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Effect of pickings on seed quality parameters of *Gossypium hirsutum* L. varieties

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Abstract
The present study was carried out in the Department of Seed Science and Technology Section, CCS Haryana Agricultural University, Hisar, India. The study aimed to evaluate the effect of pickings on seed quality of American cotton varieties (H-1098 (I), H-1117 and H-1236) and to identify the best and most suitable cotton picking stage to produce most desirable seeds. All American cotton varieties were sown in the month of May in 2012-13 and 2013-14 and three pickings were collected from each variety with fifteen days interval starting with 50 per cent boll opening. Seed quality was significantly affected by three pickings in all American cotton varieties. Seeds collected during second picking showed higher seed quality characteristics in terms of seed weight, seed density, seed germination per cent, seedling length, dry weight, vigor index I, vigor index II than seed collected in first and third pickings. Minimum seed germination per cent, seed weight, vigor indices were found in third picking.

Keywords: cotton, picking stage, seed quality, seed weight, seed germination, electrical conductivity

1. Introduction
Cotton is a kharif crop which requires 6 to 8 months to mature. Its time of sowing and harvesting differs in different parts of India depending upon the climatic conditions. In Punjab and Haryana it is sown in April-May and harvested in December-January that is before the winter frost which can damage the crop. The climatic conditions in the cotton growing regions of India show considerable variations. High temperature of about 45 ^{o}C during sowing and seedling emergence and low temperature accompanied by occasional frost coinciding with the picking period and moderate rainfall ranging from 300-700 mm are the features of the north zone. High amount of rainfall in beginning and sunny dry weather at ripening time are very useful for a good crop.

Picking time in cotton is very important phase and the quality of seed differ in different pickings. Mixing of immature bolls along with mature ones during picking of seed cotton, affect quality of the lint and the germination of the seed as accentuated by Soomro *et al*., (2004) [26]. Harvesting time of several crops depends on its maturity time and on physiological maturity. Harvesting stage influences the quality of seed, germination, vigor, viability and also storability (Khatun *et al.* 2009) [12]. Seeds should be harvested at proper time to ensure their quality in terms of germinability and vigour. Seeds harvested at physiological maturity will be well developed, matured and possess maximum viability and vigour. On the contrary, early harvesting prior to physiological maturity lowers drastically seed yield and quality on account of under developed and immature seeds. Hence harvesting of the crop at physiological maturity is important as seeds will have maximum dry weight, higher viability and vigour besides higher seed yield and yield attributing parameters. If not harvested at appropriate stage may lead to loss of seed yield and quality on account of field weathering besides heavy financial loss. Caldwell (1972) [2] observed that deterioration of seed during the post maturation, pre harvest environment is a serious seed production problem. Even one week exposure to rainy condition causes 20- 30% loss in cotton seed viability.

Therefore, present studies were conducted on three *Gossypium hirsutum* varieties to investigate the effect of picking on seed weight, germination per cent, vigor indices under Haryana conditions to provide valuable suggestion to breeders, researchers, scientist to put their efforts in right direction.

Material and Methods
Two year study to evaluate the effect of pickings with fifteen days intervals was conducted on three *Gossypium hirsutum* L. varieties. Seeds were collected from the Cotton Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University. Different cotton varieties were sown in Randomized Block Design (RBD) with three replications during

the month of April 2012-13 and 2013-14 in the cotton section field research area. The non-experimental rows were also maintained to avoid border effects. Recommended agronomic package and practices were followed to grow good and healthy crop. The observations were recorded on seeds collected from various pickings. Fifteen plants were tagged for picking treatments and three bulk samples of each treatment/variety/replication were ginned and delinted separately. The pickings were started after 50 percent boll opening and all the three pickings in each variety were taken with 15 days interval and evaluated for seed quality in Seed Science and Technology laboratory in completely randomized design with following observations.

Seed Lots (P) Three of each pickings in three American cotton varieties

Gossypium hirsutum: H-1098-(I), H-1117, H-1236,

Seed moisture content (%) of above fresh seeds at each picking stage were estimated by hot air oven method (80±1°C for 24 h) and expressed in percentage.

Seed weight (g) of 100 seeds (replicated thrice) of each variety and each picking was recorded and expressed in g.

