.825g cm^{-2} day^{-1}) found in control.

***Crop growth rate (CGR)*:** Crop growth rate (CGR) of Mung bean varied significantly due to the different level of Cropmax application at 15-30, 30-45 and 45-60 DAS (Table 6). The results revealed that the CGR was higher in between 15–30 DAS and lower at 45 -60 DAS stages. Foliar application of Cropmax 3.0ml L^{-1} received higher CGR (20.150, 16.053 and 15.135 g cm^{-2} day^{-1} respectivily) at 15-30 DAS , 30-45 and 45-60 DAS stage and lowest result found in control.

Table 4. Effect of foliar application of cropmax on dry weight of shoot and root of mungbean.

Treatment	Dry weight of shoot (g) at different DAS				Dry weight of root (g) at different DAS			
	15	30	45	60	15	30	45	60
T_1: control	2.2d	3.5c	4.6c	5.2d	0.15c	0.21c	0.37c	0.42c
T_2: 2.0 ml L^{-1} Cropmax	2.6c	4.3b	5.5b	6.5c	0.26b	0.38b	0.47b	0.59b
T_3: 3.0 ml L^{-1} Cropmax	2.9a	4.8a	5.9a	7.1a	0.32a	0.45a	0.57a	0.72a
T_4: 5.0 ml L^{-1} Cropmax	2.7b	4.5 b	5.7b	6.8b	0.28b	0.40b	0.51b	0.64b
CV%	3.56	4.62	6.38	3.17	3.71	4.32	6.22	5.31
Sig. level	**	**	**	**	**	**	**	*

**=Significant at 1% level of probability and *= significant at 5% level of probability, Figures followed by same letter(s) are statistically similar as per DMRT at 5%.

Table 5. Effect of foliar application of cropmax on total dry matter (g $plant^{-1}$) and Absolute growth rate (AGR) at different days after sowing (DAS).

Treatment	Total dry matter (g $plant^{-1}$) at different DAS				AGR at different DAS		
	15	30	45	60	15-30	30-45	45-60
T_1: control	7.25	27.57c	44.63c	51.55d	1.17c	0.94c	0.83c
T_2: 2.0 ml L^{-1} Cropmax	7.34	30.99b	48.90b	56.65c	1.27b	0.99bc	0.90b
T_3: 3.0 ml L^{-1} Cropmax	8.19	33.40a	52.16a	61.24a	1.38a	1.16a	0.10a
T_4: 5.0 ml L^{-1} Cropmax	8.1	31.53b	49.95b	59.10b	1.29b	1.04b	0.91b
CV%	5.74	2.03	3.76	3.04	5.35	3.88	3.56
Sig. level	NS	**	**	*	**	**	**

**=Significant at 1% level of probability and *= significant at 5% level of probability, Figures followed by same letter(s) are statistically similar as per DMRT at 5%.

***Relative growth rate (RGR)*:** A significant variation was also obtained in respect of relative growth rate (RGR) due to the different level of Cropmax at 15-30 DAS , 30-45 and 45-60 DAS (Table 6). Among the data recording stage, the higher RGR was recorded at the stage between 15–30 DAS and lowers at the stage between 45 -60 DAS. Foliar application of Cropmax 3.0ml L^{-1} received higher RGR (0.670, 0.492 and 0.455 g cm^{-2} day^{-1}) at 15-30 DAS, 30-45 and 45-60 DAS stage and lowest result found in control.

Responses of cropmax on yield and yield contributing characters

Number of pod plant^{-1}: The Number of pod plant^{-1} was found statistically significant due to the application of different treatments (Table 7). The Number of pod plant^{-1} varied from 17.40 to 24.30. Among the Cropmax doses, Cropmax @ 3.0 ml L^{-1} recorded significantly the maximum number of pods plant^{-1} (24.30) which was statistically significant from other treatment.Tthe minimum number of pods plant^{-1} (17.40) was recorded in control. Above results revealed that the Cropmax application @ 3.0ml L^{-1} had more efficient on pods production.

Table 6. Effect of foliar application of cropmax on the Crop growth rate (CGR) and relative growth rate (RGR) at different days after sowing (DAS).

