Effect of Salicylic Acid and $CaSO_4$ on Morphological Characters and Yield of Mungbean

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Abstract:
The experiment was conducted at the research plot of the department of Agricultural Botany of Sher-e-Bangla Agricultural University, Dhaka during the period from February 2017 to June 2017 to effect of salicylic acid and $CaSO_4$ on morphophysiology growth and yield of mungbean. In this experiment, the treatment consisted of two mungbean varieties viz. V_1 = BARI mung 4, V_2 = BARI mung 6 and four different concentration of Salicylic acid (SA) and $CaSO_4$ viz.T_0=control, T_1 =5 mMole CaSO4, T_2=Salicylic acid 0.5mMole,T_3=Salicylicacid0.5mMole+5mMoleCaSO4. The experiment was laid out in a two factors randomized complete block design (RCBD) design having three replications. Results showed that a significant variation was observed among the treatments in respect of majority of the observed parameters. The collected data were statistically analyzed for evaluation of the treatment effect. Variety and salicylic acid and $CaSO_4$ had significant influence on growth, yield and yield components of mungbean. The tallest plant (60.40 cm) was obtained from BARI Mung-6 with Salicylic acid 0.5milimole + 5 mMole CaSO4. The highest number of leaves plant^{-1} (14.33), pod length (9.52 cm), number of pods plant^{-1} (30.07), number of seeds pod^{-1} (13.53), thousand seed weight (73.17 g) was obtained from BARI Mung-6 with Salicylic acid 0.5milimole + 5 mMole CaSO4. The lowest number of leaves plant^{-1} (9.13), pod length (6.25 cm), number of pods plant^{-1} (22.60), number of seeds pod^{-1} (11.53), thousand seed weight (36. 91 g) was obtained from BARI Mung-4 with control treatment. The highest seed yield ha^{-1} (1.93 ton) was obtained from BARI Mung-6 with Salicylic acid 0.5milimole + 5 mMole CaSO4 treatment combinations while the lowest seed yield (1.26 ton) was recorded from BARI Mung-4 with control treatment combination. The most of the parameters gave the best performance which was achieved from BARI Mung-6. Again, Salicylic acid 0.5milimole + 5 mMole CaSO4 showed the best performance regarding most of the yield and yield contributing parameters. In case of combined effect, BARI Mung-6 and Salicylic acid 0.5milimole + 5 mMole CaSO4 gave the best result considering yield and yield contributing parameters.

Keywords: Salicylic Acid, CaSO4, Mungbean and Yield

1. Introduction

Mungbean (*Vigna radiata* L.) is one of the most important pulse crops of Bangladesh and belongs to the family Leguminosae and sub-family Papilionaceae. This commonly grown pulse crop belongs to the family leguminosae. It holds the 3rd in protein content and 4th in both acreage and production in Bangladesh [1].

Pulses constitute the main source of protein for the people, particularly the poor sections of Bangladesh. These are also the best source of protein for domestic animals. Besides, the crops have the capability to enrich soils through nitrogen fixation. Mungbean contains 51% carbohydrates, 26% protein, 4% mineral and 3% vitamin. On the nutritional point of view, mungbean is one of the best among pulses [2].

It has a good digestibility and flavor. The green plants are used as animal feed and the residues as manure. Life cycle of mungbean is short; it is also drought tolerant and can grow with a minimum supply of nutrients. Mungbean also improves physical, chemical and biological properties of soil by fixing nitrogen from atmosphere through symbiosis process [3] recommendation, a minimum per capita uptake of pulse should be 80 g day^{-1}, whereas it is 7.92 g day^{-1} in Bangladesh. This is because of fact that national production of the pulses is not adequate to meet our national demand. The total production of mungbean in Bangladesh in 2013-14 was 1.81 lac metric tons from the area of 1.73 lac hectares with an average yield 1.04 t ha^{-1} [4].

