Bangladesh J. Bot. **42**(1): 179-183, 2013 (June) **- Short communication**

FOLIAR APPLICATION OF CHITOSAN ON GROWTH AND YIELD ATTRIBUTES OF MUNGBEAN (*VIGNA RADIATA* (L.) WILCZEK)

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Key words: Foliar spray, Chitosan, Mungbean, Seed yield

Abstract

Plant parameters such as plant height, branch and leaf number/plant, leaf area/plant, total dry mass/plant, photosynthesis, harvest index, chlorophyll, nitrate reductase and number of pods/plant increased significantly with the increasing concentration of chitosan up to 50 ppm. It resulted the highest seed yield in mungbean.

Mungbean, *Vigna radiata* (L.) Wilczek, is one of the most important pulses in south-east Asia. However, its yield is much lower than that of other legume crops such as grasspea, chickpea and lentil (FAO 2007). Flower and pod abortion is a common phenomenon in mungbean and abscission of a large proportion of reproductive structures (69 - 90%) before maturity, would be the primary cause of lowering yield in mungbean (Fakir *et al*. 2011). There are reports that application of growth regulators reduce abscission and increase yield components in soybean and tomato (Nahar and Ikeda 2002, Imam *et al*. 2010).

A few researches were carried on the effects of chitosan on plant growth and development and its productivity (Patkowska *et al.* 2006 , Sereih *et al.* 2007, Gornik *et al.* 2008). Recently, chitosan enhanced plant growth and development have been reported Chibu *et al*. (2002), Mondal *et al*. (2012). So far our knowledge to chitosan induced growth, yield attributes and fruit yield of mungbean is scanty. So, the present research was undertaken to study the effects of chitosan on morphological features, yield attributes and yield in mungbean under sub-tropical climate.

Two varieties of mungbean, namely BINAmung-7 and BINAmung-8 obtained from BINA were used for both pot and field experiments during Kharif-I season (March-May) of 2010 and 2011. Five concentrations of chitosan *viz*., 0, 25, 50, 75 and 100 ppm were applied twice at 25 (4 - 5 leaves stage) and 35 days after sowing (DAS), just before flowering, by a hand sprayer in the afternoon. For pot culture, the soil was thoroughly mixed with urea, triple superphosphate, muriate of potash and gypsum at the rate of 2.0, 4.0, 3.0 and 2.0 g/pot corresponding to 40, 80, 60 and 40 kg/ha, respectively. Total amount of urea, TSP, MP and gypsum were applied as basal dose during soil preparation. The pots (30 × 25 cm) were filled with 10 kg of soil. The pot experiment was laid out at completely randomized design with four replications. Five seeds were sown in each pot and 15 DAS, they were thinned to two seedlings. The field experiment was also laid out at randomized complete block design with three replications. The unit plot size was 3 × 2 m. The row to row and plant to plant distances were 30 and 10 cm, respectively. Intercultural operations such as irrigation, weeding, mulching and pest control were followed as and when necessary.

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Flower counting (five plants for each replication) was made each day starting from the date of opening of first flower until flowering ceased. Chlorophyll content in leaves, nitrate reductase (NR) activity in leaves and photosynthesis in leaf were determined at 45 - 50 DAS (flowering and fruiting stage) of upper 2 - 3 nodal leaves in the canopy. Chlorophyll was determined following Yoshida *et al*. (1976). NRase was estimated following Stewart and Orebamjo (1979). Photosynthesis was measured by automatic photosynthesis meter (LICOR 6400XT, USA). Leaf area, yield and yield components, dry matter production and it's partitioning into plant parts were determined at harvest. Harvest index was calculated from the data using formula: (Economic yield/biological yield) × 100. Plant material was oven dried at 80 ± 2ºC for 72 hrs. The total dry matter/plant was estimated by summing dry matter of leaves, stem and roots per plant. The data were analyzed using Microsoft Statistical Data Management Package (MSTAT) program.

Results show that plant height, branch and leaf number and LA/plant both at pot and field conditions increased with the increasing chitosan concentration till 50 ppm (Table 1). The higher plant height, branch and leaf number and LA/plant were recorded in between 50 and 100 ppm of chitosan. Leaf number and LA were greater in chitosan treated plants than control might be due to increased number of branches/plant (Table 1). These results are in conformity in tomato and okra (El-Tantawy 2009 and Mondal *et al.* (2012).

Table 1. Effect of chitosan on growth attributes of mungbean.