Seed density (g/cc) from each sample were taken after weighing seeds on electronic balance than after dipping it in toluene solution.

$$\text{Seed density (g/cc)} = \frac{\text{Weight of 100 seeds}}{\text{Volume of displaced seed (CC)}}$$

Standard Germination (%) as per ISTA, 2011

Final count was recorded on 12 th day (ISTA, 2011). Normal seedlings were expressed as percent germination.

Seedling length (cm) of ten randomly selected normal seedlings was recorded and average seedling length was expressed in centimetres (cm).

Dry weight (mg) ten randomly taken normal seedlings whose length was measured were dried in a hot air oven for 24 h at 103 ±1 °C.

Vigour index –I & II

Vigour Index–I= Standard germination (%) × average seedling length (cm)

Vigour Index–II=Standard germination (%) × average seedling dry weight (mg)

Results and Discussion

Cotton crop from germination to maturity takes around 150-170 days and it is sensitive to weather conditions. Figure 1 & 2 depicts the recorded meteorological data of Hisar during kharif 2012-13 and 2013-14. High relative humidity percentage (85-90%) in the months of September and October in both years 2012-13 and 2013-14 badly affected seed maturity.

1.1a Details of weather collected during different pickings

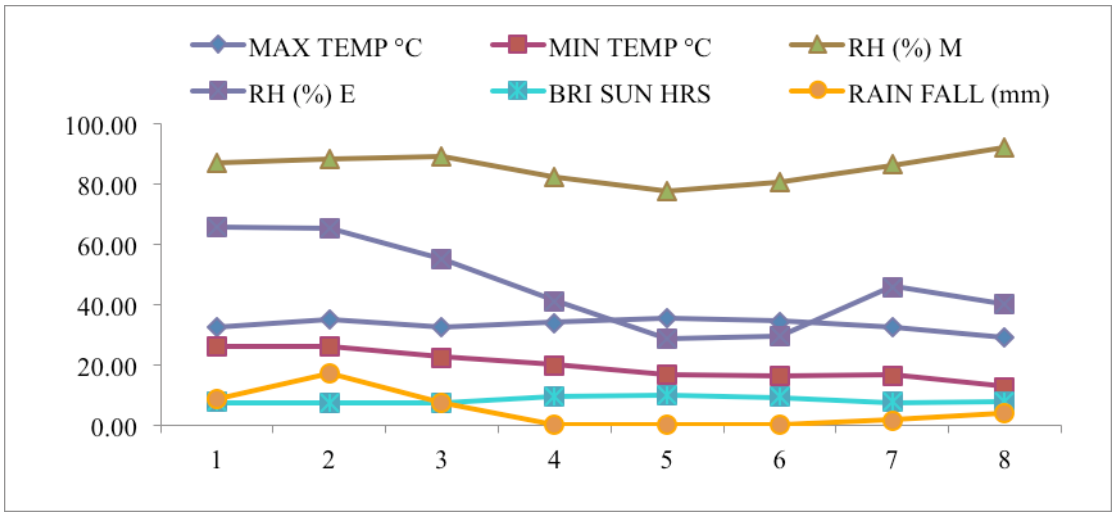

Fig 1.1a: Weather data collected during picking period (Sep- Oct) for the year 2012-2013