Variety plays an important role in producing high yield of mungbean because different varieties

perform differently for their genotypic characters also vary from genotype to genotype. Improved variety is the first and foremost requirement for initiation and accelerated crop production program. Recently, Bangladesh Agricultural Research Institute (BARI) has developed six and Bangladesh Institute of Nuclear Agriculture (BINA) has developed seven photo-insensitive high yielding cultivars mungbean, mostly known as climate smart options. There has been so far varieties released by BARI, BINA and Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU). During *kharif* season the crop fits well into the existing cropping system of many areas in Bangladesh. However, to my knowledge information are not enough to find the suitable variety/ies for *kharif-1* season.

In the integrated plant growing, growth regulators are widely applied for seed soaking. In case of vegetables, growth regulators are used mainly to improve seed germination power, increase yield, plants become resistant to diseases and unfavorable growth conditions [5]. The effectiveness of plant growth regulators by reducing longitudinal shoot growth and improving functional and qualitative aspects of several plants is well known. The plant growth regulating properties of these compounds are mediated by their ability to alter the balance of important plant hormones including gibberellic acid, ascorbic acid (ABA), salicylic acid (SA) and cytokinins. They also inhibit gibberellin and ergosterol biosynthesis in plants and fungi, respectively [6].

Salicylic acid (SA) is considered to be a hormone like substance that is important in the regulation of plant growth and development, seed germination, fruit yield, glycolysis, flowering and heat production in thermogenic plants, ion uptake and transport, photosynthetic rate, stomatal conductance and transpiration [2].

It is one of a suite of endogenous hormones that regulate the synthesis of antioxidant enzymes during abiotic and biotic stress [7].

Also, SA has been shown to be an essential signal molecule involved in both local defense reactions and induction of systemic resistance response of plants after pathogen attack [8]. It has been shown that SA provides protection in maize and winter wheat plants against low-temperature stress, induces termotolerence in mustard seedlings or modulates plant responses to salt and osmotic stresses [9], ozone or UV light, drought and herbicides [10].

Furthermore, SA is also known to be involved in plant protection to heavy metals. The SA as natural plant hormone has many effects on physiological processes and growth of plants. Foliar spray of SA increases pod plant^{-1}, number of seeds per pod^{-1}, seed weigh plant$^{-1,}$ seed yield hectare^{-1} and protein content. SA application @ 100 mgL^{-1} under saline conditions is effective in improving the growth and plant productivity of mungbean through improving the nitrogen metabolism by enhancing nitrogen uptake, protein and total amino acids [11]. Not only in pulse have crops SA also stimulated other crop. It has been suggested that the growth-promoting effects of SA could be related to changes in the hormonal status by improvement of photosynthesis, transpiration and stomatal conductance [12].

The beneficial Ca effects in ameliorating Al toxicity in different crops growing in acid soils are reported by [13] reviewed the Al^{3+}-Ca^{2+} interaction in plants growing in acid soils in comparison to the Al-phytotoxicity response to calcareous amendments and pointed out the importance of gyp-sum amendments in the reduction of toxic Al without altering pH conditions [14]. This occurs due to the replacement of exchangeable Al^{3+} by Ca^{2+}particularly in the subsoil and the formation of Al-hydroxyl-sulfate or aluminum sulfate complexes [15], which are less toxic to plants. Therefore, experimental evidences indicate that there are enough scopes to increase the productivity of mungbean under proper management. In this study, an attempt was made to effect of salicylic acid and $CaSO_4$ on morphophysiology growth and yield of Mungbean. Considering the above factors the present experiment was conducted To know the effect of SA and $CaSO_4$ on growth parameters are scanty and yield components of mungbean varieties to find out the appropriate combination of SA and $CaSO_4$ on mungbean.

2. Methodology

2.1. Climate

The climate of the locality is subtropical which is characterized by high temperature and heavy

rainfall during *Kharif* season (April-September) and scanty rainfall during *Rabi* season (October-March) associated with moderately low temperature. The experiment was conducted during *Kharif* season.