Treatments conc. (ppm)	Plant height (cm)		Branches/ plant (no.)		Leaves/ plant (no.)		Leaf area/ plant (cm^2)	
	Pot	Field	Pot	Field	Pot	Field	Pot	Field
0	31.1 c	37.3 b	1.85 c	2.00 b	12.6 d	15.2 c	1056 c	1265 b
25	34.3 b	38.1 ab	2.25 b	2.15 b	14.0 c	16.5 bc	1165 b	1305ab
50	35.4 ab	38.7 ab	2.65 a	2.25 ab	17.1 a	17.6 ab	1255 a	1295ab
75	36.8 a	39.0 a	2.57 a	2.50 a	15.5 b	18.2 a	1220ab	1390 a
100	35.8 ab	39.4 a	2.65 a	2.50 a	16.6 a	18.7 a	1241 a	1340 a
F test	**	*	**	*	**	**	**	*
Variety								
BINA mung-7	39.8 a	44.5 a	3.65 a	3.32 a	21.1 a	22.4 a	1505 a	1606 a
BINA mung-8	29.6 b	32.5 b	1.14 b	1.24 b	9.23 b	12.0 b	872 b	1019 b
F Test	**	**	**	**	**	**	**	**
CV (%)	4.08	4.64	7.87	11.56	5.96	7.92	5.36	7.22

In a column, within treatment, figures having same letter(s) do not differ significantly at $p \leq 0.05$.
*, ** indicate significant at 5 and 1% level of probability, respectively.

Total dry mass (TDM)/plant, photosynthesis, chlorophyll and NR increased significantly with the increasing chitosan concentration till 50 ppm (Table 2). The harvest index (HI) increased up to 50 ppm chitosan indicated that dry matter partitioning was in favor of economic yield in mungbean. These results are in consistent with Khan *et al.* (2002) and El-Tantawy (2009) who reported that application of chitosan increased photosynthesis in leaves of maize and soybean as well as tomato, respectively.

In the present investigation, the number of flowers/plant increased with the increasing chitosan concentration till 75 ppm followed by slightly declining whereas the number of pods/plant increased significantly till 50 ppm (Table 3). Pod length, number of seeds/pod and 1000-seed weight was apparently increased in chitosan treated plants over control plants (Table 3). Compared to 50 and 75 ppm chitosan, all yield attributes lowered down at 100 ppm chitosan indicating its toxic effect at higher concentration.

The highest seed yield/plant both at pot and field condition was at 50 ppm (8.16 and 9.31 g/plant for pot and field, respectively) followed by 75 ppm (7.66 and 8.70 g/plant for pot and field, respectively), Table 4. The yield of seeds was higher at 50 ppm chitosan due to increased production of pods/plant (25.4 and 27.1/plant for pot and field, respectively) and superior dry matter partitioning to economic yield (Table 2). Considering yield performance in unit area basis, the higher seed yields were recorded at 50 and 75 ppm chitosan with being the highest at 75 ppm (1913 kg/ha). Chibu *et al.* (2002) reported that application of chitosan at early stages increased plant growth and development thereby increased the seed yield in rice and soybean.

Table 2. **Effect of chitosan on some physiological and biochemical parameters of mungbean.**

Treatments conc. (ppm)	Physiological parameters					Biochemical parameters	
	Total dry mass/ plant (g)		Harvest index (%)		Photosynthesis (µmol CO_2/s/m^2)	Chlorophyll (mg/g/FW)	NR (µmol NO_2^- /g/FW)
	Pot	Field	Pot	Field	Field	Field	Field
0	13.8 c	15.3 b	34.9 b	31.5 ab	15.36 b	2.19 b	3.84 b
25	14.9 b	15.8 b	37.2 a	33.0 ab	16.71 a	2.29 ab	4.21 a
50	15.8ab	17.4 a	37.5 a	33.3 a	17.29 a	2.35 a	4.30 a
75	16.6 a	17.9 a	34.5 b	32.9 ab	17.25 a	2.35 a	4.29 a
100	16.0 a	17.5 a	34.5 b	30.8 b	17.41 a	2.40 a	4.33 a
F test	**	**	*	*	**	*	**
Variety							
BINA mung-7	18.2 a	19.5 a	32.4 b	30.7	15.99 b	2.21 b	4.06 b
BINA mung-8	12.6 b	14.1 b	39.0 a	33.9	17.61 a	2.42 a	4.33 a
F Test	**	**	**	*	**	**	**
CV (%)	6.40	6.85	5.87	5.29	5.56	5.04	4.28

In a column, within treatment, figures having same letter(s) do not differ significantly at $p \leq 0.05$.
*, ** indicate significant at 5 and 1% level of probability, respectively.

