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Efficacy of pretilachlor and oxadiazon on weed control and yield performance of transplant *Aman* rice

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Abstract

Two experimentswere carried out at the Agronomy Field laboratory, Bangladesh Agricultural University, Mymensingh during July to December 2014 to study the effectiveness of pretilachlor and oxadiazon on weed control and yield performance oftransplant *aman* rice. In experiment I BRRI dhan31and in experiment II BRRI dhan46 was transplanted with eight weeding practices *viz.*, weedy check; one hand weeding; two hand weeding; weed free;Pretilachlor only;Oxadiazon only;Pretilachlor + one hand weeding; and Oxadiazon+ one hand weeding. The design was split-plot with three replications. Eleven weed species were found to be infested in the experimental plots. Although weeds were completely controlled in weed free treatment, it is not practicable.Pretilachlor oroxadiazon with one hand weeding performed the best in terms of weed density and weed biomass over single application of each and even manual weeding. Weeds were completely resistant to weedy check, poorly susceptible to one hand weeding, moderately susceptible to two hand weeding and single application of both herbicide and highly susceptible to both herbicides with one hand weeding while weeds were completely susceptible to weed free treatment. Herbicides produced slight phyto-toxicity which was recovered by two weeks of application. The highest grain yield was recorded from weed free treatment and was statistically identical to pretilachlor oroxadiazon with one hand weeding. Single application of pretilachlor oroxadiazon ranked the third in terms of yield and statistically similar to two hand weeding followed by one hand weeding. Weedy check performed the worst.

Key words: Efficacy, pretilachlor, oxadiazon, weed control, yield, rice

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Introduction

Weed infestation in maize is one of the key factors responsible for the lower productivity and poor quality of produce (Ravisankar *et al.,* 2013). Reduction in grain yield is ranged from 33 to 50 per cent or even more depending upon the intensity and nature of the weed flora (Sharma *et al.,* 2000). The traditional method of manual and mechanical weeding is quite effective, but arduous, time consuming and highly costly. Under such situation, chemical weed control is a better option to conventional methods and use of herbicides forms an integral part of the modern crop production. In the last few decades' different herbicides were used alone or in combination to eliminate the weeds but their efficiencies differ because of their narrow spectrum of weed control (Main *et al.,* 2007).

In the recent years, the introduction of broad spectrum herbicides world-wide making chemical weed management popularize and benefiting over manual weeding in rice culture due to their rapid effects and less cost involvement compare to traditional methods of weeding. Severe labor crisis makes weed control very difficult at the critical period and causing huge yield gap. In such a situation herbicides are promising alternatives in controlling weeds (Rao and Pilla, 1974). Some herbicides are reported to have not only controlled weeds, but also increased the rice yield (Hossain *et al.,* 2014a).

Although herbicidal weed control is gaining popularity all over the world, most of the herbicides are very new in Bangladesh. A very little information is available on the effectiveness in controlling weeds in rice. Indiscriminate use of these chemicals may lead to notorious effect on crops as well as the environment. So it is important to study the efficacy of herbicides on weeds and crops. If the chemical weed control technology is found feasible under Bangladesh condition, it could bring a technological advancement in the field of crop production. Considering the above facts, the present study was undertaken to study the effectiveness of two pre-emergence herbicides in weed control and yield performance of transplant *aman* rice.

Materials and Methods

Experimental Site

Experiments were conducted at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh. Geographically site was at 24°75' N latitude and 90°50' E longitude at an elevation of 18 meter above the mean sea level (FAO and UNDP, 1988).

Soils

The soil belongs to Non-Calcareous Dark Grey Floodplain Soil under Sonatola series in Old Brahmaputra Floodplain, Agro-Ecological Zone 9 (FAO and UNDP, 1988). The pH level 6.8, low in organic matter and fertility. The land type was medium high with silty loam texture.

Climatic condition

The tropical climate of the locality characterized by high temperature and heavy rainfall during *Kharif* season (April to September) and scanty rainfall associated with moderately low temperature during *Rabi* season (October to March). The agro-climate condition during the experimentation presented in the Figure 1.