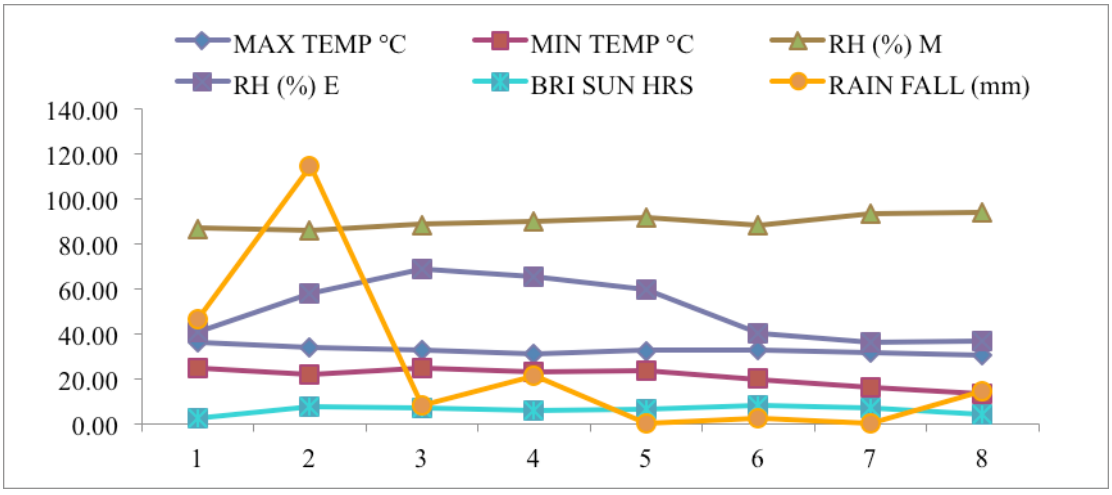

Fig 1.1b: Weather data collected during picking period (Sep - Oct) for the year 2013-2014

In both the years of study seed moisture content was observed higher in first picking and thereafter it found reducing and minimum found in third picking. The result revealed declining trend in seed moisture with delay in harvest. Maximum moisture content observed in first picking (12.80 %), followed by second picking (11.79%) and minimum in third picking (11.65%) in American varieties in 2012-13 and same trend followed in 2013-14. Results were in conformity with earlier findings of Dharmalingam and Basu, (1990) [8] in cotton, Mehta *et al*. (1993) [15-17] in chickpea, Khatun, *et al*. (2009) [12] in lentil and Sharma *et al*. (2013) [23, 24] in groundnut.

Result revealed that picking had significant effect on seed weight. Maximum seed weight (7.56 mg) reported in H – 1098 (I) followed by (7.42 mg) in H – 1236 in American varieties. Maximum seed weight found in second picking (7.39 mg) which reveals that at physiological maturity seeds are said to be completely developed due to maximum accumulation of food reserves, amino acids, phosphorus active substances, dry matter, sugar, water soluble protein and acids and thereafter translocation of food ceases but senescence begins as reported by Dhanelappagol *et al*., (1994) [7] in pigeon pea and chilli crops respectively. Minimum seed weight observed in third picking (7.09 mg), in late pickings lesser seed weight was due to decrease in translocation of photosynthates because of ageing in plants which leads to retardation in net assimilation rate or at late picking there is loss in seed weight because of dead or immature cotton seed. Results are in conformity with earlier findings of Chaudhry *et al*. (1993) [3] in cotton, Pandita and Shantha (2001) [19] in chilli, Vasudevan *et al*. (2008) [27, 28] in fenugreek, Abass *et al*. (2010) [1].

Seed density is important quality parameter which showed positive association with vigour potential of seed lot in several crops and results revealed that maximum seed density found in second picking (0.776 g/cc) seeds followed by first picking (0.762 g/cc) and minimum in third picking (0.741 g/cc). Seed density declined at third picking stage may be because seeds at later stages are weak competitors in drawing nutrition under changed micro and macro environments as compared to the early pickings stages. Similar findings were observed by Krieg and Bartee (1975) [13] in cotton seed and Merwade and Kattarki (1986) [18] in cotton.

The mean values of seed germination per cen is presented in Table 1.1 that ranged from 71.67% to increase 87.45 in 2012-13 and 69.78% to 82.67% in 2013-14. The maximum seed germination was observed, under second picking on 15st October and minimum was measured under third picking, after fifteen days interval, which depicts the effects of climatic condition and humidity that deteriorate the viability of seed germination percent. Among the mean values of varieties H-1236 has shown highest seed germination per cent as compared to others when picked early. The same results also presented by Deho *et al*. (2012) [6] to determine the impact of different picking dates on seed germination per cent, it reduced when picked late due to fluctuating levels of temperature and humidity. Solangi *et al* (2001) [25] presented that result decreased in seed germination percent as picking dates were delayed from 1st October. Results are in conformity with earlier findings of Patil and Dighe (1985) [21] in cotton, Panse and Khargonkar (1948) [20] in cotton, Weaver and Thakarasook (1975) [29] in cotton and Soomro *et al*., (2004) [26] in cotton, Vasudevan *et al*., (2008) [27, 28], Deho (2012) [6] in cotton and Dayal *et al*., (2014) [5] in maize.