2.2. Plant materials

2.2.1. BARI Mung-4

BARI Mung-4 was used as planting material. BARI Mung-4 was released and developed by BARI in 1996. Plant height of the cultivar ranges from 52 to 57 cm. Average yield of this cultivar is about 1200 kg ha^{-1}. The seeds of BARI Mung-4 for the experiment were collected from pulse research cenre, BARI, Joydepur, Gazipur.

2.2.2. BARI Mung-6

BARI Mung-6 was used as planting material. BARI Mung-6 was released and developed by BARI in 2003. Plant height of the cultivar ranges from 40 to 45 cm. Average yield of this cultivar is about 1600 kg ha^{-1}. The seeds of BARI Mung-6 for the experiment were collected from pulse research cenre, BARI, Joydepur, Gazipur.

2.2. Fertilizer application

The fertilizers were applied as basal dose at final land preparation where N, K_2O, P_2O_5,Ca and S were applied @ 20.27 $kgha^{-1}$, 33 kg ha^{-1}, 48 kg ha^{-1}, 3.3 kg ha^{-1} and 1.8 kg ha^{-1} respectively in all plots. All fertilizers were applied by broadcasting and mixed thoroughly with soil.

2.3. Sowing of seeds

Seeds were sown at the rate of 25 kg ha^{-1} in the furrow on March 29, 2017 and the furrows were covered with the soils soon after seeding.

2.4. Intercultural operations

Weeding was done once in all the unit plots with care so as to maintain a uniform plant population as per treatment in each plot at 15 DAS. Thinning was done at 20 DAS and 35 DAS. Plant to plant distance was maintained at 10 cm. Pre sowing irrigation was given to ensure the maximum germination percentage. During the whole experimental period, there was a shortage of rainfall in earlier part; however, it was heavier in later one. So it was essential to remove the excess water from the field at later period.

2.5. Insect and pest control

Malathion 57 EC @ 1.5 L ha^{-1} was sprayed when required.

2.6. Determination of maturity

At the time when 80% of the pods turned brown color, the crop was considered to attain maturity.

2.7. Harvesting and Threshing

The crop was harvested at 70 DAS from prefixed 1.0 m^2 areas. Before harvesting ten plants were selected randomly from each plot and were uprooted for data recording. The rest of the plants of prefixed 1 m^2 area were harvested plot wise and were bundled separately, tagged and brought to the threshing floor.

The crop was sun dried for three days by placing them on the open threshing floor. Seeds were separated from the plants by beating the bundles with bamboo sticks.

2.8. Data analysis technique

The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique with the help of a computer package program MSTAT-C and the mean differences were adjusted by Least Significance Difference (LSD) test (Gomez and Gomez, 1984).

3. Results and Discussion

3.1. Plant height

The plant height was varied with the different varieties at harvest (Fig. 1). The tallest plant (56.91 cm) was obtained from BARI Mung-6 (V_2) and the shortest plant (43.26 cm) was obtained in BARI Mung-4 (V_1). This variation in plant height might be attributed to the genetic characters. Different varieties showed different plant height on the basis of their varietal characters and an improved variety is the first and foremost

requirement for initiation and accelerated production program of any crop. [16] reported that SML 668 has an average plant height of 44.6 cm as an early maturing cultivar.

There was a significant variation in plant height due to the difference concentration of salicylic acid with $CaSO_4$. The tallest plant (54.84 cm) was obtained from T_3 (Salicylic acid 0.5mMole + 5 mMole $CaSO_4$) treatment and the shortest plant height (44.28 cm) from T_0, control condition. Data revealed that with the application of salicylic acid plant height showed an increasing trend.

Interaction effect of varieties and salicylic acid and $CaSO_4$ had a significant variation on plant height of mungbean (Table 1). The tallest plant (60.40 cm) was obtained from V_2T_3 (BARI Mung-6 with Salicylic acid 0.5mMole + 5 mMole $CaSO_4$) treatment combination, which was statistically similar with V_2T_1. The shortest plant height (36.43 cm) was observed from V_1T_0 (BARI Mung-4 with control) treatment combination.