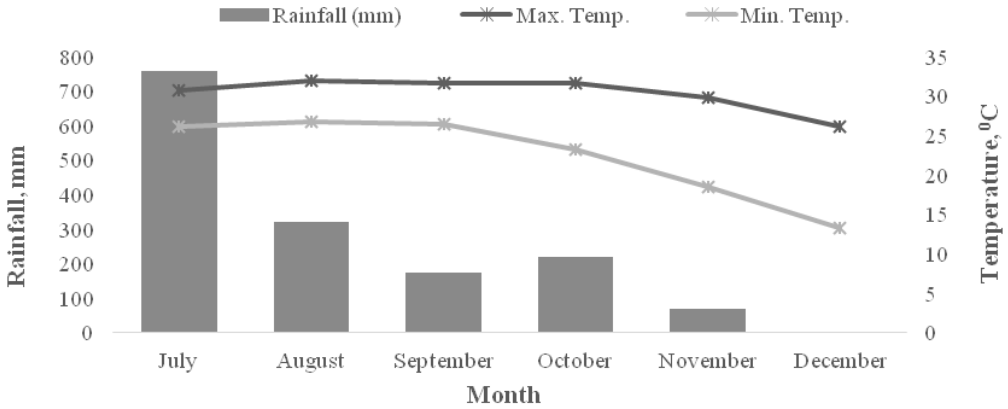

Figure 1. Climatic condition of the experiment site (July - December, 2014) [Source: Department of Irrigation, BAU, Mymensingh]

Plant materials

BRRI dhan31 and BRRI dhan46 were used as the test crops. Both varieties were developed by Bangladesh Rice Research Institute (BRRI) and recommended for *Aman* season. The average grain yield of BRRI dhan31 is 4.2t ha^{-1} and of BRRI is 4.5 t ha^{-1} (BRRI, 2013).

Experimental protocol

There were two experiments. In the experiment I, BRRI dhan31was transplanted with eight weed control treatments *viz.,* Weedy check; One hand weeding; Two hand weeding; Weed free; Pratilachlor only; Oxadiazon only; Pratilachlor + one hand weeding and Oxadiazon + one hand weeding. In the

experiment II, BRRI dhan46 was transplanted with same weed control treatments. The design was Split-Plot with three replications. Keeping the varieties in the main plots the weed control treatments were applied in the subplots having the size each 4.0 m × 2.5 m.25 days aged seedlings were used in both experiment.

Description of herbicides

A short description of herbicides that were used in the experiment are given in Table 1.

Table 1. A short description of herbicides that were used in the experiment.

Herbicide	Trade name	Active ingredient	Mode of action	Group	Time and dose of application
Pretilachlor	Rifit® 500EC	250g Pretilachlor L^{-1}	Systemic Selective	PE	3-5 DAT@ 1 L ha^{-1}
Oxadiazon	Ronstar® 25EC	250g Oxadiazon L^{-1}	Systemic Selective	PE	3-5 DAT@ 2L ha^{-1}

Land preparation

The land was opened with a tractor drawn disc plough and puddled thoroughly by three ploughing and cross-ploughing followed by laddering. Weeds and stubbles were removed. Recommended dose of all fertilizers were applied and all sorts of cultural operations were performed according to BRRI (2013).

Data recording

Data on weed vegetation

Weed density (no. m^{-2})

The density of weed was determined by counting the total number of each species fall within a quadrate of 1 m × 1 mfrom three places at random in each plot.

Weed dry weight (g m^{-2})

The collected weeds were dried in the sun and in an electric oven at 70^0C for 72 hours.

Weed control efficacy

Weed control efficiency (on the basis of dry weight) was calculated using the following formula by Sawant and Jadav (1985).

$$WCE = \frac{DWC - DWT}{DWC} \times 100$$

Where, WCE= Weed control efficacy; DWC= Dry weight of weed in weedy check; DWT= Dry weight of weeds in the treatment

The extent of weed control

The extent of weed control and susceptibility of different weed species to the treatments were graded on the basis of weed control efficacysuggested by Mian and Gaffer (1968) presented in the Table 2.

Table 2. Grade of weed control and degreeof weed susceptibility scale

Weed control efficacy	Grade of weed control	Degree of weed susceptibility
100	Completely control (CC)	Completely susceptible (CS)
90-99	Excellent control (EC)	Very highly susceptible(VHS)
70-89	Good control (GC)	Highly susceptible (HS)
40-69	Fair control (FC)	Moderately susceptible (MS)
20-39	Poor control (PC)	Poorly susceptible (PS)
1-19	Slightly control (SC)	Slightly susceptible (SS)
0	No control (NC)	Completely resistant

Phyto-toxicity of herbicides

Phyto-toxicity of herbicides to rice plants was determined visually (yellowing leaves, burning leaf tips, stunting growth etc.) according to the scale suggested by IRRI (1999). The rating of toxicity was done within a week (2^{nd}, 4^{th}, and 6^{th} days) of herbicides application from 10 samples of each plot. Day of recovery from the toxicity was also recorded visually. Toxicity level was measured on the five classes *viz.,* No toxicity, Slight toxicity, Moderate toxicity, Severe toxicity and Toxic (plant killed).

