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Original Paper

Effect of Lead Acetate ($Pb(C_2H_3O_2)_2$) on Yield and Yield Associated Traits of Different Wheat (Triticum Aestivum L.) Varieties

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Abstract
Heavy metals in the environment can cause serious health problems to plants and animals. Plants absorb Pb from the soil as well as from the air. Experiments in the laboratory and in the pot-house conditions were carried out at the center for the environmental sciences, the University of Sindh, Jamshoro to see the effect of lead acetate $Pb(C_2H_3O_2)_2$ on the yield and yield attributes of wheat (*Triticum aestivum* L.). Experiments were conducted in a factorial design with three replicates. Six wheat varieties namely Abadgar, SKD-1, Anmol-91, Tj-83, Imdad, and Sonalika, were tested for lead acetate tolerance. Four treatment T1= Control (no lead application), T2= 30ppm Pb acetate, T3= 50ppm Pb acetate, and T4= 70ppm Pb acetate were designed. Results indicated that variety SKD-1 produced significantly higher shoot and root length at 30, 50, and 70ppm lead acetate stress than other varieties. An analysis of variance revealed that lead had a considerable impact on yield and yield-related characteristics except for SPAD chlorophyll, the genotype-treatment interaction was significant for all characteristics. The varieties Imdad and SKD-1 produced the highest grains spike^{-1} (39.6 and 37.0) and grain yields plant^{-1} (14.33 and 13.0gram) respectively, at the highest stress level and are declared as tolerant cultivars.

Keywords: Wheat, Heavy metals, Stress, Pollutants, Lead (Pb), Elucidation

Introduction

Heavy metals are extremely poisonous and are extremely detrimental to soil and plants [1]. Zinc, Copper, and other contaminants such as Cadmium, Arsenic, Lead, Chromium, Nickel, and others are required by the human body for structural and essential activities in very minimal quantity, however, a higher concentration is extremely toxic [2–5]. Heavy metals are industrial waste products that end up as contaminants in the soil [6–10]. Agriculture is also a source of these contaminants. [11–13]. These pollutants subsequently migrate from the soil to the human body via various mechanisms such as agricultural consumption or animal products grazing on the damaged plants. [14, 15]. These harmful components in crops come from a variety of sources, including soil, air, and industrial waste. [16–20]. Pandey and Pandey [21], for example, reported that the greater deposition of Lead, Cadmium, and Chromium in vegetables is due to atmospheric contamination. The wheat crop was produced using domestic sewerage and industrial wastes in a study, and it was discovered that some heavy metals were collected in wheat, which is an alarming revelation because wheat is a staple meal for half of the world's population, and it can be very dangerous for human health.

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Sharma et al. [22] noted that these metals are taken by high-level professionals such as athletes to enhance their performance, but that many others consume these metals through food supplements. As a result, numerous organizations and regulatory authorities, such as the FAO, WHO, and the European Commission, have established standard limits for certain metals in food items [23, 24]. A carcinogenic or non-carcinogenic approach can be used to detect the risk factor from these hazardous heavy metals. The Hazard Quotient (HQ) calculates the ratio between the observed dosage of a pollutant and the Reference dose, which is determined when a metal is not at a threshold level to constitute a risk. The Hazard Index (HI), which is the sum of the HQ obtained for different heavy metals, notifies us about the state and hazard of non-carcinogenic heavy metals in various channels. The United States Environmental Protection Agency (US EPA) recommends this method [24], and it is still valid and used today for all food items [25–29]. Wheat is the world's most important crop, with per capita consumption outpacing all other cereals [30, 32]. As a result, excessive levels of heavy metals in crops (wheat) grown in polluted soil pose a major health risk to those who consume such poisoned wheat grains. [33].Lead (Pb) affect negatively plant growth, germination, root, shoot biomass, photosynthesis and various enzymes [34] The purpose of the current research was to look at the impact of lead on wheat crops at the beginning and during their entire life cycle. We also attempted to determine the degrees of tolerance and susceptibility to lead pollution of various wheat cultivars grown in Sindh.