Treatment	Crop growth rate (cm^{-2} day^{-1}) at different DAS			RGR (g cm^{-2} day^{-1}) at different DAS		
	15-30	**30-45**	**45-60**	**15-30**	**30-45**	**45-60**
T_1: control	15.74d	13.69c	10.89d	0.55 d	0.45 d	0.32 d
T_2: 2.0 ml L^{-1} Cropmax	18.23c	14.96b	13.36c	0.60 c	0.47 c	0.39 c
T_3: 3.0 ml L^{-1} Cropmax	20.15a	16.05a	15.13a	0.67 a	0.49 a	0.46 a
T_4: 5.0 ml L^{-1} Cropmax	19.33b	15.23b	14.46b	0.66 b	0.48 b	0.44 b
CV%	2.18	5.07	5.24	5.24	4.46	1.36
Sig. level	**	*	**	**	**	**

**= significant at 1% level of probability and *= significant at 5% level of probability, Figures followed by same letter(s) are statistically similar as per DMRT at 5%.

Table 7. Effect of foliar application of cropmax on yield contributing characteristics and yield of mungbean

Treatment	Number of seed pod^{-1}	Pod length (cm)	Number of pods plant^{-1}	Thousand -seed weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
T_1: control	17.4d	7.37d	11.3d	31.8c	1.68d	3.44d	4.98d	33.61c
T_2: 2.0 ml L^{-1} Cropmax	22.8c	7.74c	12.7c	33.7b	1.89c	3.54c	5.41c	35.3bc
T_3: 3.0 ml L^{-1} Cropmax	24.3a	9.33a	13.3a	35.3a	2.11a	3.86a	5.75a	37.17a
T_4: 5.0 ml L^{-1} Cropmax	23.3b	8.51b	13.0b	34.3b	1.99b	3.66b	5.61b	35.35b
CV%	2.54	1.30	1.35	2.34	2.33	4.47	1.95	3.56
Sig. level	**	**	**	**	**	**	*	**

**=Significant at 1% level of probability and *= significant at 5% level of probability, Figures followed by same letter(s) are statistically similar as per DMRT at 5%.

***Pod length (cm*)**: Foliar application of Cropmax exerted a significant effect on the pod length. The pod length was found statistically significant due to the application of different Cropmax (Table7). The pod length ranged from 9.333 cm to 7.367 cm. The longest pod (9.333 cm) was produced in plants with foliar application of 3.0 ml L^{-1}. The lowest pod length (7.367 cm) was produced with control.

***Number of seed pod^{-1}*:** Analysis of variance data regarding to the production of seeds pod^{-1} was significantly influenced by the effect of different level of Cropmax (Table 7). The result indicated significant difference whereas the Cropmax application @ 3.0ml L^{-1} produced the maximum number of seeds (13.33 pod^{-1}). On the other hand, without Cropmax (control) recorded the minimum number of seeds (11.33 pod^{-1}). This result indicated that Cropmax application @ 3.0ml L^{-1} had highly significant and more efficient effect to produce more seeds.

***Thousand-seed weight (g)*:** Thousand-seed weight (g) was found statistically significant due to the application of different level of Cropmax (Table 7). Thousand-seed weight ranged from 35.25 g to 31.77 g. Cropmax application @ 3.0 ml L^{-1} produced the highest weight of 1000–seed (35.25 g) and control treatment recorded the lowest weight of 1000–seed weight (31.77 g).

***Seed yield (t ha^{-1})*:** Yield per hactare of mungbean varied significantly to the use of different doses of Cropmax (Table 7). The yield ranged from 1.675 t ha^{-1} to 2.107 t ha^{-1}. The highest yield () was recorded in treatment T_3 (Cropmax @ 3.0 ml L^{-1}) which was statistically superior to all other treatments The second highest yield was found in T_4 (Cropmax @ 5.0 ml L^{-1}) and the lowest seed yield (1.675 t ha^{-1}) was observed in control condition with out cropmax used.

***Straw yield*:** Various treatments of the present study showed significant variation in respect of straw yield (Table 7). The highest straw yield (3.860 t ha^{-1}) was found in the foliar application of Cropmax @ 3.0 ml L^{-1} (T_3) while it was the lowest (3.660 t ha^{-1}) in control treatment.

***Biological yield (t ha^{-1})*:** The data on biological yield varied significantly from 4.982 to 5.757 t ha^{-1} due to studied various treatments regarding foliar application of Cropmax (Table 7). The highest biological yield (5.757t ha^{-1}) was found in treatment T_3(3.0 ml L^{-1} Cropmax) while it was lowest (4.982 t ha^{-1}) in control treatment. The variation in biological yield was found due to the variation in application of Cropmax .

Harvest index (%): Harvest index was significantly influenced by Cropmax application in respect of harvest index (Table 7). Among the Cropmax application levels, Cropmax @ 3.0 ml L^{-1} produced significantly the higher HI (37.17 %) while the lowest HI (33.61%) was found in control treatment.

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