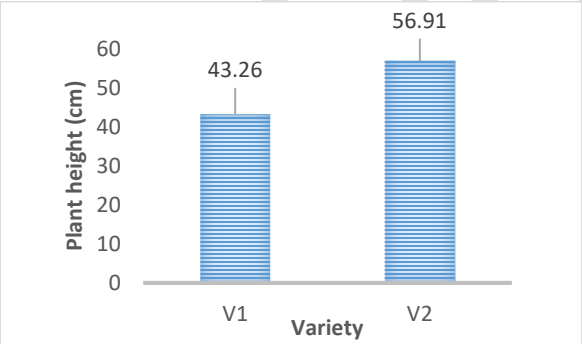

Fig.1: Effect of varieties on the plant height of Mungbean

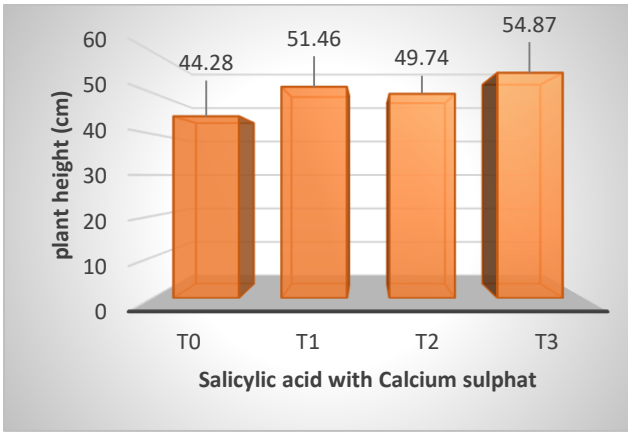

Fig.2: Effect of salicylic acid with calcium sulphate on the plant height of Mungbean

3.2. Number of leaves plant^{-1}

The number of leaves plant^{-1} was influenced by varieties (Fig. 3).The BARI Mung-4 produced maximum number of leaves (11.52) and the minimum number of leaves (9.85) was recorded in BARI Mung-6. Rahman (2002) observed leaf was significantly greater in BARI Mung-2 and BARIMung-5 than in the BINA Mung-l with the BINA Mung-l with the magnitude being intermediate in the BINA Mung-2. There was a significant variation in the number of leaves plant^{-1} due to the difference concentration of salicylic acid withcalcium sulphate (Fig. 4). The maximum number of leaves plant^{-1} (12.67) was obtained from T_3 (Salicylic acid 0.5mMole + 5 mMole CaSO4) treatment. The minimum number of leaves plant^{-1} (8.97) from T_0 control condition. The number of leaves was increased with increasing in salicylic acid at certain level. [17] who reported that high concentration of SA (200 ppm) caused an increase of 74.94% in leaf area and number of leaf. Interaction effect of varieties and salicylic acid with calcium sulphate had significant variation on number of leaves plant^{-1} of mungbean. The highest number of leaves plant^{-1} (14.33) was obtained from V_1T_2 (BARI Mung-6 with Salicylic acid 0.5mMole) treatment while the lowest number of leaves plant^{-1} (9.13) from V_2T_0 (BARI Mung-6 with control) treatment, which was statistically similar with. V_1T_0, V_2T_1 and V_2T_2 (Table 1).

4.3 Number of pod plant^{-1}

The number of pod plant^{-1} was varied with to the different varieties (Fig. 5). The highest number of pod plant^{-1} (28.85) was recorded in V_2 (BARI Mung-6). The lowest number of pods plant^{-1} (26.03) was recorded in BARI Mung-4.

There was significant variation in the number of pods plant^{-1} due to the salicylic acid with $CaSO_4$ (Fig 6). The maximum number of pods plant^{-1} (29.63) was observed from T_3 and the minimum number of pods plant^{-1} (24.87) was obtained in T_0 control condition. [18] reported that 100 ppm SA foliar spray registered significantly higher number of pod plant^{-1} compared to water spray.