Materials and Methods

During the 2016-17, wheat rabi season, the experiments were conducted in the laboratory and in the pot-house conditions at the Centre for the Environmental Science, University of Sindh, Jamshoro to see the effect of lead acetate $Pb(C_2H_3O_2)_2$ on yield and yield attributes of wheat (*Triticum aestivum* L). Treatments included T1=Control (no lead application), T2=30ppm Pb acetate, T3=50ppm Pb acetate and T4=70ppm Pb acetate. The effect of lead acetate was observed on various yield and yield components of six different wheat varieties viz Abadgar, SKD-1, Anmol-91, Tj-83, Imdad, and Sonalika. The laboratory and pot-house experiments were conducted using the same varieties and treatments. Experiment 1 was carried out in the laboratory, where we employed Petri dishes to cultivate wheat seedlings under both control and lead acetate treatments. In experiment 1, a total of 100 seeds were planted in each of the control and treatments. Data on Root length (cm), shoot length (cm) root fresh weight (mg), shoot fresh weight (mg), root dry weight (mg), and shoot dry weight (mg) were recorded in experiment 1. Data was noted after 21 days of experimentation, with 10 seedlings per replication per genotype per treatment. For recording root and shoot dry weight, samples were oven-dried for 72 hours at 72°C and then were weighed on an electronic balance.

Experiment 2 was carried out in a pot house. Data recorded in the pot-house experiment was based on days to heading, days to maturity, plant height, grain yield hundred-grain weight, spike length, spikelets per spike, main spike yield, SPAD chlorophyll, relative water content both in control and different treatments. Days to heading were noted when 75% of the plant's spike had appeared in the pot, which was estimated from the date of planting to the opening of spikes. Days to maturity were calculated from the time of sowing to the time when the grain was completely filled. When the seed is fully formed and filled. Plant height was measured in each variety by recording data from five plants. It was measured using a meter scale from the bottom of the container where the soil was poured to the top of the plant up to the spike, omitting the awns. In each pot, the number of tillers per plant was counted by collecting five plant data. Each plant tiller was counted visually. A hundred grains were counted and weighed on balance in each pot. Spike length was measured from the base to the top of the spike, omitting awns, using a foot scale. The number of spikelets in each spike was visually counted in five spikes per pot per treatment, variety by variety. Spikelets per spike were counted using five spikes data. Each plant's main spike was threshed by hand and weighed using an electronic scale. Each plant was individually threshed to record grain yield plant^{-1} with the help of analytical balance in all repeats and treatments. The SAPD meter was used to determine the amount of chlorophyll in the leaves samples. Leaf area was manually recorded and determined by multiplying the length and width of the leaf. In each variety, five leaves were measured per replication and treatment. The relative water content percent was determined by measuring the fresh weight of three leaves per treatment and replication. After immediately measuring the fresh weight of leaves, they were placed in a bucket for 24 hours, and their turgid weight was measured with a balance. After recording turgid weight, leaves were oven-dried for 48 hours at 72°C to record dry weight, and then relative water percent was calculated using the formula

RWC= (FW-DW)/TW-DW) X100

Data was statistically analyzed according to Gomez & Gomez and using Statistix 8.1 software.

