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EFFICACY OF TEBUCONAZOLE TREATMENT IN PROMOTING GROWTH OF *VIGNA MUNGO* (L.) HEPPER VAR. VAMBAN-3

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ABSTRACT
Tebuconazole (TEBU) is a member of triazole family shown to protect plants from environmental stress by promoting vigorous growth. An experiment was conducted to device a suitable method for applying TEBU to test its efficacy as plant growth promoter. Black gram, *Vigna mungo* (L.) Hepper var. Vamban-3 was grown in pot culture under natural photoperiodic conditions. TEBU was supplied through seed-soaking, priming, foliar spray or as soil drench. Seeds were either soaked overnight in aqueous TEBU (ml L^{-1}) or primed by soaking in the above solution for 6 hr and shade drying subsequently. Alternatively, the emerging seedlings (7 DAS - Days after seed sowing) were irrigated or sprayed with 100 ml of the aqueous TEBU. Growth was assessed on the 15 and 30 DAS. Application of TEBU by soaking, priming and irrigation heavily inhibited growth compared to control. The performance was better when it was sprayed onto the foliage (2.5 ml L^{-1}). Soaking, priming or irrigation was least effective, as the surviving seedlings were shorter than the control plants. However, foliar spray (11.83 % to 98.25 %) enhanced the plant height and weight (7.68 to 81.62 %) and total leaf area and its weight (11.83 % to 98.25 %). Yet, the total leaf area and its weight which were decreased by 45.48 % to 58.78 % under other concentrations (1, 1.5, 2, 3, 3.5, 4, 4.5 and 5 ml L^{-1}) of TEBU spraying, it is recommended that foliar spray (2.5 ml L^{-1}) could be an effective method of TEBU supply to enhance the growth of black gram.

KEY WORDS: Application, black gram, concentration, growth, tebuconazole, triazole, foliar spray.

INTRODUCTION

Triazoles are compounds that have both plant growth regulating and fungitoxic properties (Fletcher *et al*., 1986). They protect plants against various stresses including low and high temperatures, drought, salinity and air pollutants. Hence they have been referred to as "Plant multi-protectants", and it is suggested that their protective effects are mediated by shifting the balance of important plant hormones in the isoprenoid pathway (Fletcher and Hofstra 1985). Tebuconazole, popularly known as TEBU with molecular formula $C_{16}H_{22}ClN_3O$ and IUPAC name (RS)-1-p-chlorophenyl-4,4-dimethyl-3-(1H-1,2,4-triazol-1-ylmethyl)pentan-3-ol, is a systemic fungicide with protective, curative, and eradicative action. From a biochemical point of view, the properties of TEBU are due to their dual effect on plants: inhibition of the biosynthesis of gibberellins in the plant (retardant properties), and inhibition of the biosynthesis of sterols (fungicide properties) (Matysiak and Kaczmarek, 2013). TEBU is rapidly absorbed into the vegetative parts of the plant, with translocation principally acropetally. As a seed dressing, TEBU is effective against various smut and bunt diseases of cereals and as a spray; it controls numerous fungal pathogens in various crops (Henneken *et al*., 2000). TEBU given as foliar spray at 1 L/ha had a shortening effect on the height of the oilseed rape plants, length of the petiole, leaf position and the intensity of green colour of the leaves (Henneken *et al*., 2000). Recent reports have shown that the properties of TEBU go significantly beyond having just retardation effects. TEBU given as foliar spray at 250 gm/ha increased growth and yield of *Brassica napus L. var. Oleifera* (Matysiak and Kaczmarek, 2013). In view of the diverse recommendations, the present investigation was attempted to perfect an application schedule of TEBU to black gram to test its efficacy as growth regulator.

