



Original Research Article

Evaluation of Soybean (*Glycine max L.*) Cultivars Under Salinity Stress During Early Vegetative Growth

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ABSTRACT

Keywords

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This study was to determine the effect of salinity on germination and seedling growth of soybean. For this, 15 soybean genotypes were tested in sand culture experiment. The seeds were irrigated with saline waters of different EC levels (0, 3, 6, 7.2, 10, 12, 14 dSm⁻¹). Length and dry weight of root and shoot as well as PR were evaluated under salinity at 7 DAS. Salinity significantly reduced dry matter accumulation in both roots and shoots in all the cultivars, though declension was more pronounced in PS 1347 and PS 1024. Shoot growth was affected more adversely than root growth. Cultivars showed a wide range of variation in their salinity tolerance as mediated by, PR (percent reduction in seedling dry weight over control) and SSI (salinity susceptibility index). PK 1029 and PK 416 exhibited higher levels of tolerance to salinity compared to the other cultivars.

Introduction

Soil degradation caused by salinization and sodification is of universal concern. Nearly one billion hectares of soil around the world were having some degree of salinization and sodification problem (FAO, 1992). About 2.78 million hectares of land is classified as unsuitable for agriculture due to salinization and sodification problem. This problem manifests itself especially in arid and semi-arid areas with poorly drained soils because of continual addition of salts with irrigation practices (Ayars and Tanji, 1999). Saline soils are classified as those containing high

levels of soluble salts, mainly sodium chloride and sodium sulphate. As salinity level increases, plant extract water less from soil, aggravating water stress conditions. High soil salinity cause nutrient imbalances, result in the accumulation of elements toxic to plants, and reduce water infiltration if the level of one salt element—sodium—is high. Salinity affects plant growth through ionic and osmotic effects. Sometimes these effects are distinct from each other; sometimes these effects overlap each other.

Results have indicated that salinity affects growth and development of plants through osmotic and ionic stresses. Because of accumulated salts in soil under salt stress condition plant wilts apparently while soil salts such as Na^+ and Cl^- disrupt normal growth and development of plant (Farhoudi *et al.*, 2007; Khajeh-Hosseini *et al.*, 2003; Letly, 1993). The difference in a plant response to a given level of salinity is dependent on the concentration and composition of ions in solution as well as the genotype that is exposed to the salinity (Cramer, 1992). Seed germination is usually the most critical stage in seedling establishment, determining successful crop production (Almansouri *et al.*, 2001). Factors adversely affecting seed germination may include sensitivity to drought stress (Wilson *et al.*, 1985) and salt tolerance (Perry, 1984; Sadeghian and Yavari, 2004).

Numerous studies have been conducted on the management and identification of salinity tolerant crops such as cotton or cereals (Leidi and Saiz, 1997; Hoffman and Jobes, 1978).

Soybean is an important agricultural crop and has, among its genotypes, a relatively wide variation of salt tolerance. As measured by vegetative growth and yield, however, the emergence or failure of a high emergence ratio and seedling establishment on saline soils can have significant economic implications in areas where soil salinity is a potential problem for soybean. Until now no published information has been available concerning the effects of NaCl , Na_2SO_4 , NaHCO_3 , CaCl_2 on soybean germination and seedling growth.

The study reported here was performed to examine the effects of salinity on germination, emergence and seedling growth, and to estimate the germination

salinity threshold. A better understanding of the effects of salinity on soybean germination and emergence is important for the development of cultivation practices for stand establishment of this crop under saline conditions.

This research describes the effects of salinity on the germination and growth of selected genotypes of soybean. Fifteen genotypes of soybean were used to study their response to salinity at germination and seedling stage.

Materials and Methods

A sand culture experiment was conducted to screen 15 varieties of soybean against salinity tolerance in the Plant Physiology laboratory under ambient conditions. The temperature during the study ranged between 25°C and 34°C . The soybean varieties namely PK 564, PK 472, PK 416, PK 262, PK 1029, PK 327, PS 1092, PS 1024, PS 1042, PS 1347, PS 1241, JS 335, VLS 47, Bragg, Bhatt were obtained from the Govind Vallabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. The experimental set was consisted of 315 plastic trays (15 genotypes x 3 replications x 7 treatments) having a size of 30 x 25cm and a depth of 4cm, filled with 1.5kg sand. The sand was thoroughly washed, sterilized at 48°C for 36 hours and used in the experiment.