Results & Discussion

In the Laboratory experiment, shoot length data recorded from control and other treatments showed that Sonalika, SKD-1, and Tj-83 produced maximum shoot length under untreated or control conditions, whereas SKD-1 produced significantly higher shoot length under 30, 50, and 70ppm lead acetate stress conditions than other varieties (Figure 1). When the decreased percentage of the control treatment for all six wheat genotypes was compared to the maximum 70ppm lead acetate pollutant treatment, the reduction percent ranged from 43.7 to 76.87 percent. When compared to other cultivars, SKD-1 (43.72) and Imdad exhibited a smaller decline (43.72 & 62.95%). The effect of lead on seed germination and seedling growth was investigated by Lamhamdi et al., 2011 [35]. They experimented with several lead nitrate solutions of 0.05, 0.1, 0.5, and 1g/liter. Lead affected various germination, root shoot weight, enzymes, antioxidants, and protein, resulting in a severe reduction in wheat production and yield-related characteristics. Sonalika produces a higher root length under control/non-stress conditions. SKD-1 was found tolerant at 30, 50, and 70 ppm lead acetate stress-producing maximal root length and showing a smaller decrease (Figure 2). When reduction percent for the trait root length were compared, it ranged from 58 percent to 83 percent. SKD-1 and Imdad showed a reduced decline (Figure 2). During the trial, shoot fresh weight demonstrated that under control conditions, SKD-1 and Anmol-91 produced more shoot biomass weight as compared to other contesting entries, SKD-1, Anmol, and Imdad yielded higher shoot fresh weight under stressful conditions (Figure 3). Imdad, Anmol, and SKD-1 showed the minimal loss in their shoot fresh weight as compared to the control. The percent reduction ranged from 21 in SKD-1 to 66% in Tj-83. In terms of root fresh weight, only SKD-1 and Tj-83 produced greater root fresh weight than other kinds under normal or controlled settings, as well as under varying levels of stress at 30, 50, and 70 ppm lead acetate stressed conditions (Figure 4). Root fresh weight was found to be a very sensitive feature to lead acetate pollution based on the percent reduction. The reduction was between 95 and 98 percent. The root fresh weight of SKD-1 and Imdad was less affected by lead pollution (figure 4). The maximum shoot dry weight was produced by SKD-1, Imdad, and Abadgar at control, as indicated in Figure 5. At 70ppm lead acetate pollutant treatments, Abadgar and Imdad gave the highest shoot dry weight when compared to treatments. When comparing shoot dry weight at 70ppm to control, the reduction percentage ranged from 33 to 55 percent. In the varieties SKD-1, Imdad, and Abadgar, a minimum reduction of 33.4, 34.4, and 37.8% was found. (Figure 5). The effect of varying concentrations of lead acetate (0, 20, 40, 60, 80, and 100ppm) on wheat seedling growth was studied by Mehboob *et al*., 2018 [36]. Higher concentrations of lead acetate had a negative impact on root length, root growth, shoot length, root shoot dry weight, and germination, according to the researchers. Figure 6 shows the root dry weight of various wheat genotypes under control and various lead pollutant treatments. At control, the varieties Anmol, Tj-83, and SKD-1 produced a higher root dry weight. At 70ppm, the SKD-1 and Imdad varieties produced the higher root dry weight. (Figure 6.) The decrease percent of several genotypes at 70ppm treatments as compared to control shows that for the traits root dry weight, the reduction percent ranged from 33 to 68 percent. SKD-1 and Imdad varieties exhibited a minimum reduction of 33 and 40%, respectively. Initial laboratory testing revealed that SKD-1, Anmol-91, and Tj-83 showed some level of tolerance to lead pollution.

The result of Experiment 2 conducted in the pot-house is shown in table-1 to table 7. Results in Table 1 show the analysis of variance and mean square values for pot experiments. Days to heading, days to maturity, plant height, tiller plant-1, hundred-grain weight, spike length, spikelet spike, grain spike grain yield, SPAD chlorophyll, and relative water content were all highly significant, according to the study. All genotype x treatment interactions were significant, with the exception of SPAD chlorophyll, which was non-significant. (Table 1). The mean data for days to heading revealed that variety Abadgar had the highest number of days to heading (85.33) and sonalika had the earliest genotypes (59.7 days). Under extreme stress, varieties Imdad, abadgar, and SKD-1 produced their spikes in 67.33, 62.0, and 51.0 days, respectively, when genotypes were kept under lead acetate stress (Table 2). Saadony et al., 2018 [37] investigated and compared the resistance of several (*Triticum aestivum* l.) genotypes to heavy metal stress, including lead, cadmium, and zinc. Heavy metal stress influenced proline, chlorophyll, leaf area, relative water content, and other parameters in their studies. MISR-1 and line-3 wheat genotypes were shown to be resistant to heavy metal stress, whereas Giza-168 was found to be highly vulnerable