Table 1. Interaction effect of varieties and salicylic acid on the plant height of mungbean

Treatment	Plant height (cm)	Number of leaf per plant	Number of pod per plant
V_1T_0	36.43 d	9.13 b	22.60 c
V_1T_1	43.28 cd	11.67 ab	26.73 ab
V_1T_3	44.00 cd	10.93 ab	25.60 bc
V_1T_2	49.33 bc	14.33 a	29.20 ab
V_2T_0	52.13 ab	8.80 b	27.13 ab
V_2T_1	59.63 a	9.33 b	29.13 ab
V_2T_3	55.47 ab	10.27 b	29.07 ab
V_2T_2	60.40 a	11.00 ab	30.07 a
$LSD_{(0.05)}$	7.76	3.38	3.36
CV(%)	8.85	8.06	5.47

In a column, means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.

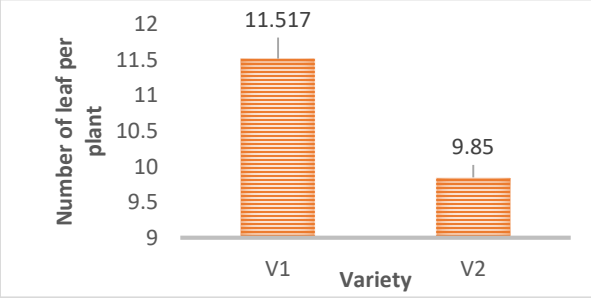

Fig.3: Effect of varieties on the number of leaf plant^{-1}of mungbean

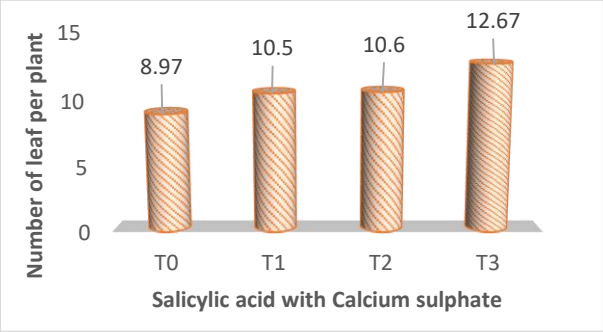

Fig.4: Effect of salicylic acid with Calcium sulphate on the number of leaf plant^{-1}of Mungbean

Interaction effect of different varieties and different salicylic acid with $CaSO_4$ had a significant variation on number of pods plant^{-1}. The highest number of pods plant^{-1} (30.07) was obtained from V_2T_3 (BARI Mung-6 with Salicylic acid 0.5mMole + 5 mMole CaSO4) treatment, whiles the lowest number of pod plant^{-1} (22.6) from V_1T_0 (BARI Mung-4 with control) treatment combination (Table 1).

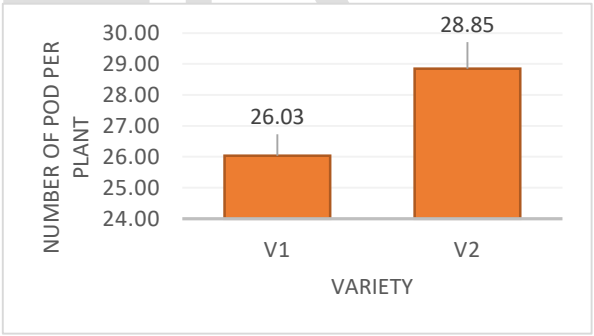

Fig.5: Effect of varieties on the number of pod plant^{-1}of mungbean

3.4 Pod Length

Pod length is one of the most important yield contributing characters of mungbean. Varieties showed variation in pod length (Table 2). The longest pod length (9.19 cm) was observed in V_2 (BARI Mung- 6). The shortest pod length (6.12 cm) was obtained in V_1, (BARI Mung-4). These results have the agreement with the results of [19]

who reported that pod length differed from varieties to varieties. The probable reason of this difference could be the genetic make-up of the varieties.