Uniform sized seeds of all the varieties were surface sterilized with 0.01% HgCl_2 for 1 minute and washed thoroughly in distilled water before sowing. Twenty five seed replicas were used at each salinity regime. Saline water with six different salinity levels 3, 6, 7.2, 10, 12 and 14 dSm^{-1} were prepared by adding a mixture of sodium chloride (NaCl), sodium sulphate (Na_2SO_4), calcium chloride (CaCl_2), sodium bicarbonate (NaHCO_3) in distilled water as per US

Salinity laboratory staff (1954) and distilled water served as control.

The seeds were sown in 3 rows in the trays having a seed to seed distance of 1 cm and row to row distance of 2 cm at uniform depth (0.5cm). Different sets were irrigated with different saline solutions. Each set was consisted of 3 replicates. The amount of water evaporated was also compensated by adding suitable quantity of distilled water to the respective trays. Seeds were considered as having germinated when a radicle protruded to a length of 1mm. Germination was recorded every day from the beginning of the experiment. For the assessment of the varieties, the observations were recorded 7 days after sowing. The samples were collected randomly in triplicate and data were noted on length of root and shoot, and then parallel plant samples were kept at 60°C in a hot air oven for 48 hours. The dry weight of the corresponding plant samples was taken.

The experiment was designed by using a randomized complete block design with three replications. To access salinity tolerance, the percentage reduction under saline conditions compared to control was computed as $PR=1-(\text{biomass under salinity}/\text{biomass under control})$ and salinity susceptibility index as per formula $SSI=(1-Y_{ss}/Y_{ns})/SII$ where Y_{ss} and Y_{ns} are the mean of a given genotype in SS and NS environment, respectively. SII (salinity intensity index) $=1-X_{ss}/X_{ns}$, X_{ss} and X_{ns} are the mean of all genotype under salinity stress (SS) and non stressed environment (Fisher and Maurer, 1978). For all investigated parameters analysis of variance was performed using MS-Excel and differences between the means were compared through LSD test ($P<0.05$). A critical difference (CD) was constructed when F- tests indicated statistically significant differences between genotypes

using the method described by Bruning and Kintz (1977) at $P=0.05$.

Results and Discussion

Germination

Germination had been differentially affected under various salinity regimes in different cultivars of soybean (Table 1). Overall data indicate a gradual and significant ($P\leq 0.001$) decline at 3–14 dSm^{-1} while germination was differentially affected at 3 dSm^{-1} . Germination counts were not affected in PK 1029 and JS 335 while more than 20% reduction was noted in VLS 47, PK 1347 and PS 1024. All other cultivars registered 4–24% reduction at 3 dSm^{-1} .

Data also revealed differential germination behavior in different cultivars in controls as well as under varying salinity regimes. Control sets indicated more than 80% germination in different varieties. Germination count had been adversely affected from 6-14 dSm^{-1} . However, evident reductions were noted at 12 and 14 dSm^{-1} . More than 75% inhibition in seed germination was recorded in all varieties at 14 dSm^{-1} except for PK 1029 and PK 416.

Screening of the varieties will be considered on the performance of growth at moderate EC levels ($7.2dSm^{-1}$). At 6 dSm^{-1} , cultivars PK 1029, PK 416, PK 262, JS 335 and VLS 47 registered 8–25% reduction while cultivar PS 1241, PS 1024 and PS 1347 registered 45-52% inhibition. Remaining cultivars ranged in between these two groups. At 7.2 dSm^{-1} , cultivars PK 1029, PK 416, JS 335 and PK 327 registered 16–40%; cultivars VLS 47, Bragg, PK 427, PS 1241, PS 1347 and PS 1024 registered 50-60% while remaining varieties (PK 262, Bhatt, PK 564 and PK 1029) registered 40–45% inhibition in seed germination.

10 dSm⁻¹ is quite high EC level for soybean genotypes, caused more than 80% inhibition in seed germination in PK 427, PK 262, JS 335, VLS 47, Bragg, PS 1347, PS 1024, PS 1092 and PS 1241 while remaining varieties expressed 66–79% inhibition. Therefore on the basis of seed germination cultivars PK 1029, PK 416 and JS 335 are better tolerant to salinity while cultivars PS 1347, PS 1024 and PS 1241 are more sensitive at 6 and 7.2 dSm⁻¹.