MATERIALS & METHODS

Seeds of black gram (*Vigna mungo* (L.) Hepper var. Vamban-3) was sown in earthenware pots (25 x 25 cm) filled with a mixture of sand, red soil and farmyard manure (2:1:1 v/v). Twenty seeds were sown at equal distances at a depth of 2 cm in each pot. They were grown under natural photoperiodic condition (day- temperature, maximum 38 ± 2°C; minimum night-temperature 18 ± 2°C; relative humidity 60 ±5%; maximum irradiance (PAR) 1,400mol $m^{-2}s^{-1}$; photoperiod (12 to 14 hours); solar radiation (UV-B:10 kJ $m^{-2}d^{-1}$).Tebuconazole (TEBU) was supplied as seed soak, priming, soil drench or as foliar spray. Seeds were either soaked for 6 hour in aqueous TEBU (ml L^{-1}) or primed by soaking in the above solution for 6 hours followed by shade drying for sowing subsequently. Thirdly, the 7 DAS (day after seed sowing) old seedlings were irrigated with 100 ml pot^{-1} of the aqueous TEBU per pot as soil drench. Finally, the emerging seedlings were sprayed on the 7 DAS when the primary leaves were open. Growth was assessed on the 15 DAS. A control set of test plants was maintained separately in each treatment under ambient conditions. For determining the LD_{50} concentration of the TEBU extracts three separate sets of experiments each with triplicates were conducted. In the first set, various concentrations of TEBU (25, 50, 75, and 100 ml L^{-1}) were made in distilled

water. Viable seeds of black gram (*Vigna mungo* (L.) Hepper var. Vamban-3) soaked in distilled water for 6 hours were sown in soil in earthen pots of equal size. The seed soak, priming, soil drench and foliar spray were given as treatments and the seedlings watered with distilled water served as control. The second treatment of different concentrations of TEBU (5, 10, 15, 20 and 25 ml L^{-1}) was given to fresh set of seeds and seedlings grown in earthen pots. The third set of treatment consisted of 2.5, 5, 7.5, 10, 12.5 and 15 ml L^{-1} of TEBU to a new set of seeds and seedlings. Through the three sets of experiments conducted using the test plant, the concentrations of TEBU for the fourth set were fixed as 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5 and 5 ml L^{-1} based on the LD_{50} values obtained. The seedlings of set 4 were allowed to grow till 30 DAS.

Assessment of growth of test plants on 15 and 30 DAS were recorded and calculated using standard methods. Ten plants were selected at random from each of the treatments. The leaf area (the leaflets from all the nodes) was determined at various stages using Area meter (Analytical Development Corporation, UK, model AM100). The total leaf area per plant was obtained by summing up the area of the leaves from all the nodes of the plant. Leaf area index (LAI) (Williams 1946), specific leaf weight (SLW) (Pearce *et al.* 1968), relative growth rate (RGR) (Williams 1946) and shoot / root ratio (Racey *et al.,* 1983) were calculated using the following formulae.

$$LAI = \frac{\text{Leaf area of the plants (cm}^2\text{)}}{\text{Ground area occupied (cm}^2\text{)}}$$

$$SLW = \frac{\text{Leaf dry weight (g)}}{\text{Leaf area (m}^2\text{)}}$$

$$RGR = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{t_2 - t_1}$$

Where, W_1 and W_2 are dry masses of whole plants at t_1 and t_2 (time in days) respectively.

$$S/R \text{ ratio} = \frac{\text{Shoot weight (g)}}{\text{Root weight (g)}}$$

The values were analysed by Tukey's multiple range test (TMRT) at 5 % level of significance (Zar 1984).

