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Impact of varied levels and seed soaking period of water on seedling emergence sown with *Bt* cotton planter

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ABSTRACT : Field and labortary studies were conducted to visualize the changes in size and weight of *Bt* cotton seed in water soaking and their impact on seedling emergence. *In vitro* studies indicated that *Bt* cotton seed is capable of absorbing water equivalent to 1/3 of its dry weight within 1 h of soaking. An increased seed weight over the initial weight in the range of 33.3-117.0 per cent was recorded under various levels of water soaking and time intervals. Mean seed length for SWCH 4711 increased by 15.3-21.0 per cent, whereas breadth was enhanced by 20.8-31.4 per cent upon varying intervals of water soaking as compared to control. Similarly, for MRC 7017, length increased by 17.3-22.3 per cent while breadth increased significantly by 24.4-31.1 per cent. Data revealed that as a result of enhanced size (length/breadth) and weight, soaked seed was exposed to mechanical damage in the slots/compartments of *Bt* cotton planter. These findings were verified by conducting field experiment comprising of 5 seed soaking treatments {*viz.,* T_1: control, dry sowing without soaking in water; T_2: sowing seed after soaking in 20 ml water for 1 h and thrice stirring; T_3: sowing seed after soaking in 20 ml water for 2 h and thrice stirring; T_4: sowing seed after soaking in 60 ml water for 1 h and T_5: sowing seed after soaking in 60 ml water for 2 h} , whereby a counted number and quantity of *Bt* cotton seed (60 g) was used to study the seedling emergence after sowing with *Bt* cotton planter. Overall mean of two years indicated highest emergence (75.0%) with dry sowing of *Bt* seed and a gradual decline in the emergence with increasing quantity of water and prolonged soaking period from 75.0 to 58.8 per cent thereby indicative of mechanical damage to soaked *Bt* seed.

Key words: *Bt* cotton planter, cotton, *in vitro* studies, seedling emergence

India has all the potential to emerge as a world leader of cotton as it occupies one third of the global cotton area. The area under *Bt* cotton increased to 121.9 lakh ha in 2011 with an adoption rate of 92.0 per cent of the total cotton area. In Punjab, *Bt* cotton is presently covering 94 per cent of total cotton acreage (Kranthi, 2012). Owing to fast growth and development resulting in better performance in terms of high seed cotton yield, *Bt* cotton hybrids have become popular among farmers in the state. No doubt besides improvement in yield, *Bt* cotton has lowered the pest incidence and reduced environmental pollution by limited use of insecticides by about 50 per cent (Karihaloo and Kumar, 2009). Prior to introduction of *Bt* cotton planter, farmers used to sow *Bt* seed manually by dibbling which was not only labour intensive and time consuming but coverage of area/unit time was very low. Moreover, for reasons such as costly seed, labour shortage besides their timely availability, now farmers mostly prefer *Bt* cotton planter for sowing *Bt* cotton seed which has inclined discs having precise slots for accurate distribution of even small amount of seed. Besides, it has associated advantages such as uniform seed distribution, sowing at proper depth and coverage of more area/unit time etc. Singh *et al.*, (2012a) has also reported considerable energy saving by use of *Bt* cotton planter in cotton agro ecosystems of Haryana. Farmers are in a dilemma regarding the water soaking treatment of *Bt* cotton seed prior to sowing by *Bt* cotton planter. Generally, breakage of seed has been reported by the farmers particularly if *Bt* seed is soaked for prolonged duration prior to sowing through this planter. As a result of this, swollen seed either fails to pass through the slots of planter owing to increased size/weight or gets mechanical injuries, which ultimately leads to poor plant stand and reduced seed cotton yield. According to the existing

recommendations, the ordinary acid delinted seed of non *Bt hirsutum* varieties should be soaked in water for 2 – 4 h prior to sowing. However, most of the *Bt* cotton seed produced by the companies is packed after delinting and seed treatment with suitable fungicides/insecticides against soil born diseases and sucking pests such as *Amrasca biguttula (Ishida)*. The water soaking treatment of *Bt* cotton seed causes imbibition of water, resulting in morphological changes in volume, weight and size besides removal of treated chemical in the left over water after seed soaking. At present, no studies are available that show the quantitative effects of changes in cotton seed under varied levels and periods of water soaking on germination/ emergence of such seed sown with *Bt* cotton planter. Generation of such information through field and laboratory experimentation is therefore of utmost importance for guiding the farmers. Hence, the present studies were undertaken to verify and establish these facts.