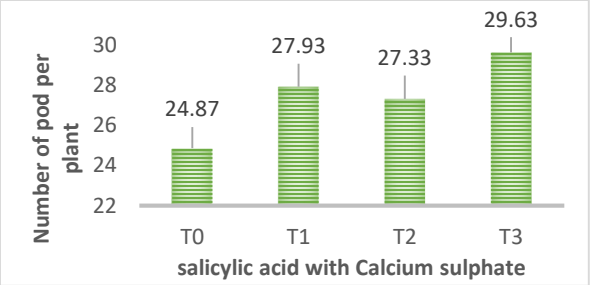

Fig.6: Effect of salicylic acid with Calcium sulphate on the number of pods plant^{-1}of Mungbean

Pod length of mungbean was significantly influenced by variation with the different concentration of salicylic acid with calcium sulphate (Table 2). The longest pod length (8.56 cm) was recorded from T_3 treatment, which was statistically different from all other treatment. The shortest pod length (7.48 cm) was observed in T_0 (control condition) treatment.

Interaction effect of different varieties and salicylic acid with $CaSO_4$ had a significant variation on pod length of mungbean (Table 2). The highest pod length (9.52 cm) was obtained from V_2T_3 (BARI Mung-6 with Salicylic acid 0.5mMole + 5 mMole $CaSO_4$) treatment, which was statistically similar with V_2T_2 whiles the lowest (6.25 cm) from V_1T_0 treatment.

Table 2. Interaction effect of varieties and salicylic acid on yield contributing characters of mungbean

Treatment	Pod length (cm)		Number of seed per pod		Thousand seed weight (g)	
Effect of Variety						
V1	7.12b		12.26a		42.86b	
V2	9.19a		12.8a		68.77a	
CV(%)	4.82		5.28		5.73	
Effect of salicylic acid with Calcium sulphate						
T_0	7.48	b	11.8	c	49.39	c
T_1	8.18	ab	13	a	57.16	ab
T_3	8.4	ab	12.1	b	55.87	b
T_2	8.56	a	13.21	a	60.84	a
$LSD_{(0.05)}$	1		0.97		4.1	
CV(%)	4.82		5.28		5.73	
Interaction effect of variety and salicylic acid with Calcium sulphate						
V_1T_0	6.25	d	11.53	c	36.91	f
V_1T_1	7.33	c	13.00	ab	43.52	e
V_1T_3	7.31	c	11.60	c	42.51	e
V_1T_2	7.60	c	12.90	ab	48.51	d
V_2T_0	8.71	b	12.07	bc	61.87	c
V_2T_1	9.03	ab	13.00	ab	70.79	ab
V_2T_2	9.48	a	12.60	abc	69.23	b
V_2T_3	9.52	a	13.53	a	73.17	a
$LSD_{(0.05)}$	0.69		1.16		3.65	
CV(%)	4.82		5.28		5.73	

In a column, means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.

3.5. Number of seeds pod^{-1}

The number of seeds pod^{-1}of mungbean was varied with varieties (Table 2). The highest number of seeds pod^{-1} (12.80) was observed in V_2 treatment. The lowest number of seeds pod^{-1} (12.26) was obtained from V_1. A result was found by [20] which was not similar with this study. They found significant difference on number of seeds pod^{-1} among the varieties.

The number of seeds pod^{-1} was significantly influenced by different concentration of SA with $CaSO_4$ (Table 2). The maximum number of seeds pod^{-1} (13.00) was obtained from T_3 which was followed by T_1. The minimum number of seeds pod^{-1} (11.8) was recorded from T_0 (control condition. Interaction effect of different varieties and SA with $CaSO_4$ was a significant effect on number of seeds pod^{-1} (Table 2). The highest number of seeds pod^{-1} (13.53) was obtained from V_2T_3 (BARI Mung-6 with Salicylic acid 0.5mMole + 5 mMole $CaSO_4$) while the lowest 11.53 from V_1S_0, BARI Mung-4 with control treatment combination.