RESULTS & DISCUSSION

In set 1, all seeds under soaking and priming treatments with TEBU did not germinate (Table 1; Plate 1, Fig. 1). The seedlings receiving TEBU as irrigation and spraying also died and only the seedlings under control conditions survived (Table 1; Plate 1, Fig. 1). From the results of set 1 the concentrations for set 2 were fixed as 5, 10, 15, 20 and 25 ml L^{-1} TEBU and the seedlings were allowed to grow till 15 DAS. In set 2, seedlings in all treatments died, except the seedlings sprayed with 5 ml $L^{-1}$and 10 ml L^{-1} TEBU (Table 2; Plate 1, Fig. 2). Seedlings under 5 ml L^{-1} TEBU spraying showed 100% survival while 10 ml L^{-1} TEBU recorded only 50% (Table 2; Plate 1, Fig. 2). Through the survival value of set 2 the concentrations for set 3 was decided as 2.5, 5, 7.5, 10, 12.5 and 15 ml L^{-1} TEBU and the assessment was made on 15 DAS. In set 3, seeds and seedlings of black gram in all other treatments except spraying were highly sensitive as they did not germinate after soaking and priming and did not grow at 5 ml L^{-1} TEBU and above concentrations (Table 3; Plate 2, Fig. 1). Only 25% seeds germinated in 2.5 ml L^{-1} of soaking and 20% seeds in priming followed by a survival of 40% seedlings in irrigation. In spraying LD_{50} concentration was 10 ml L^{-1} TEBU. All the seedlings that received 2.5 ml L^{-1} of TEBU as spraying survived, while in 5 and 7.5 ml L^{-1} concentrations it decreased to 80% and 65 % respectively (Table 3; Plate 2, Fig. 1).

TABLE 1. Germination of seeds of *Vigna mungo* (L.) Hepper var. Vamban-3 sown in soil in pots (20 seeds pot^{-1}) and survival of seedlings under control and various concentration of TEBU treatment in Set 1 on 15 DAS.

Treatment	Control (%)	25 ml L^{-1} (%)	50 ml L^{-1} (%)	75 ml L^{-1} (%)	100 ml L^{-1} (%)
Soaking (6 hrs)	100	0	0	0	0
Priming (soak - 6 hrs + shade dried)	100	0	0	0	0
Irrigation on 7 DAS	100	0	0	0	0
Spraying on 7 DAS	100	0	0	0	0

PLATE 1 Sets 1 and 2 showing 15 DAS *Vigna mungo* (L.) Hepper var. Vamban-3 seedlings under control condition and various methods and concentrations of TEBU treatment

FIGURE 1: Set 1 - Germination of seeds and growth of 15 DAS seedlings.

FIGURE 2: Set 2 - Germination of seeds and growth of 15 DAS seedlings.

TABLE 2. Germination of seeds of *Vigna mungo* (L.) Hepper var. Vamban-3 sown in soil in pots (20 seeds pot^{-1}) and survival of seedlings under control and various concentrations of TEBU treatment in Set 2 on 15 DAS.

Treatment	Control (%)	5 ml L^{-1} (%)	10 ml L^{-1} (%)	15 ml L^{-1} (%)	20 ml L^{-1} (%)	25 ml L^{-1} (%)
Soaking (6 hrs)	100	0	0	0	0	0
Priming (soak - 6 hrs + shade dried)	100	0	0	0	0	0
Irrigation on 7 DAS	100	0	0	0	0	0
Spraying on 7 DAS	100	100	50	0	0	0

TABLE 3. Germination of seeds of *Vigna mungo* (L.) Hepper var. Vamban-3 sown in soil in pots (20 seeds pot^{-1}) and survival of seedlings under control and various concentrations of TEBU treatment in Set 3 on 15 DAS

Treatment	Control (%)	2.5 ml L^{-1} (%)	5 ml L^{-1} (%)	7.5 ml L^{-1} (%)	10 ml L^{-1} (%)	12.5 ml L^{-1} (%)	15 ml L^{-1} (%)
Soaking (6 hrs)	100	25	0	0	0	0	0
Priming (soak - 6 hrs + shade dried)	100	20	0	0	0	0	0
Irrigation on 7 DAS	100	40	0	0	0	0	0
Spraying on 7 DAS	100	100	80	65	50	0	0

Seedlings that received TEBU through spraying were weak and short in 5 ml L^{-1} and above concentrations. So the concentration for set 4 was fixed from 1 to 5 ml L^{-1} TEBU with an interval of 0.5 ml L^{-1} and the seedlings were allowed to grow till 15 DAS. The same trend observed in set 3 continued in set 4 also. Except in spraying, black gram in other treatments performed poorly (Table 4; Plate 2, Fig. 2). Seedlings receiving 1 ml L^{-1} TEBU also performed very poorly. In addition, seedlings sprayed with 1.5, 2, 3, 3.5, 4, 4.5 and 5 ml L^{-1} TEBU was also weaker and shorter than control. However, seedlings sprayed with 2.5 ml L^{-1} of TEBU were healthy and taller than control. Taking into account of the results of all the four sets, a treatment with 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5 and 5 ml L^{-1} concentrations of TEBU was repeated and the seedlings were allowed to grow till 30 DAS.