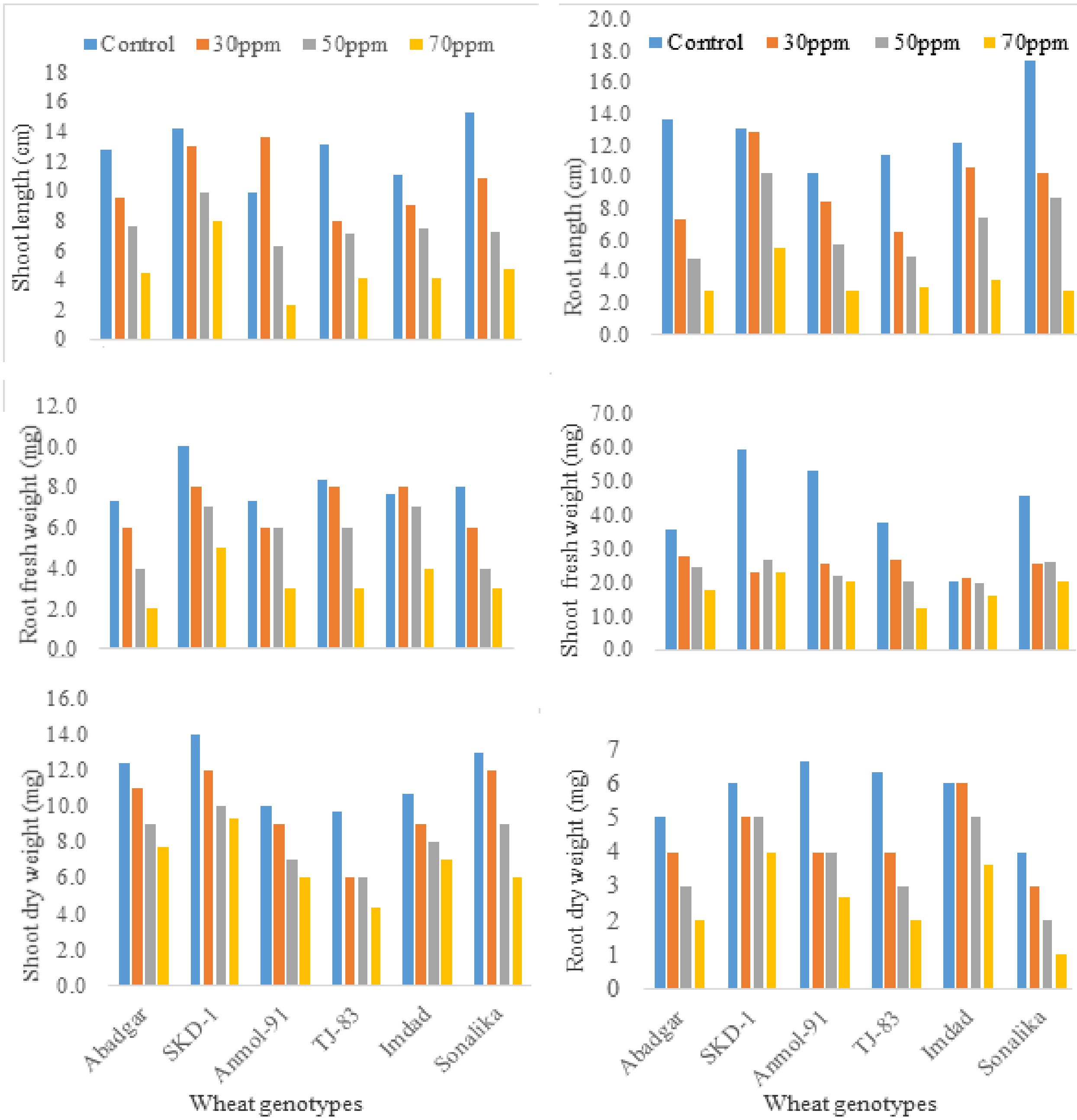

Figure 1. Effect of lead acetate on shoot length of different wheat varieties as compared to control

to heavy metal stress. The mean data of days to maturity revealed that variety Imdad and SKD-1 took the highest number of days to maturity (129, 127) under control, while sonalika was shown to be an early maturing variety (115.33 days). When genotypes were kept under lead acetate stress, abadgar were less impacted and matured in 118.3 and 117 days, respectively, under severe stress. As a result, it might be said to be lead acetate tolerant as far this trait is concerned (Table 2).

The mean data of plant height revealed that the varieties Abadgar, Anmol -91, and Imdad produced the highest plant heights (97.33, 95.0, and 92.33) under control, whereas Sonalika produced the shortest plant height (72.66). When genotypes were kept under lead acetate stress, the Imadad, Abadgar, and SKD-1 varieties developed taller plants and were less damaged (table 4). The mean data of tiller $plant^{-1}$ revealed that variety Abadgar, Imdad, and SKD-1 produced the higher number of tillers (8.33, 8.20,7.9)

Table No 1: Mean square for various traits, genotypes, treatments, and genotypes x treatments interaction