Table 3. **Effect of chitosan on yield attributes of mungbean.**

Treat-ments conc. (ppm)	Flowers/ plant (no.)	Pods/ plant (no.)		Pod length (cm)		Seeds/pod (no.)		1000-seed weight (g)	
	Field	Pot	Field	Pot	Field	Pot	Field	Pot	Field
0	43.2 b	19.9 c	23.4 b	7.54	7.62	10.26	10.80	37.26b	35.70
25	43.7 b	22.8 b	25.1ab	7.59	7.87	10.30	11.21	37.87a	36.10
50	46.9 a	25.4 a	27.1 a	7.59	7.90	10.40	11.30	38.00a	36.40
75	49.3 a	23.7 b	27.3 a	7.64	7.90	10.52	11.20	37.65ab	36.20
100	48.1 a	22.0 b	25.6ab	7.59	7.82	10.22	11.27	36.80 c	35.65
F test	**	**	*	NS	NS	NS	NS	**	NS
Variety									
BINA mung-7	66.2 a	29.9 a	34.7 a	7.00b	7.21b	10.04b	10.81b	29.71b	28.90a
BINA mung-8	26.3 b	15.6 b	16.8 b	8.18a	8.44a	10.65a	11.50a	45.32a	43.12b
F Test	**	**	**	**	**	**	**	**	**
CV (%)	5.40	7.28	8.38	1.77	2.96	3.71	4.07	1.70	3.16

In a column, within treatment, figures having same letter(s) do not differ significantly at $p \leq 0.05$.
*, ** indicate significant at 5 and 1% level of probability, respectively; NS = Not significant.

Among the varieties, BINAmung-7 showed superiority in plant height, branch and leaf production, TDM production, flower and pod production and seed yield over BINAmung-8 whereas it showed superiority in photosynthesis, chlorophyll, NR, pod and seed size and HI than BINAmung-7 (Tables 1- 4).

Table 4. Effect of chitosan on seed yield and interaction of variety and chitosan concentration on seed yield of mungbean.

Treatments conc. (ppm)	Seed weight/ plant (g)		Seed yield (kg/ha)	Interaction (× ppm)	Seed weight/ plant (g)		Seed yield (kg/ha)
	Pot	Field	Field		Pot	Field	Field
				$V_1 \times 0$	7.51 c	8.23 cd	1728 bc
0	6.55 d	7.28 d	1556 c	$V_1 \times 25$	7.97 b	8.91 b	1870 ab
25	7.08 c	8.70 b	1696 b	$V_1 \times 50$	9.23 a	9.77 a	2052 a
50	8.16 a	9.31 a	1893 a	$V_1 \times 75$	7.99 b	9.70 a	2037 a
75	7.66 b	8.70 b	1913 a	$V_1 \times 100$	7.74 b	8.70 bc	1827 b
100	7.09 c	8.26 c	1704 b	$V_2 \times 0$	5.58 e	5.99 g	1384 d
F test	**	**	**	$V_2 \times 25$	6.18 d	6.59 fg	1522 d
Variety				$V_2 \times 50$	7.09 c	7.50 e	1733 bc
BINA mung-7	8.09 a	8.80 a	1902 a	$V_2 \times 75$	7.32 c	7.74 de	1788 b
BINA mung-8	6.52 b	7.60 b	1601 b	$V_2 \times 100$	6.43	6.84 f	1580 cd
F test	**	**	**		*	*	*
CV (%)	4.52	3.89	6.22		3.89	4.52	6.22

In a column, within treatment, figures having same letter(s) do not differ significantly at $p \leq 0.05$.
*, ** indicate significant at 5 and 1% level of probability; V_1 = BINAmung-7, V_2 = BINAmung-8.

The highest seed yield of BINAmung-7 was recorded at 50 ppm (9.23 and 9.77 g/plant for pot and field conditions, respectively) which was statistically similar to 75 ppm chitosan (7.99 and 9.70 g/plant for pot and field conditions, respectively). On the other hand, the highest seed yield of BINAmung-8 was at 75 ppm (7.32 and 7.74 g/plant for pot and field conditions, respectively) which was statistically similar to 50 ppm chitosan (7.09 and 7.50 g/plant for pot and field conditions, respectively). Result revealed that BINAmung-8 (bold seeded plant) were more influenced by chitosan application in seed yield (maximum 31.2% yield increased over control) than BINAmung-7, the small seeded variety (maximum 22.9% yield increased over control). And 50 and 75 ppm had superiority for plant growth, yield components and fruit yield over 25 and 100 ppm.

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(Manuscript received on 22 January, 2012; revised on 10 April, 2013)