PLATE 2: Sets 2 and 3 showing 15 DAS *Vigna mungo* (L.) Hepper var. Vamban-3 seedlings under control condition and various methods and concentrations of TEBU treatment

FIGURE 1: Set 3 - Germination of seeds and growth of 15 DAS seedlings

FIGURE 2: Set 4 - Germination of seeds and growth of 15 DAS seedlings.

The number of leaves in *Vigna mungo* (L.) Hepper var. Vamban-3 seedlings were more than control (33.33 %) after spraying with 1, 1.5, 3.5, 4, 4.5 and 5 ml L^{-1} concentrations of TEBU, the highest being in 2, 2.5 and 3 ml L^{-1} concentrations (66.66 %) on 15 DAS (Table 5). However, on 30 DAS, under 1, 3, 3.5, 4, 4.5 and 5 ml L^{-1} concentrations of TEBU spray the leaves were fewer by 14.29 % to 42.86 % (Table 6). Total leaf area, leaf area index, specific leaf weight, fresh and dry weight of foliage also followed the same trend of reduction in the values by 45.48 % to 58.78 % in 1, 1.5, 2, 3, 3.5, 4, 4.5 and 5 ml L^{-1} TEBU concentrations on 15 and 30 DAS (Table 5, 6; Plate 3, Fig. 1,2). In contrast, the black gram seedlings receiving foliar spray of 2.5 ml L^{-1} TEBU showed enhancement in all characteristics of foliage by 11.83 to 98.25 % on 15 DAS and 23.40 to 81.48 % on 30 DAS (Table 5, 6; Plate 3, Fig. 1, 2). The trend observed in the foliage of seedlings continued with the growth parameters of black gram seedlings both on 15 DAS as well as on 30 DAS. However, the growth of the plants was suppressed by 1, 1.5, 2, 3.5, 4, 4.5 and 5 ml L^{-1} spraying as indicated by the reduction in root and shoots length, fresh and dry weight of plant and relative growth rate (20.04 to 82.14 %) than the controls (Table 7; Plate 3, Fig. 1, 2). Spraying TEBU at 3 ml L^{-1} concentration induced growth of seedlings by 5.55 to 14.8 %, while it failed to accumulate biomass in the seedling showing a reduction of 16.73 to 66.92% compared to control seedlings on 15 and 30 DAS (Table 8; Plate 3, Fig. 1, 2). The stimulatory effect of TEBU spray at 2.5 ml L^{-1} concentration continued in plant growth also, showing an enhancement in plant height, biomass and relative growth rate over the control on 15 DAS (7.78 % to 34.12 %) and 30 DAS (7.68 to 81.62 %) (Table 7, 8; Plate 3, Fig. 1, 2). TEBU spray at 1, 1.5, 2, 3.5, 4, 4.5 and 5 ml L^{-1} suppressed growth and biomass accumulation on 30 DAS seedlings (11.12 to 68.02 %) (Table 8; Plate 3, Fig. 2). 3 ml L^{-1} TEBU showed mild stimulatory effect on the length of the root and shoot (5.12 to 15.38%) but failed to accumulate biomass, recording a reduction of 33.73 to 85.61 % than the control plants (Table 8; Plate 3, Fig. 2).

TABLE 4. Germination of seeds of *Vigna mungo* (L.) Hepper var. Vamban-3 sown in soil in pots (20 seeds pot^{-1}) and survival of seedlings under control and various concentrations of TEBU treatment in Set 4 on 15 DAS

Treatment	Control (%)	1ml L^{-1} (%)	1.5 ml L^{-1} (%)	2 ml L^{-1} (%)	2.5 ml L^{-1} (%)	3 ml L^{-1} (%)	3.5 ml L^{-1} (%)	4 ml L^{-1} (%)	4.5 ml L^{-1} (%)	5 ml L^{-1} (%)
Soaking (6 hrs)	100	40	35	35	25	0	0	0	0	0
Priming (soak - 6 hrs + shade dried)	100	40	30	20	20	0	0	0	0	0
Irrigation on 7 DAS	100	65	50	45	40	0	0	0	0	0
Spraying on 7 DAS	100	100	100	100	100	100	100	100	100	100