SOV	Replications	Genotypes	Treatments	Genotypes X Treatments	Error	CV (%)
DF	2	5	3	15	46	-
Day to heading	17.68	988.81**	1028.38**	22.16**	2.68	2.61
Days to maturity	1.264	624.756**	830.278**	12.489**	2.148	1.28
Plant height	11.37	1008.09**	1408.05**	28.97**	4.17	2.63
Tiller plant-1	2.1579	10.7809**	46.6153**	1.5130**	0.2086	7.95
Hundred-grain weight	0.07764	2.3662**	3.43000**	0.9444**	0.0085	2.04
Spike length	0.3268	8.5776**	27.2854**	0.6584**	0.2122	6.12
Spikelet spike-1	0.1679	25.8946**	74.1883**	1.0550*	0.4620	4.55
Grains spike-1	20.349	317.102**	861.828**	7.905**	2.637	3.90
Grain yield	9.847	146.756**	167.204**	2.926**	0.876	7.93
Leaf area	4.167	355.258**	742.829**	11.429**	2.268	4.85
SPAD chlorophyll	20.222	830.347**	581.199**	6.555ns	7.048	6.05
RWC (%)	9.60	1169.66**	2213.54**	21.45**	4.03	3.13

Table No 2: Mean values of different cultivars for days to heading and days to maturity under control and different lead acetate pollutant levels

Varieties	Days to heading				Days to Maturity			
	Control (T1)	T2 (30ppm)	T3 (50ppm)	T4 (70ppm)	Control (T1)	T2 (30ppm)	T3 (50ppm)	T4 (70ppm)
Abadgar	85.33 a	79.0 b	72.0 cde	62.0 fg	127 ab	125 abc	122 cde	117 gh
SKD-1	61.33 gh	59.0 hi	56.0 ij	51.0 jk	121 def	116 h	111 ij	104 kl
Anmol-91	71.33 de	65.0 fg	59.33 hi	49.0 k	119 efg	115.33 hi	108.33 jk	102 l
Tj-83	69.0 def	65.0 fg	57.64 hi	47.66 jk	129 a	126 abc	123.33 bcd	118.33 fgh
Imdad	76.66 bc	73.66cd	71.66 cde	67.33 ef	115.33 hi	111.0 ij	103 l	94 m
Sonalika	59.7 hi	55.0 ij	49.33 k	47.66 jk	119.0 efgh	115 hi	110 j	101 l

under control, whereas Tj-83 produced the least tillers plant^{-1} (5.9). When genotypes were subjected to lead acetate stress, the varieties Imdad and SKD-1 produced more tillers (5.26, 5.53) and were less damaged (table 3). The effect of heavy metal lead on two wheat genotypes, Sehar-2006 and Chakwal -97 was investigated by Bhatti et al., 2013 [38]. In their trials, they employed concentrations of 0, 40, and 60 ppm lead acetate. Lead has an impact on morphological and yield-related characteristics. Shoot, root length, fresh and dry weight of shoot roots, and tiller plant-1 chlorophyll were all seriously damaged. The mean data for hundred-grain weight discovered that the varieties Abadgar, Imdad, and SKD-1 provided the highest grain weight (5.30,5.23,5.10) under control, whereas Tj-83 produced the lowest grain weight (4.60). When genotypes were put under lead acetate stress, the varieties SKD-1 and Imdad produced the highest hundred-grain weight (4.70, 4.50) and were less damaged (Table 4). Under control, the varieties Abadgar and Imdad produced the largest spike length (9.6, 9.50), whereas Anmol-91 produced the smallest spike length (7.83cm). When genotypes were kept under lead acetate stress, the Imdad and SKD-1 varieties developed the longest spike length (7.63, 7.0) and were less damaged (Table 5).

The mean data for spikelet spike^{-1} showed that the variety Tj-83 and Imdad under control produced the higher number of spikelets (18.66, 18.36), while Anmol-91 produced the lower numbers of spikelets (15.16cm). When genotypes were kept under lead acetate stress, variety Imdad and SKD-1 produced a higher number of spikelets (15.50 and 13.83, respectively) and were less damaged (Table 5). The mean data for grains spike^{-1} revealed that varieties Abadgar, Tj-83, and Imdad had the most grains per