Maximum seedling length recorded in second picking (38.49 cm) and minimum in third picking (34.39 cm) in American varieties. Second picking produced maximum seedling length which may be due to favorable weather conditions which could have resulted in accumulation of photosynthates in the seeds and during this stage seed attained complete development due to maximum accumulation of food reserves, amino acid, phosphorus active substances, dry matter, sugar, water soluble protein and acids and thereafter translocation of food ceases but senescence begins. Maximum seedling length during second picking may be due to seeds reaches its maximum dry weight at physiological maturity and healthy seeds are formed and food reserves were more as compare to others. Significant results was observed for seedling weight, maximum was observed in second picking (0.413mg) wheras minimum in third picking (0.356 mg). All the cultivars attained maximum dry matter accumulation at physiological maturity (Mehta *et al*., 1993, in chickpea) [15-17] thereafter, dry weight decreased because of restricted supply of nutrients from mother plant to seed due to disruption of vascular connection and utilization in various physiological and metabolic processes Khatun *et al*., (2010) [1]. Results are in conformity with Khatun *et al*., (2009) [12] in lentil and Sharma *et al*., (2013) [23, 24] in groundnut and Dayal *et al*., (2014) [5] in maize. There was enhancement in vigour index during second picking stage which may be due to maturation of seeds resulting in improvement of germination percentage and seedling length as reported by Gore *et al*., (1997) [9] in soybean, which further enhanced dry matter of the seedling (Khare and Satpute, 1999) [11].

Delay in harvesting, aging processes and damage to membranes increased minerals and amino acids seeping out of the seed and gradually increased the electrical conductivity of the material leaking from seeds (Davoodi *et al*., 2013) [4]. High levels of electrolyte leakage during seed imbibition have been associated with mechanical damage, cryptic damage, poor organellar and cellular membrane integrity and low seed vigor. This leakage may result in the unavailability of metabolites for the embryo. Results are in conformity with the findings of Woodstock (1973) [30], Jacqueline *et al*., (1978) [10], Vasudevan *et al*., (2008) [27, 28], Davoodi *et al*., (2013) [4] in wheat and Dayal *et al*., (2014) [5] in maize.

Conclusion

Harvesting the seeds before the attainment of physiological maturity recorded lesser viability and vigour potentials due to more number of immature seeds with relatively low degree of embryo development and high moisture content. The effect of temperature and humidity had badly affected the cotton seed due to continuous high humidity effect from August to October. Due to dew/ humidity seed opened the micropyle and water entered into micropyle and wakeup the plumule. High humidity risks the attack of fungus on cotton seed which reduce the viability of seed, loses the weight of seed finally turns it to dead. Temperature falls down and it automatically affected the growth and maturity of cotton seed. The late picking would lose seed weight because of dead or immature cotton seed of all varieties. Seed vigor and viability the important components influencing seedling establishment, crop growth are adversely affected due to high humidity and day night fluctuated temperature.