TABLE 5. Changes in foliage of 15 DAS *Vigna mungo* (L.) Hepper var. Vamban-3 under control and various concentrations of TEBU treatment applied through foliar spraying

Treatment	Treatment	Number of leaves	Total leaf area (cm^2)	Leaf area index	Specific leaf weight (g^{-2})	Fresh weight of foliage (g)	Dry weight of foliage (g)
Water	Control	3 a	124.39 d	0.448 c	0.028 c	2.296 b	0.356 c
	1 ml L^{-1}	4 b	73.92 c	0.153 a	0.002 a	2.575 b	0.192 b
	1.5 ml L^{-1}	4 b	69.48 c	0.221 b	0.004 a	2.258 b	0.264 b
	2 ml L^{-1}	5 c	68.43 c	0.236 b	0.009 b	4.384 d	0.628 d
	2.5 ml L^{-1}	5 c	145.15 e	0.501 d	0.049 d	4.842 d	0.712 d
	3 ml L^{-1}	5 c	42.24 b	0.269 b	0.008 b	3.711 c	0.334 c
	3.5 ml L^{-1}	4 b	31.68 a	0.134 a	0.004 a	1.836 a	0.148 a
	4 ml L^{-1}	4 b	26.40 a	0.131 a	0.005 a	1.413 a	0.137 a
	4.5 ml L^{-1}	4 b	26.29 a	0.127 a	0.004 a	1.409 a	0.136 a
TEBU	5 ml L^{-1}	4 b	26.31 a	0.129 a	0.004 a	1.411 a	0.140 a

Taking into account of the collected data for different methods and various concentrations of TEBU treatments, only 2.5 ml L^{-1} concentration of TEBU given as foliar spray was most effective in enhancing the growth of black gram seedlings. Foliar spray with TEBU applied at 250 gm/ ha decreased plant height by 13 to 18 %, increased greenness of leaves by 20 % and yield by 11 to 12 % of oilseed rape seeds (Matysiak and Kaczmarek, 2013) without affecting the fat and protein content of seeds. On the contrary, TEBU application as spraying at 145ml/ha recorded 43.43% reduction in yield in wheat (James *et al.*, 2008). The recommendation of presoaking method for seeds with a triazole called triadimefon through irrigation which proved to be a potent method in enhancing plant growth to overcome salt stress in soybean (Panneerselvam *et al*., 1998), bhendi (Sujatha *et al*., 1999), pigeon pea (Karikalan *et al*., 1999), cowpea (Gopi *et al*., 1998) and UV-B irradiation in green gram (Rajendiran and Ramanujam, 2003, Rajendiran and Ramanujam, 2004) was not supported by this study. The reports that TEBU given as soil drench improved the growth of *Lablab purpureus* (L.) Sweet var. Pairy at 2.5ml L^{-1} (Arulmozhi and Rajendiran 2015), *Sesbania bispinosa* (Jacq.) W. Wight at 1.5 ml L^{-1} (Sudaroli Sudha and Rajendiran 2015) and *Vigna mungo* (L.) Hepper var. Nirmal-7 at 2 ml L^{-1} (Vijayalakshmi and Rajendiran 2015) also not corroborated either. Fletcher *et al.* (2000) suggested that priming of cucumber and tomato seeds with triazoles reduced the irrigation needs and helped the crops to tide over drought conditions. Further, primed seeds of sweet corn, a chilling susceptible crop, during frost periods also ensured greater seedling survival in Canada (Fletcher and Kraus 1995). On the contrary, in the present work with black gram, priming method with TEBU proved to be the least effective. Barrett *et al*. (1994a) and Barrett *et al*. (1994b) also observed that spray applications could only result in non uniform plant size if suitable coverage was not obtained. Davis *et al.* (1988) opined that root application of a triazole, Paclobutrazol (PBZ) was more active than spraying over leaves. They also proved that drenching had greater efficacy than spike application (Barrett *et al.* 1994a). Earlier studies with triadimefon treatment showing enhancement in growth (Rajendiran and Ramanujam 2003, Rajendiran and Ramanujam 2004) and nodulation and nitrogen metabolism (Rajendiran and Ramanujam 2006) in green gram when triazole was given as soil drench did not support this work. Hence, it is concluded that spraying of seedlings could be an effective method of TEBU application to black gram plants for enhancing the growth of the crop. However, the efficiency of TEBU in ameliorating the adverse effects of environmental stresses in plants remains to be explored.