Shoot growth

Data revealed significant reductions ($P \leq 0.001$) in shoot length at all salinity levels in all soybean genotypes. At 3 dSm⁻¹, cvs. PK 1029, PS 1092, Bhatt and PK 416 exhibited less than 40% while cv. PS 1347, PS 1042 and PS 1024 showed more than 60% reduction. Rest of the cultivars recorded 40–60% reductions. At 6 dSm⁻¹, cvs. PK 1029, PK 416 and PK 1092 registered 50–60% reductions while cvs. JS 335, PK 564, Bragg, PS 1347, PS 1042 and PS 1024 showed more than 80% reductions. At 7.2 dSm⁻¹, most of the cultivars recorded more than 80% reduction except PK 1029, PK 262, PK 416 and PS 1092. At 10 dSm⁻¹, cvs. PK 472, VLS 47 and PS 1347 showed more than 90% reduction while remaining exhibited 80–90% reductions. At 12 dSm⁻¹ all the cultivars exhibited drastic (80–97%) reductions.

Increasing salt concentration also caused a remarkable and significant ($P \leq 0.001$) decline in shoot dry weight. At 3 dSm⁻¹, cvs. PK 327, PK 472, PK 1029, PK 416, Bragg and PS 1024 recorded reductions in the range of 18–30%; cvs. PK 262, Bhatt, VLS47, PS 1042 and PS 1092 showed 30–50% while cvs. JS335, PS 1347 and PS 1024 registered more than 50% reductions. At 6 dSm⁻¹, cv. Bragg, PS 1347, PS 1042 and PS 1024 registered more than 70%

reduction while all other cultivars exhibited reductions in the range 50–70%. At 7.2 dSm⁻¹, reductions in dry weight were recorded in most of the cultivars but the results were more marked (more than 80%) in PS 1367, PS 1024 and PS 1241. At 10 dSm⁻¹, most of the cultivars registered more than 80% reduction leaving for PS 1029, PK 262, PK 416 and VLS 47 ranged from 70–79%. At 12 and 14 dSm⁻¹, all the cultivars experienced drastic reductions ranged from 80–98% followed by PK 262 and VLS 47 (100%) reduction.

Root growth

Salinity has differentially affected root growth which has been measured at length and dry weight (Table 1). Data indicate that length of root was not affected significantly in cvs. PK 472, PK 262, PK 416, Bhatt, VLS 47 at 3 dSm⁻¹ but significant reductions were noted in remaining varieties. Greater reductions were noted in cvs. PS 1347, PS 1042 and PS 1024 which ranged between 50–62%. The inhibitory effect of salinity gradually increases at 6 and 7.2 dSm⁻¹ and seeds failed to produce roots at 10 dSm⁻¹ and beyond. Cvs. PS 1347, PS 1042, PS 1024 and PS 1092 registered higher reduction in root length at 6 dSm⁻¹ which ranged between 70 and 90%. Lesser reductions were noted in PK 1029, PK 416, PK 262 and VLS 47 (10–25%) while remaining varieties recorded 30–64% reduction. The inhibitory effect further aggravated at 7.2 dSm⁻¹. It is clear that cvs. PS 1347, PS 1042 and PS 1024 proved most sensitive at 3, 6 and 7.2 dSm⁻¹ while cvs. PK 416 and PK 1029 proved tolerant to salinity in terms of root elongation.

The data for dry weight of root indicate significant reductions as the level of salinity increased. At 3 dSm⁻¹ cultivars PK 327, PK 472, PK 1029, PK 416, Bhatt and PS 1241 showed marginal reduction (520%)

while other cultivars exhibited more than 50% reductions. As the salinity level is raised to 6 dSm⁻¹, cv. PS 1347 showed 77% reduction which was followed by PS 1024 (79.5%) while cvs. PK 472, PK 1029, PK 262, and PK 416 exhibited 20-50% reductions. Rest of the cultivars registered 51-72% reduction. At 7.2 dSm⁻¹, cvs. PK 327, JS 335, VLS 47, Bragg, PS 1347, PS 1042 and PS 1024 exhibited 80-96% reduction while remaining varieties indicated 50-79% reductions.