Table No 3: Mean values of different cultivars for plant height & tiller $Plant^{-1}$ under control and different lead acetate pollutant levels								
Varieties	Plant height (cm)				Tiller $plant^{-1}$			
	Control (T1)	T2 (30ppm)	T3 (50ppm)	T4 (70ppm)	Control (T1)	T2 (30ppm)	T3 (50ppm)	T4 (70ppm)
Abadgar	97.33 a	92.0 abc	83.0 def	72.0 ij	8.33 a	7.53 abc	5.43 efg	3.4 ij
SKD-1	79.66 efg	77.0 fgh	74.0 ghi	70.o j	7.1 abc	7.5 abc	6.46 bcd	5.53 ef
Anmol-91	95.0 ab	87.66 cd	79.33 efg	67.66 j	7.9 ab	5.23 efg	4.06 ghi	2.966 j
Tj-83	84.0 de	78.0 efg	70.0 j	60.3 k	5.9 def	4.60 fghi	3.96 hij	3.0 j
Imdad	92.33 abc	89.0 bcd	83.66 de	79.0 efgh	8.20 a	7.30 abc	6.23 cde	5.26 efgh
Sonalika	72.66 hij	68.0 j	59.33 k	50.0 l	7.8 ab	6.66 bcde	4.60 fghi	2.866 j

Table No 4: Mean values of different cultivars for 100 grain weight and spike length under control and different lead acetate pollutant levels								
Varieties	100 grain weight (g)				Spike length (cm)			
	Control (T1)	T2 (30ppm)	T3 (50ppm)	T4 (70ppm)	Control (T1)	T2 (30ppm)	T3 (50ppm)	T4 (70ppm)
Abadgar	5.30 a	5.20 ab	4.80 cde	4.10 ij	9.6 a	8.9 ab	8.0 bcd	6.30 fghi
SKD-1	5.10 abc	5.0 bcd	4.90 cde	4.70 efg	8.56 abc	8.50 abc	8.0 bcd	7.0 def
Anmol-91	4.70 efg	4.60 fg	4.30 hi	3.70 lm	7.83 bcd	7.70 bcd	6.76 efgh	5.36 hij
Tj-83	4.60 fg	4.0 jk	3.80 kl	3.16 n	8.53 abc	7.30 cdef	6.60 efgh	5.10 ij
Imdad	5.23 ab	5.13 abc	4.90 cde	4.50 gh	9.50 a	9.0 ab	8.23 abcd	7.63 bcd
Sonalika	4.73 def	4.53 fgh	4.06 ijk	3.46 m	8.53 abc	7.40 cdef	6.16 ghi	4.13 j

Table No 5: Mean values of different cultivars for spiklets spike-1& Grain spike-1 under control and different lead acetate pollutant levels								
Varieties	Spikelet $spike^{-1}$				Grain $spike^{-1}$			
	Control (T1)	T2 (30ppm)	T3 (50ppm)	T4 (70ppm)	Control (T1)	T2 (30ppm)	T3 (50ppm)	T4 (70ppm)
Abadgar	17.30 abc	16.13 bcd	14.73 efg	12.70 jkl	53.76 a	49.0 abc	43.26 def	36.0 ij
SKD-1	17.23 abc	15.70 bcd	14.96 def	13.83 ghi	48.33 bcd	45.33 cde	41.66 efgh	37.0 hij
Anmol-91	15.16 cde	13.46 hij	12.13 klm	10.10 m	44.90 cdef	40.06 fgh	34.73 jk	27.0 lm
Tj-83	18.36 a	16.20 bcd	14.06 fgh	11.96 klm	53.76 a	47.33 bcd	40.30 efgh	36.76 hij
Imdad	18.66 a	17.60 ab	16.60 abc	15.50 bcd	52.0 ab	48.93 abc	44.93 cde	39.66 ghi
Sonalika	17.0 abc	15.0 def	13.0 ijk	11.06 lm	43.33 def	38.0 hij	30.70 kl	23.66 m

Table No 6: Mean values of different cultivars for grain yield plant-1 & leaf area under control and different lead acetate pollutant levels								
	Grain yield plant-1(gram)				Leaf area (cm)			
Varieties	Control (T1)	T2 (30ppm)	T3 (50ppm)	T4 (70ppm)	Control (T1)	T2 (30ppm)	T3 (50ppm)	T4 (70ppm)
Abadgar	16.0 bcd	13.0 efg	9.66 ijk	7.0 klm	37.0 bcd	32.66 efg	25.0 jk	20.0 l
SKD-1	19.33 a	17.33 ab	16.33 bc	14.33 cdef	43.33 a	40.0 abc	38.0 bcd	32.66 efg
Anmol-91	15.0 bcd	10.66 ghi	8.66 jk	5.66 lmn	37.0 bcd	34.0 def	28.0 bcd	21.0 kl
Tj-83	12.0 fgh	9.0 jk	7.0 klm	4.00 n	35.0 def	31.0 ghi	25.0 jk	19.0 lm
Imdad	17.0 abc	16.0 bcd	15.0 bcd	13.0 efg	41.00 ab	38.66 abc	36.0 cde	31.67 fghi
Sonalika	13.33 def	10.33 jkl	8.33 jkl	5.33 mn	35.0 def	27.33 ij	22.0 kl	14.66 m