TABLE 6. Changes in foliage of 30 DAS *Vigna mungo* (L.) Hepper var. Vamban-3 under control and various concentrations of TEBU treatment applied through foliar spraying

Chemical	Treatment	Number of leaves	Total leaf area (cm^2)	Leaf area index	Specific leaf weight (g^{-2})	Fresh weight of foliage (g)	Dry weight of foliage (g)
Water	Control	7 c	148.50 d	0.421 c	0.027 b	9.607 d	4.094 d
	1 ml L^{-1}	6 b	104.54 c	0.559 d	0.026 b	7.490 c	2.713 c
	1.5 ml L^{-1}	10 d	89.54 b	0.233 b	0.026 b	8.554 c	2.348 c
	2 ml L^{-1}	10 d	105.60 c	0.483 c	0.024 b	9.042 c	2.542 c
	2.5 ml L^{-1}	10 d	183.25 e	0.591 d	0.049 d	11.992 e	5.417 e
	3 ml L^{-1}	6 b	98.74 b	0.400 c	0.021 a	8.422 c	2.096 b
	3.5 ml L^{-1}	6 b	54.91 a	0.148 a	0.033 c	3.976 a	1.864 b
	4 ml L^{-1}	4 a	41.82 a	0.256 b	0.033 c	4.481 b	1.420 a
	4.5 ml L^{-1}	4 a	41.69 a	0.152 a	0.030 c	3.988 a	1.456 a
TEBU	5 ml L^{-1}	4 a	41.57 a	0.167 a	0.030 c	3.973 a	1.434 a

TABLE 7. Changes in growth parameters of 15 DAS *Vigna mungo* (L.) Hepper var. Vamban-3 under control and various concentrations of TEBU applied through foliar spraying

Chemical	Treatment	Root length (cm)	Shoot length (cm)	Shoot / root ratio	Root fresh wt. (g)	Shoot fresh wt. (g)	Plant fresh wt. (g)	Root dry wt. (g)	Shoot dry wt. (g)	Plant dry wt. (g)
Water	Control	15.04 c	27.0 d	1.80 b	0.556 d	3.878 d	4.434 d	0.194 d	0.507 e	0.701 d
	1 ml L^{-1}	12.57 b	20.03 a	1.60 a	0.338 b	3.483 c	3.821 c	0.138 c	0.298 c	0.436 c
	1.5 ml L^{-1}	13.03 b	21.01 b	1.62 a	0.404 c	3.777 d	4.181 d	0.121 b	0.355 d	0.476 c
	2 ml L^{-1}	12.02 b	26.05 d	2.17 d	0.367 b	3.297 c	3.664 c	0.160 d	0.277 c	0.437 c
	2.5 ml L^{-1}	17.09 d	33.07 e	1.94 c	0.742 e	4.746 e	5.488 e	0.257 e	0.680 f	0.937 e
	3 ml L^{-1}	16.34 d	31.04 e	1.90 c	0.463 c	2.364 b	2.827 b	0.122 b	0.188 b	0.310 b
	3.5 ml L^{-1}	11.51 a	24.02 c	2.09 d	0.376 b	1.863 a	2.239 a	0.085 a	0.191 b	0.276 a
	4 ml L^{-1}	11.05 a	21.03 b	1.91 c	0.223 a	2.675 b	2.675 b	0.097 a	0.162 a	0.259 a
TEBU	4.5 ml L^{-1}	11.00 a	21.06 b	1.87 c	0.219 a	2.386 b	2.239 a	0.089 a	0.169 a	0.252 a
	5 ml L^{-1}	11.07 a	21.07 b	1.93 c	0.221 a	2.372 b	2.672 b	0.098 a	0.164 a	0.255 a

TABLE 8. Changes in growth parameters of 30 DAS *Vigna mungo* (L.) Hepper var. Vamban-3 under control and various concentrations of TEBU applied through foliar spraying.