3.6. 1000 seed weight

Variety had been variation in 1000-seed weight and it was also observed in studied varieties of mungbean (Table 2). The highest 1000-seed weight (68.77g) was recorded in V_2 (BARI Mung-6). In contrast, the lowest 1000-seed weight (42.86 g) was recorded inV_1, (BARI Mung-4). Genotypic variation in 1000-seed weight was also observed in mungbean that also supported the present experimental results. Similar results were found by [20] and they observed significant differences between mungbean genotypes for 1000 seeds weight.

There was significant variation in the thousand seed weight due to the salicylic acid with $CaSO_4$. The maximum thousand seed weight (60.84g) was obtained from T_3, which was followed by T_1 and the minimum thousand seed weight (49.39) g from T_0 (Table 2).

Interaction effect of different varieties and salicylic acid with $CaSO_4$ was significant variation on thousand seed weight. The highest thousand seed weight (73.17 g) was obtained from V_2T_3 (BARI Mung-6 with Salicylic acid 0.5mMole + 5 mMole $CaSO_4$) treatment while the lowest (36.91 g) from V_1T_0 treatment (Table 2).

4.7. Seed yield

The yield of mungbean was varied with different varieties. Yield is a function of various yield components such as number of pod plant^{-1}, seed pod^{-1} and 1000-grain weight. The highest seed yield (1.69 tha^{-1}) was recorded in V_2 (BARI Mung-6). In contrast, the lowest seed yield (1.42 tha^{-1}) was obtained from V_1 (BARI Mung-4) (Table 3). The probable reason of this difference might be due to higher number of pod length, number of seeds pod^{-1}. There was significant variation in the seed yield hectare^{-1} due to the salicylic acid with $CaSO_4$. The maximum seed yield hectare^{-1} 1.75 ton was obtained from T_3, and the minimum (1.40 ton) was obtained in T_0, control condition (Table 3).

Interaction effect of different varieties and salicylic acid with $CaSO_4$ had a significant variation on seed yield ha^{-1}. The highest seed yield ha^{-1} (1.93 ton) was obtained from V_2T_3 (BARI Mung-6 with Salicylic acid 0.5mMole + 5 mMole CaSO4) treatment combination while the lowest (1.26 ton) from V_1T_0 (BARI Mung-4 with control) treatment combination (Table 3)

3.8. Stover yield

Varieties on stover yield in mungbean genotypes had a significant variation (Table 3). Results revealed that the highest stover yield 1.83 t ha^{-1} was recorded from BARI Mung-6. Whereas, the lowest stover yield 1.53 t ha^{-1} was achieved from BARI Mung-4. The experimental result varied with growth and yield of Mungbean by salicylic acid with $CaSO_4$ on stover yield (t ha^{-1}) of Mungbean (Table 3). Results showed that the maximum stover yield 1.78 t/ha was recorded from T_3, which was statistically similar with T_1 and T_3, whereas the lowest stover yield 1.49 t/ha was achieved from control.

Significant variation was observed in the interaction effect of different types of varieties and different concentration of salicylic acid on stover yield (Table 3). The highest stover yield

1.96 t/ha was recorded fromV_2T_1 (BARI Mung-6 with 5 mMole $CaSO_4$), which statistically different from all other treatments, whereas the stover yield 1.31 t/ha was recorded from V_1T_0 treatment combination.

Table 3. Interaction effect of varieties and salicylic acid on yield and yield contributing characters of mungbean