Table 1.1: Effect of pickings on different quality attributes of cotton seed

		2012-13						2013-14					
		H-1098(I)	**HD-1117**	**H-1236**	**MEAN**	**CD at 5 %**	**SE(m)**	**H-1098(I)**	**HD-1117**	**H-1236**	**MEAN**	**CD at 5 %**	**SE(m)**
Seed moisture content (%)	PICK1	13.61	12.12	12.68	**12.8**	V=0.180 P=0.204 VxP=0.333	V=0.064 P=0.064 V×P=0.111	14.15	12.96	13.98	**13.69**	V=0.047 P= 0.047, V×P=0.081	V= .016, P= 0.016, V×P=0.027
	PICK2	11.46	11.27	12.65	11.79			12.64	12.07	12.2	12.3		
	PICK3	11.25	12.2	11.51	11.65			11.03	12.54	11.68	11.75		
	MEAN	12.11	11.86	12.28				12.6	12.52	12.62			
Seed weight (g)	PICK1	7.58	6.86	7.41	7.29	V = 0.061, P = 0.077, V×P=0.12	V=0.023 P=0.023, V×P=0.04	7.7	6.87	7.56	7.38	V=0.034, P= 0.034, V×P=0.059	V=0.011 P= 0.011, V×P=0.02
	PICK2	7.63	6.95	7.6	7.39			7.79	6.92	7.75	7.49		
	PICK3	7.48	6.54	7.25	7.09			7.62	6.56	7.35	7.18		
	MEAN	7.56	6.78	7.42				7.7	6.78	7.55			
Seed density (g/cc)	PICK1	0.78	0.753	0.753	0.762	V = 0.007, P=0.0011, V×P=.016	V= .002, P=0.004, V×P=0.005	0.783	0.773	0.753	0.77	V=0.003, P=0.007, V×P=0.009	V=0.002, P=0.002, V×P=0.003
	PICK2	0.807	0.77	0.75	0.776			0.81	0.79	0.783	0.794		
	PICK3	0.723	0.75	0.75	0.741			0.737	0.753	0.777	0.756		
	MEAN	0.77	0.758	0.751				0.777	0.772	0.771			
Standard germination (%)	PICK1	87.33	84.67	86	86	V=1.264 P = 0.894, V×P=2.19	V=0.256P=0.256 VxP=0.444	83.67	79.67	80.33	81.22	V=0.635, P= 0.695, V×P=1.152	V=0.222, P=0.222, VxP=0.385
	PICK2	89.67	85.33	87.34	87.45			85	81.33	81.67	82.67		
	PICK3	72	71.33	71.67	71.67			70.33	69	70	69.78		
	MEAN	83	80.44	81.67				79.67	76.67	77.33			
Seedling length (cm)	PICK1	37.16	35.08	36.74	36.32	V=0.264, P=0.304, V×P=0.491	V=0.095P=0.095 V×P=0.164	34.1	32.54	32.98	33.21	V=0.655, P= 0.745, V×P=1.204	V=0.232, P= 0.232, V×P=0.402
	PICK2	39.76	37.07	38.65	38.49			36.72	34.87	35.07	35.55		
	PICK3	36.86	31.58	34.73	34.39			33.15	28.18	31.42	30.92		
	MEAN	37.93	34.57	36.71				34.66	31.86	33.16			
Seedling weight (mg)	PICK1	0.392	0.358	0.377	0.376	V = 0.005, P = 0.007, V×P=0.001	V=.002 P=0.002 V×P=0.003	0.371	0.338	0.347	0.352	V=0.003, P= 0.005, V×P=0.007	V=0.001, P= 0.001, V×P=0.002
	PICK2	0.463	0.387	0.389	0.413			0.41	0.352	0.366	0.376		
	PICK3	0.376	0.322	0.369	0.356			0.354	0.313	0.329	0.332		
	MEAN	0.41	0.355	0.378				0.378	0.334	0.347			
Vigor index I	PICK1	3,245	2,970	3,159	3,125	V=34.46, P=36.46, V×P=61.42	V=11.84 P=11.84 V×P=20.51	2,853	2,593	2,649	2,698	V=52.25 P=53.45 V×P=91.89	V=17.72 P =17.72, V×P=30.69
	PICK2	3,565	3,163	3,375	3,368			3,121	2,836	2,864	2,940		
	PICK3	2,654	2,253	2,489	2,465			2,332	1,945	2,199	2,159		
	MEAN	3,155	2,795	3,008				2,769	2,458	2,571			
Vigor index II	PICK1	34.23	30.28	32.42	32.31	V = 0.50, P = 0.60, V×P=0.952	V=0.184 P=0.184, V×P=0.318	31.04	26.95	27.85	28.61	V=0.35, P= 0.43, V×P=0.676	V=0.13, P=0.13, V×P=0.226
	PICK2	41.49	33	33.95	36.14			34.85	28.72	29.74	31.1		
	PICK3	27.07	22.97	26.43	25.49			24.87	21.6	23.03	23.17		
	MEAN	34.26	28.75	30.93				30.25	25.76	26.87			
EC ($\mu S\ cm^{-1}g^{-1}$)	PICK1	0.309	0.355	0.318	0.327	V = 0.002, P = 0.002, V× P = 0.004	V=0.001 P=0.001, V×P=0.001	0.33	0.306	0.363	0.333	V=0.002, P= 0.002, V×P=0.003	V=0.001 P= 0.001, V×P=0.001
	PICK2	0.303	0.342	0.305	0.317			0.358	0.342	0.38	0.36		
	PICK3	0.352	0.393	0.363	0.369			0.35	0.33	0.37	0.35		
	MEAN	0.321	0.363	0.329				0.346	0.326	0.371			
V= Variety, P= Picking, V x P = Variety x Picking (interaction)													

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