MATERIALS AND METHODS

The experiments were conducted during *kharif* 2011 and 2012 at Pujab Agricultural University, Regional Research Station, Faridkot (30 ^{0} 40'N and 74 ^{0} 44 'E) in south western zone (Zone IV) of Punjab situated at 200 m above MSL. The *in vitro* studies were carried out in petri dishes to study the changes in size and weight of *Bt* seed which indicated amount of water absorbed under variable water levels as well as duration of soaking. In first laboratory experiment intended to study the changes in weight/volume of *Bt* cotton seed under variable levels of water soaking and time intervals with 5 treatments { *i.e* T_1**:** soaking in 10 ml limited water for 1 h and stirring thrice, T_2**:** soaking in 10 ml limited water for 2 h and stirring thrice, T_3**:** soaking in 30 ml water for 1 h, T4**:** soaking in 30 ml water for 2 h and T_5**:** soaking in unlimited water for 2h} arranged in complete randomized design having 6 replicates (3 replications/ hybrid). A uniform quantity of seed (30 g) was used for soaking in all the treatments for both the hybrids. The second laboratory experiment was comprised of 4 treatment combinations (*i.e* DT_1**:** dry seed with no soaking, DT_2**:** soaking in 20 ml water for 1 h, DT_3**:** soaking in 20 ml water for 2 h and DT_4**:** soaking in 20 ml water overnight) arranged in complete randomized design replicated thrice. A uniform number of seeds (*i.e* 20/replication) were used for soaking in all the treatments for both the hybrids. Change in length and breadth of soaked seed was measured with the help of Vernier Caliper. Apart from above said *in vitro* studies, the field experiments were also conducted to study the emergence of *Bt* cotton seed under different periods and levels of water soaking. Sowing of *Bt* hybrids namely SWCH 4711 and MRC 7017 was done on 16.5.2011 and 6.6.2011, respectively. The tractor operated *Bt* cotton planter was used by keeping a row to row distance of 67.5 cm with proper *wattar* (moisture) conditions. The field experiment was repeated during *kharif* 2012 as on 18.5.2012 using *Bt* hybrid MRC 7017.The field study comprised of 5 treatments arranged in 4 replications of randomized block design. A uniform quantity of seed (60 g) was used for soaking in all the treatments and 170 seeds/replication (~15g) were sown in each plot. The executed treatments in the field using *Bt* cotton planter comprised of FT_1: Control, dry sowing without soaking in water; FT_2: sowing seed after soaking in 20 ml limited water for 1 h and thrice stirring of seed; FT_3: sowing seed after soaking in 20 ml limited water for 2 h and thrice stirring of seed ; FT_4: sowing seed after soaking in 60 ml unlimited water for 1 h and T_5 : sowing seed after soaking in 60 ml unlimited water for 2 h. The final emergence of *Bt* cotton seed was recorded 15 days after sowing. The data generated from laboratory and field studies was analyzed statistically as per the standard procedure proposed by Cheema and Singh (1991).

RESULTS AND DISCUSSION

a) Laboratory studies Changes in seed weight after water soaking : The average of 6 replications (3 for each *Bt* hybrid) presented in

Table 1 revealed that all the treatments except for T_1 and T_2 differed significantly with each other. Soaking in 100 ml unlimited water overnight *i.e* T_5 resulted in significantly highest gain in seed weight (65.1g) as compared to rest of the treatments. It was surprising to record that acid delinted *Bt* cotton seed was capable of absorbing water equivalent to 1/3 of its weight within 1 h of soaking without any left over water to be drained as was evident from T_1 treatment where all the water was imbibed by the seed. There was a progressive and significant enhancement in weight of the soaked seed with increased duration as well as quantity of the water used. There was an increase of 74.0 and 83.6 per cent over the initial seed weight (30g) with a soaking duration of 1 and 2 h as evident from T_3 and T_4 treatments, respectively. An increased seed weight due to imbibed water in the range of 33.3-117.0 per cent under variable levels of water soaking and extended time intervals over the initial seed weight was recorded. Singh *et al.,* (2012b) has also reported the similar findings.

Changes in seed size after water soaking: The data presented in the Table 2 clearly revealed that seed length in case of SWCH4711 increased significantly with every successive increased water soaking period from 7.17 (Control) to 8.27,8.58 and 8.68 mm for DT_2, DT_3 and DT_4 treatments ,respectively. However, average breadth of seed improved significantly only from 3.88 mm (DT_1) up to 5.07 mm (DT_3) only. Highest level of increased seed length was recorded in DT_4 (5.10 mm) though it was statistically *at par* with DT_3. A similar trend for increase in seed length was recorded under MRC7017 which significantly increased from control (7.33mm) with every successive increase in soaking period. However, seed breadth of MRC7017 increased non significantly from 3.97 (Control) to 4.93 in case of DT_2 ,but subsequent increase in water soaking periods enhanced the seed breadth significantly upto 5.13 mm (DT_3) with highest breadth under DT_4 (5.20 mm). Soaking in 20 ml of water for overnight resulted in statistically highest increase in seed breadth. It was found that average length of the seed increased in the range of 15.3-21.0 per cent, whereas breadth was enhanced by 20.8-31.4 per cent for varying intervals of water soaking as compared to control for SWCH4711. Similarly, in case of MRC 7017, average length increased by 17.3-22.3 per cent while breadth increased by 24.4-31.1 per cent. Overall, mean increase in seed length for the tested *Bt* hybrids ranged from 16.3-21.7, while for breadth range was 22.6-31.3 per cent over the control. Changes in seed breadth were found to be higher than compared to corresponding changes in seed length. Data clearly indicated that as a result of enhanced size (length/breadth) and weight (Table1), soaked seed is exposed to mechanical damage in the slots/compartments of *Bt* cotton planter. Such damage during mechanical sowing results into reduced germination and consequently leads to decline in the emergence and finally results in reduced seed cotton yield. These results are in accordance with findings of Singh *et al.,* (2012b).