Treatment	Seed yield (t/ha)	Stover yield (t/ha)	Biological yield (t/ha)	Harvest Index (%)
Effect of Variety				
V1	1.42	1.53	2.95	47.90
V2	1.69	1.83	3.52	48.02
CV(%)	5.58	7.82	5.93	6.41
Effect of salicylic acid with Calcium sulphate				
T_0	1.40 c	1.497 b	2.894 b	48.05 ab
T_1	1.54 b	1.708 a	3.251 ab	47.47 ab
T_2	1.54 b	1.718 a	3.253 ab	46.93 b
T_3	1.75 a	1.777 a	3.527 a	49.38 a
$LSD_{(0.05)}$	0.12	0.14	0.40	2.39
CV(%)	5.58	7.82	5.93	6.41
Interaction effect of variety and salicylic acid with Calcium sulphate				
V_1T_0	1.26 e	1.31 e	2.58 e	48.60 ab
V_1T_1	1.40 de	1.46 de	2.85 de	48.50 ab
V_1T_3	1.46 cd	1.70 bcd	3.15 cd	45.93 b
V_1T_2	1.57 bc	1.63 cd	3.20 cd	48.57 ab
V_2T_0	1.53 bcd	1.68 bcd	3.21 cd	47.50 ab
V_2T_1	1.69 b	1.96 a	3.65 ab	46.43 b
V_2T_2	1.61 bc	1.74 abc	3.35 bc	47.93 ab
V_2T_3	1.93 a	1.92 ab	3.85 a	50.20 a
$LSD_{(0.05)}$	0.16	0.23	0.34	2.86
CV(%)	5.58	7.82	5.93	6.41

In a column, means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.

3.9. Biological yield

Biological yield of mungbean was significantly influenced by variety (Table 3). The maximum biological yield 3.52 t ha^{-1} was found in V_2 (BARI Mung-6). The lowest yield 2.95 t ha^{-1} was observed from V_1, BARI Mung-4. Varietal performance showed significant variation on biological yield [22].

There was a significant influence in the biological yield of mungbean due to SA and $CaSO_4$ (Table 3). The maximum biological yield 3.53 t ha^{-1} was found from T_3 and the minimum

biological yield 2.89 t/ha from T_0, control condition.

Interaction of variety and SA had a significant influence on biological yield of mungbean (Table 3). The highest biological yield 3.85 t/ha was obtained from V_2T_3 (BARI Mung-6 with Salicylic acid 0.5mMole + 5 mMole CaSO4) while the lowest 2.58 t/ha from V_1T_0, BARI Mung-4 with contro).

3.10 Harvest index

Harvest index was influenced by variety (Table 3). The maximum harvest index (48.02%) was found in V_2 (BARI Mung-6). The lowest yield (47.90%) was observed from V_1 (BARI Mung-4).

There was a significant influence in the harvest index due to SA and $CaSO_4$ (Table 3). The maximum harvest index 49.38% was found from T_3 and the minimum harvest index 46.93% from T_0, control condition.

Interaction of variety and SA with $CaSO_4$ had a significant influence on harvest index (Table 3). The highest harvest index 50.20% was obtained from V_2T_3 (BARI Mung-6 with Salicylic acid 0.5mMole + 5 mMole CaSO4), while the lowest 45.93 % from V_1T_3.

4. Conclusion

From the above findings it can be concluded that most of the parameters gave the best performance which was achieved from V_2, BARI Mung-6. Again, application of salicylic acid 0.5milimole + 5 mMole $CaSO_4$ showed the best performance regarding most of the yield and yield contributing parameters. In case of combined effect, BARI Mung-6 and salicylic acid 0.5milimole + 5 mMole $CaSO_4$ gave the best result considering yield and yield contributing parameters. The highest seed yield 1.93 t ha^{-1} was obtained from BARI Mung-6 and Salicylic acid 0.5milimole + 5 mMole $CaSO_4$. So, this treatment combination can be treated as the best treatment combination under the present study. With the increasing demand of protein and to meet the challenge of 21st century mungbean are needed with higher yield.

Considering the results obtained from the present experiment, further studies in the following areas may be suggested:

- We got clear information about the reproductive pattern of different varieties of mungbean.
- The performance of mungbean variety named BARI mung-6 was better in respect of growth, yield and yield components during the whole life cycle of the plant.
- Other growth regulators with different management practices may be included in future study for more accurate results,
- Future study may be carried out with more varieties/genotypes, and
- Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional compliance and other performances.

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