Seedling growth

Seedling growth has been measured in terms of height and dry weight which is mentioned in (Table 1). Data revealed that seedling growth significantly declined with increasing salinity levels in all the soybean genotypes. At 3 dSm⁻¹, cv. PK 1029 revealed lesser reduction (16.49%) while cvs. PK 1347, PS 1042 and PS 1024 registered greater reduction (> 64%). Rest of the cultivars recorded reductions which ranged from 20 to 60%. At 6 dSm⁻¹, cvs. PK 472, PK 1029, PK 262, Bhatt, VLS 47 and 1092 showed 50-70% reduction while rest of the cultivars recorded more than 70% reduction. PS 1347 and PS 1024 recorded 82.97 and 85.62% reduction. The varieties have expressed genetic variability by registering more than 80% reduction in most of the cultivars except PK 1029, PK 262 and PK 416 which recorded 60-80% reduction. The inhibitory effect further aggravated at 10 dSm⁻¹. Most of the varieties registered more than 90% reduction except PK 1029 and PK 416. However, at 12 and 14dSm⁻¹, all the varieties underwent drastic reduction (>90%).

Dry weight of seedling decreases as the level of salinity increased from 3–14 dSm⁻¹ in all the cultivars of soybean. Most of the cultivars expressed 10-50% reduction while

PS 1347, PS 1042 and PS 1024 recorded more than 50% reductions in dry weight of seedling at 3 dSm⁻¹. Dry weight also significantly decreased as the level of salinity raised to 6 and 7.2 dSm⁻¹, the reduction being more pronounced in PS 1347, PS 1024 and PS 1042. In contrast cvs. PK 416, PK 262 and PK 1029 recorded least reductions (44–55 and 67–72%) at 6 and 7.2dSm⁻¹. Remaining cvs. Registered 56–79% and 73–84% reduction at 6 and 7.2 dSm⁻¹. At 10 dSm⁻¹, most of the cultivars exhibited more than 90% reduction except PK 1029, PK 262, PK 416, Bhatt and JS 335. At 12 and 14 dSm⁻¹, all the cultivars showed 80-97% and 93-100% reduction respectively.

Salinity susceptibility index (SSI)

There were variations among soybean cultivars in regard to SSI (Salinity Susceptibility Index) and PR (Percent Reduction) under saline conditions which were noted at 7.2 dSm⁻¹. Genotypes having SSI values > 1.00 and PR higher than 84% were considered as sensitive, whereas the genotypes with SSI between 0.80 and 1.00 and PR less than 66% were classified as tolerant (Table 1). Genotypes PK 416 and PK 1029 were identified as relatively tolerant as their SSI ranged between 0.857 and 0.833. On the other hand PS 1024 and PS 1347 were considered as sensitive genotypes as their SSI ranged between 1.110 and 1.120.

Salt stress declined the germination and also delayed the emergence of radicle in soybean. It is also assumed that in addition to toxic effects of certain ions, higher concentration of salt reduced the water potential in the medium which hinders water absorption by germinating seeds and thus reduces germination (Maas and Nieman, 1978). It appears that a decrease in

germination is related to salinity induced disturbance in metabolic process leading to increase in phenolic compounds (Ayaz *et al.*, 2000). It is assumed that germination rate and the final seed germination decreased with the decrease of the water movement into the seeds during imbibitions (Hadas, 1977). Our results demonstrated that germination of soybean seeds decreased with increase in salt concentration. These results corroborate the findings of Mauromicale and Licandro (2002) Gulzar *et al.* (2001) Kandil *et al.*, (2012), Moradi and Zavareh (2013). Khajeh-Hosseini *et al.* (2003) found faster germination in NaCl in soybean. Jamil *et al.* (2005) reported that increased salt concentration caused a decrease in final germination percentage. Sadeghian and Yavari (2004) stated that seedling growth was severely diminished by water stress in sugar beet. Shoot growth of Brassica species were more affected as compared to root growth at all salinity levels (Jamil *et al.*, 2005).