Chemical	Treatment	Root length (cm)	Shoot length (cm)	Shoot / root ratio	Root fresh wt.(g)	Shoot fresh wt.(g)	Plant fresh wt.(g)	Root Dry wt.(g)	Shoot dry wt.(g)	Plant dry wt.(g)	Relative growth rate
Water	Control	12.31 b	26.0 c	2.11 d	3.188 e	11.988 e	14.988 e	2.818 c	8.881 d	11.699 d	0.081 e
	1 ml L^{-1}	13.74 c	22.0 b	1.16 a	1.283 c	5.423 c	6.706 c	0.253 a	1.515 b	1.760 b	0.040 b
	1.5 ml L^{-1}	12.72 b	24.0 c	1.89 c	0.745 b	3.319 a	4.064 b	0.268 a	3.134 c	3.402 c	0.050 c
	2 ml L^{-1}	10.55 a	25.5 d	2.43 e	2.606 d	3.667 b	6.273 c	0.275 b	4.421 c	4.696 c	0.064 d
	2.5 ml L^{-1}	14.57 d	32.0 f	2.21 d	3.995 f	14.195 f	18.190 f	3.385 d	10.905 e	14.290 e	0.092 f
	3 ml L^{-1}	13.52 c	30.0 e	2.22 d	0.459 a	7.945 d	8.404 d	0.360 b	1.594 b	1.954 b	0.053 c
	3.5 ml L^{-1}	12.07 b	23.0 c	1.92 c	0.447 a	3.219 a	3.664 a	0.227 a	1.924 b	2.151 b	0.059 c
	4 ml L^{-1}	12.04 b	22.0 b	1.69 b	0.496 a	3.694 b	4.190 b	0.245 b	0.422 a	0.667 a	0.027 a
	4.5 ml L^{-1}	12.08 b	20.3 a	1.90 c	0.453 a	3.214 a	3.659 a	0.222 a	0.430 a	0.651 a	0.029 a
TEBU	5 ml L^{-1}	12.03 b	20.7 a	1.87 c	0.448 a	3.220 a	3.654 a	0.218 a	0.441 a	0.658 a	0.026 a

PLATE 3: Growth of *Vigna mungo* (L.) Hepper var. Vamban-3 seedlings under control condition and various concentrations of TEBU applied through foliar spraying.

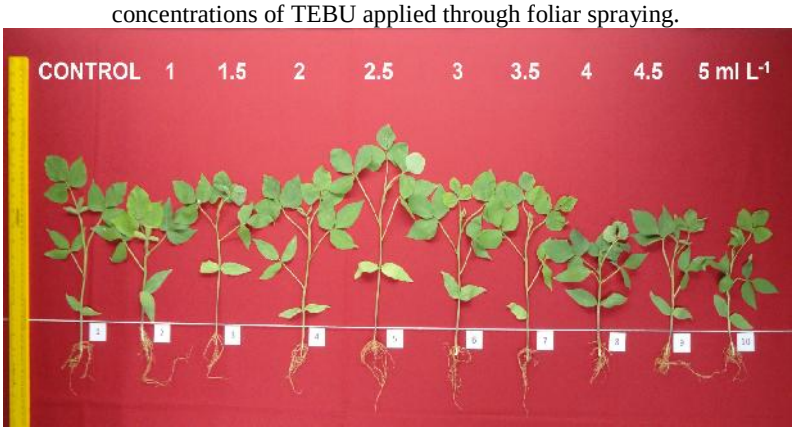

FIGURE 1: Set 4 - Growth of seedlings on 15 DAS

FIGURE 2: Set 4 - Growth of seedlings on 30 DAS

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