Table 1. Changes in weight of *Bt* cotton seed under variable water soaking and time intervals (*in vitro* studies)

Treatments	Water used (ml)	Time/ duration (h)	Initial seed weight (g)	Final weight (g)
T_1	10	1	30	40.0**(33.3)**
T_2	10	2	30	40.0**(33.3)**
T_3	30	1	30	52.2**(74.0)**
T_4	30	2	30	55.1**(83.6)**
T_5	untreated	overnight	30	65.1**(117.0)**
CD (p=0.05)		2.4	-	-

Values in the parenthesis indicate per cent increase in weight over the initial seed weight

b) Field studies : During 2011, highest emergence (80.0 %) for SWCH 4711 was observed under control treatment (Table 3). Although there was a declining trend with increased levels and periods of water soaking but significant reduction was noticed with the emergence of SWCH4711 only upto FT_2 (68.9%) over control. SWCH4711 recorded least emergence in FT_5 (60.3%), though *at par* with FT_4 (63.4%) but was significantly reduced as compared rest all the treatments.MRC7017 also recorded least values

Table 2 . Changes in size of *Bt* cotton seed (in vitro studies)

Treat ments-	Length (mm)			Breadth (mm)		
	SWCH 4711	MRC 7017	**Mean**	SWCH 4711	MRC 7017	**Mean**
DT_1	7.17	7.33	**7.25**	3.88	3.97	**3.92**
DT_2	8.27	8.60	**8.43**	4.69	4.93	**4.81**
	(15.3)	(17.3)	**(16.3)**	(20.8)	(24.4)	**(22.6)**
DT_3	8.58	8.83	**8.7**	5.07	5.13	**5.1**
	(19.6)	(20.5)	**(20.1)**	(30.6)	(29.4)	**(30.0)**
DT_4	8.68	8.97	**8.82**	5.10	5.2	**5.15**
	(21.0)	(22.3)	**(21.7)**	(31.4)	(31.1)	**(31.3**
CD (p=0.05)	0.05	0.12	-	0.14	0.06	-

Values in the parenthesis indicate per cent increase for the respective character

of 54.0 and 62.3 per cent for seedling emergence under FT_5 during 2011 and 2012, respectively. However, highest emergence with of 74.2 and 70.9 per cent was recorded in control for MRC 7017 during 2011 and 2012, respectively. A total of 5 rows had been sown under FT_4 and FT_5 as a result of increased seed size to exhaust the total quantity of seed taken for studying total emergence as compared to only 4 rows required to exhaust the same number of seeds in case of FT_1, FT_2 and FT_3. Overall mean of two years study indicated highest emergence (75.0 %) with dry sowing of *Bt* seed with gradually declined emergence with increased quantity of water and prolonged soaking from 75 to 58.8 per cent. These findings are supported by laboratory studies where increase in seed weight, size (Tables 1 and 2) has been recorded. This was primary reason responsible for mechanical damage to the healthy seed. As a result of all this, a declined seed emergence of upto 16.2 per cent was recorded due to mechanical damage experienced by the soaked *Bt* seed under highest level and period of water soaking. On the basis of these laboratory and field studies, it could be concluded that water soaked seed of *Bt* cotton hybrids gets mechanically damaged if sown with *Bt* cotton planter. Therefore, when good moisture/*wattar* conditions are available in the fields, farmers must sow *Bt* cotton seed without water soaking to avoid seed damages due to *Bt* cotton planter.

Table 3. Effect of different soaking treatments on seedling emergence of *Bt* cotton hybrids

Treatments	Emergence (%)			
	2011		2012	**Mean**
	SWCH 4711	MRC 7017	MRC 7017	
FT_1	80.0	74.2	70.9	**75.0**
FT_2	68.9	66.4	70.2	**68.5**
FT_3	64.9	58.6	66.5	**63.3**
FT_4	63.4	55.5	63.8	**60.9**
FT_5	60.3	54.0	62.3	**58.8**
CD (p=0.05)	4.4	4.9	5.7	-

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