The growth of root and shoot is the most important parameter for salt tolerance because roots are in direct contact with the soil and absorb water from soil and shoot supply it to the rest of the plant. For this reason, root and shoot length provides an important clue to the response of plants to salt stress (Jamil *et al.*, 2004). Salt stress inhibited the root and shoot length of all the soybean genotypes as the level of salinity increased, however shoot length was more affected than the root length. Similar results were reported by (Bernstein and Hayward, 1958; Kondetti *et al.*, 2012; Farhoudi *et al.*,

2011) who demonstrated that root growth is less inhibited than the shoots in most of the crops. These results differ from those reported by Jamil *et al.* (2007). They found that decrease in the length of root was more prominent as compared to the shoot.

That salinity reduced the plant growth irrespective of the cultivar is evident from the decline in dry weight of both roots and shoots with increasing stress. As stated by Munns (2003), suppression of plant growth under saline conditions may either be due to the decreasing availability of water or to the increasing toxicity of NaCl associated with increasing salinity. Elsheikh and Wood (1990) had earlier observed decrease in root and shoot dry weight with increasing salinity levels, which is similar to the results of this present study.

The variations among cultivars on the basis of SSI also corroborate the findings of Goudarzi and Pakniyat (2008). In the light of these results, it is concluded that salinity stress inhibit the growth of different soybean cultivars. However, important variability in terms of seedling growth and dry matter accumulation was observed amongst different cultivars of soybean. In general, both PK 416 and PK 1029 seemed to have better potential for salt tolerance compared with other cultivars while PS 1347 and PS 1024 showed poor results. The existence of intraspecific genetic variability among soybean cultivars, as shown in this work, might be useful in selective optimal cultivars to increase agricultural production in soils subjected to salinity.

Table.1 Effect of salinity on germination and seedling growth in some cultivars of soybean (*Glycine max L.*) at 7 days after germination (DAG)

Variety	Salinity levels (dSm ⁻¹)	% germ.	Length (cm)		Dry weight (mg/plant)		Seedling		SSI
			Shoot	Root	Shoot	Root	Height (cm)	Dry weight (mg/plant)	
PK 327	Control	92	13.60	6.00	18.00	8.00	19.60	23.00	
	3.0	80	9.00	5.20	14.00	4.46	14.20	18.46	0.511
	6.0	68	3.30	2.20	6.00	1.40	5.50	7.40	1.050
	7.2	56	2.50	1.20	4.20	0.80	3.70	5.00	1.030
	10.0	32	1.50	0.00	3.20	0.00	1.50	3.20	1.010
	12.0	24	0.80	0.00	2.80	0.00	0.80	2.80	0.987
	14.0	10	0.60	0.00	2.40	0.00	0.60	2.40	0.965
CD at 5%		1.98	0.45	0.75	0.77	0.69	0.54	0.74	
PK 472	Control	84	19.80	4.30	26.00	4.60	24.10	30.60	
	3.0	72	11.60	3.60*	18.00	3.60	15.20	21.60	0.761
	6.0	60	5.00	3.00	10.00	3.30	8.00	13.00	0.890
	7.2	36	2.60	1.80	5.60	1.70	4.40	7.30	0.997
	10.0	28	1.80	0.00	4.20	0.00	1.80	4.20	1.020
	12.0	16	0.80	0.00	3.60	0.00	0.80	3.60	0.992
	14.0	8	0.60	0.00	1.80	0.00	1.60	1.80	1.010
CD at 5%		1.15	0.68	0.74	1.53	0.16	0.30	1.15	
PK 1029	Control	100	15.80	3.60	22.00	3.80	19.40	25.80	
	3.0	100	12.80	3.40	18.00	3.60	16.20	21.60	0.421
	6.0	92	6.50	3.20	10.80	2.80	9.70	13.60	0.732
	7.2	84	3.80	1.50	7.60	1.40	5.50	9.40	0.833
	10.0	72	2.30	0.00	5.40	0.00	2.30	5.40	0.931
	12.0	56	2.00	0.00	4.40	0.00	2.00	4.40	0.933
	14.0	48	1.30	0.00	3.60	0.00	1.30	3.60	0.927
CD at 5%		1.62	0.22	0.15	1.48	1.48	0.35	0.67	
PK 262	Control	92	15.10	4.00	23.70	4.50	19.10	28.20	
	3.0	80	7.50	3.30*	12.00	3.40	10.80	15.40	1.170
	6.0	72	5.60	3.00	8.00	2.80	8.60	10.80	0.955
	7.2	52	3.50	1.80	6.70	1.80	5.30	8.40	0.919
	10.0	36	2.10	0.00	4.80	0.00	2.10	4.80	0.977
	12.0	16	1.80	0.00	3.60	0.00	1.80	3.60	0.981