Table No 7: Mean values of different cultivars for SPAD chlorophyll & Relative water content under control and different lead acetate pollutant levels								
Varieties	SPAD Chlorphyll				Relative water content %			
	Control (T1)	T2 (30ppm)	T3 (50ppm)	T4 (70ppm)	Control (T1)	T2 (30ppm)	T3 (50ppm)	T4 (70ppm)
Abadgar	52.33 bcd	47.33 cde	40.33 fgh	38.0 ghi	70.33 def	64.33 gh	56.30 i	43.33 kl
SKD-1	60.33 a	57.66 ab	49.0 bcd	40.33 fgh	87.66 a	82.66 ab	74.0 cd	48.00 def
Anmol-91	47.0 cdef	38.66 ghi	31.33 jk	31.3 jk	73.0 cde	66.66 fg	54.66 ij	41.33 lm
Tj-83	44.66 def	39.66 fgh	35.66 ijk	35.6 ijk	74.0 cd	67.33 efg	59.30 hi	46.66 kl
Imd ad	58.33 a	55.33 abc	50.0 bcd	50.0 bcd	82.33 ab	78.0 bc	72.66 cde	65.33 gh
Sonalika	43.66 efgh	39.66 fgh	29.66 k	29.6 k	67.66 efg	60.0 hi	48.66 jk	37.0 m

spike (53.76, 52.0) under control, while sonalika produced the least grains (43.33). When genotypes were kept under lead acetate stress, variety Imdad and SKD-1 produced the most grain (39.66 and 37.0, respectively) and were less damaged (table 5). The mean data for grain yields plant^{-1} revealed that variety SKD-1 and Imdad produced maximum yield (g) plant^{-1}(19.33, 17.0 gram) under control, whereas Tj-83 produced minimum yield plant^{-1} (12.0). When genotypes were kept under lead acetate stress, the SKD-1 and Imdad varieties gave the highest grain yield plant^{-1} (14.33 and 13.0, respectively) and were least damaged (table 6). Under control, variety SKD-1 and Imdad produced the largest leaf area (cm) (43.33, 41.0 cm), while Tj-83 produced the smallest leaf area (cm). When genotypes were kept under lead acetate stress, the SKD-1 and Imdad varieties produced the highest leaf area (32.66 and 31.67, respectively) and were least damaged (table 6). The mean data for SPAD chlorophyll revealed that variety SKD-1 and Imdad produced the highest SPAD chlorophyll (60.33, 58.33), while Sonalika produced the lowest. When genotypes were held under lead acetate stress, variety Imdad and SKD-1 produced the most SPAD chlorophyll (50.0, 4033.) and were least impacted by the stress (table 7). Zhou et al., 2018 [39], investigated the effects of lead stress on plant seedling development, physiology, and cellular structure. They tested different lead concentrations in soil (0, 200, 600, 1000, 1400 mg kg-1) and discovered that as the lead concentration grew, Privet growth decreased and lead levels in the root, stem, and leaves increased. Chlorophyll levels were impacted, and transpiration rates were slowed.

The mean data for relative water content revealed that variety SKD-1 and Imdad produced the highest relative water content (87.66, 82.33) under control, while Sonalika produced the lowest relative water content (67.66). When genotypes were kept under lead acetate stress, the cultivar Imdad and SKD-1 produced the higher relative water content (65.33, 48.0) and was the least affected (table 7).

Conclusions

This study showed that varieties responded differently to lead application. The tolerant varieties showed less reduction % in their yield, yield components, and physiological traits. However, we recommend that lead uptake by each tolerant and sensitive cultivar may also be considered before recommending tolerant varieties in the area polluted with lead.

Conflict of interest

The authors declare that no conflict of interest exists.

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