	14.0	0	0.00	0.00	0.00	0.00	0.00	0.00	1.070
CD at 5%		1.62	0.31	0.76	1.37	0.11	0.29	1.15	
PK 416	Control	100	16.30	6.20	24.00	5.20	22.50	29.20	
	3.0	96	10.80	5.70*	19.00	4.80	16.50	23.80	0.487
	6.0	92	7.20	5.20	10.00	3.60	12.40	13.60	0.827
	7.2	84	3.80	3.50	7.60	2.50	7.30	10.10	0.857
	10.0	60	3.00	0.00	6.20	0.00	3.00	6.20	0.927
	12.0	52	2.60	0.00	4.60	0.00	2.60	4.60	0.947
	14.0	44	1.30	0.00	3.80	0.00	1.30	3.80	0.937
CD at 5%		1.75	0.39	0.67	0.77	0.17	0.07	1.15	
Bhatt	Control	100	22.00	3.80	23.20	3.50	25.80	26.70	
	3.0	80	13.30	3.30*	13.30	3.20	16.60	16.50	0.988
	6.0	64	5.40	2.40	7.84	1.70	7.80	9.50	0.997
	7.2	52	3.03	1.20	5.14	1.20	4.23	6.40	0.996
	10.0	32	2.80	0.00	3.80	0.00	3.30	3.80	1.010
	12.0	24	1.50	0.00	2.65	0.00	1.50	2.60	1.010
	14.0	36	0.80	0.00	1.80	0.00	0.80	1.80	1.000
CD at 5%		1.87	0.67	0.67	0.68	0.09	0.37	0.94	
JS 335	Control	88	19.60	5.30	25.80	4.60	24.90	30.40	
	3.0	88	9.30	3.00	12.50	2.40	12.30	14.90	1.320
	6.0	68	3.80	2.30	7.80	2.00	6.10	9.80	1.050
	7.2	56	3.30	1.50	5.20	0.80	4.80	5.80	1.060
	10.0	48	2.50	0.00	4.40	0.00	2.50	4.42	1.010
	12.0	16	1.50	0.00	3.20	0.00	1.50	3.20	1.010
	14.0	4	0.50	0.00	2.20	0.00	0.80	2.20	0.999
CD at 5%		1.15	0.21	0.47	0.77	0.67	0.78	0.94	
PK 564	Control	84	18.00	3.30	24.00	3.75	21.30	27.80	
	3.0	64	9.80	2.20	12.80	1.93	12.00	14.67	1.220
	6.0	52	3.30	1.50	8.00	1.81	4.80	9.81	1.000
	7.2	48	2.50	1.50	4.80	1.20	4.00	6.00	1.030
	10.0	32	2.00	0.00	4.20	0.00	2.00	4.20	0.999
	12.0	28	1.50	0.00	4.00	0.00	1.50	4.00	0.962
	14.0	8	0.60	0.00	2.80	0.00	0.60	2.80	0.969
CD at 5%		1.15	0.39	0.66	1.38	0.17	1.02	0.76	
VLS 47	Control	80	11.80	3.00	13.50	2.80	14.81	16.30	

	3.0	60	6.80	2.80*	7.00	1.40	9.60	8.40	1.250
	6.0	60	2.60	2.50*	4.80	0.80	5.10	5.60	1.020
	7.2	40	2.20	0.40	4.20	0.30	2.60	4.50	0.948
	10.0	28	1.00	0.00	3.20	0.00	0.80	3.20	0.946
	12.0	16	0.60	0.00	2.20	0.00	0.50	2.20	0.973
	14.0	0	0.00	0.00	0.00	0.00	0.00	0.00	1.080
CD at 5%		2.09	0.25	0.94	0.76	0.17	0.17	0.94	
Bragg									
Control	88	12.50	4.50	18.40	4.40	17.00	22.80		
3.0	68	7.30	3.80*	14.00	3.30	11.10	17.33	0.621	
6.0	64	2.30	2.30	5.20	1.80	4.60	7.00	1.070	
7.2	44	1.80	1.20	3.80	0.60	3.00	4.40	1.060	
10.0	28	1.50	0.00	3.20	0.00	1.50	3.20	1.010	
12.0	8	1.30	0.00	3.00	0.00	1.30	3.00	0.976	
14.0	4	0.50	0.00	2.60	0.00	0.50	2.60	0.954	
CD at 5%		1.75	0.19	0.94	0.82	0.13	0.35	0.81	
PS 1347									
Control	92	10.20	2.90	17.80	2.60	13.10	20.4		
3.0	60	3.40	1.20	7.30	0.80	4.60	8.10	1.560	
6.0	44	1.60	0.60	4.20	0.60	2.23	4.80	1.180	
7.2	36	1.30	0.30	2.80	0.20	1.63	3.00	1.120	
10.0	28	1.00	0.00	1.80	0.00	0.60	1.80	1.070	
12.0	4	0.40	0.00	0.80	0.00	0.40	0.80	1.080	
14.0	4	0.20	0.00	0.40	0.00	0.20	0.40	1.060	
CD at 5%		1.32	0.13	0.14	0.31	0.2	0.12	0.75	
PS 1042									
Control	92	18.30	5.20	20.80	4.50	23.53	25.30		
3.0	76	6.80	2.50	12.00	2.20	9.30	14.23	1.320	
6.0	68	3.20	1.80	5.60	1.70	5.03	7.30	1.100	
7.2	52	2.40	0.50	5.10	0.33	2.94	5.43	1.030	
10.0	40	1.90	0.00	3.80	0.00	1.90	3.80	1.000	
12.0	24	0.80	0.00	2.20	0.00	0.80	2.20	1.030	
14.0	16	0.50	0.00	2.00	0.00	0.50	2.00	0.992	
CD at 5%		1.75	0.54	0.68	1.00	0.13	0.22	0.74	
PS 1024									
Control	96	17.20	5.30	17.80	4.40	22.46	22.200		
3.0	68	0.20	1.90	6.40	1.47	7.70	7.87	1.670	
6.0	52	2.60	0.60	4.40	0.90	3.23	5.35	1.180	
7.2	36	2.00	0.40	3.20	0.21	2.40	3.41	1.110	
10.0	24	1.50	0.00	1.60	0.00	1.80	1.60	1.090	
12.0	12	0.80	0.00	0.80	0.00	0.80	0.80	1.080	

	14.0	4	0.20	0.00	0.50	0.00	0.20	0.50	1.050
CD at 5%		1.32	0.55	0.68	0.17	0.3	0.24	1.15	
PS 1092	Control	96	14.60	4.83	33.40	3.74	19.43	40.60	
	3.0	80	9.16	2.60	18.80	1.87	11.76	20.67	1.270
	6.0	60	6.60	1.40	11.60	1.20	7.73	12.76	1.060
	7.2	52	3.00	1.30	8.20	0.80	4.33	8.96	1.020
	10.0	36	1.90	0.00	6.40	0.00	1.90	6.40	0.991
	12.0	25	1.80	0.00	3.20	0.00	1.80	3.20	1.030
	14.0	16	1.30	0.00	2.90	0.00	1.20	2.90	1.000
CD at 5%		1.15	0.94	0.93	0.20	0.16	0.66	0.94	
PS 1241	Control	88	22.00	6.00	21.80	5.33	28.03	27.10	
	3.0	68	15.03	4.90	15.20	4.40	19.93	19.60	0.716
	6.0	48	5.20	2.30	8.20	1.80	7.53	10.00	0.977
	7.2	36	3.50	1.70	4.20	1.50	5.26	5.70	1.030
	10.0	28	2.80	0.00	3.40	0.00	2.80	3.40	1.030
	12.0	16	2.30	0.00	2.80	0.00	2.30	2.80	1.010
	14.0	12	0.50	0.00	1.60	0.00	0.50	1.60	1.010
CD at 5%		1.32	0.73	0.66	0.75	0.23	0.67	1.32	

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