Data on crops

The crops were harvested at full maturity when 80% of the grains became golden yellow colored. From each plots five hills were uprooted carefully and tagged for data recording. Threshed grains were cleaned, weighted and converted to t ha^{-1} at 14% moisture content. Straw were sun dried up to the constant weight finally weighted and converted to t ha^{-1}.Harvest index was calculated by the following formula (Gardner *et al.,* 1985) considering the yields in t ha^{-1}.

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Grain yield} + \text{Straw yield}} \times 100$$

Statistical Analysis

The recorded data were subjected to ANOVA using MSTAT-C. The mean differences were adjudged by Duncan's Multiple Range Test according to Gomez and Gomez, 1984.

Results and Discussion

Weed infestation in the rice field

The experimental plots were infested with 11 weed species belonging to five families (Table 3). Six weed species were of the family Poaceae, two of the family Cyperaceae, and one each of the familyPontederiaceae, Onagraceae and Oxalidaceae.

Table 3. Weed species identified in the experimental plots

Sl. No.	Local name	Scientific name	Family	Morphology	Life cycle
1.	Holde mutha	*Cyperus difformis* L.	Cyperaceae	Sedge	Annual
2.	Angulee ghash	*Digitaria sanguinalis* L.	Poaceae	Grass	Annual
3.	Khudey Shama	*Echinochloa colonum* L.	Poaceae	Grass	Annual
4.	Shama	*E. crus-galli* L.	Poaceae	Grass	Annual
5.	Joina	*Fimbristylis miliaceae* L.	Cyperaceae	Sedge	Annual
6.	Arail	*Leersia hexandra* Sw.	Poaceae	Grass	Perennial
7.	Panilong	*Ludwigia hyssopifolia* L.	Onagraceae	Broadleaved	Annual
8.	Panikachu	*Monochoria vaginalis* L.	Pontederiaceae	Broadleaved	Perennial
9.	Amrul shak	*Oxalis europaea* L.	Oxalidaceae	Broadleaved	Annual
10.	Chelaghash	*Parapholis incurva* L.	Poaceae	Grass	Perennial
11.	Angta	*Paspalum scrobiculatum* L.	Poaceae	Grass	Perennial

Based on the importance value, grasses (55%) were dominant over broadleaves (27%) and sedges (18%). Perennial weeds constituted 64% where annuals constituted36% of the weed population (Figure 2).

Treatments effect on weed density and dry matter

Weed control treatments exerted significant effect on weed density and weed biomass both in BRRI dhan31 and BRRI dhan46 (Table 4). Naturally, weedy check produced the highest weed population and biomass followed by one hand weeding, Pretilachlorand Oxadiazon. Two hand weeding performed better over single application of each herbicide but herbicide with one hand weeding suppress weeds more compared to hand weeding. Pretilachlorwith one hand weeding performed the best to control weeds. Although there was no weed in weed free treatment, it is not practical for controlling

weeds in the crop field. Hossain*et al.* (2014a) also found the similar result concluding herbicide with manual hand weeding control weeds more efficiently compared to manual weeding only. This statement is in agreement with Hossain *et al.* (2014b).

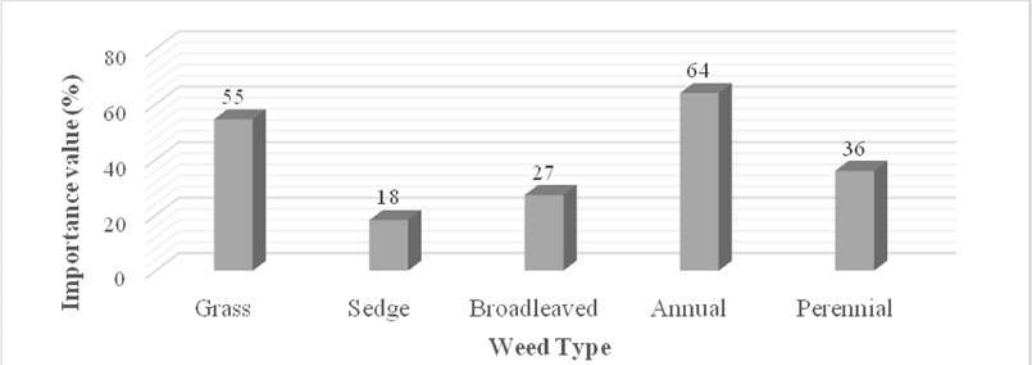

Figure 2. Infested weed types in the experimenal plot

Table 4. Effect of weed control practices on weed density and weed dry matter of BRRI dhan31 and BRRI dhan46

Treatments	Weed density (no. m^{-2})		Dry weight (g m^{-2})	
	20 DAT	40 DAT	20 DAT	**40 DAT**
BRRI dhan31				
Weedy check	44.33a	49.33a	16.33a	15.14a
One hand weeding	12.33b	13.67b	9.50b	6.91b
Two hand weeding	7.67d	9.33cd	6.71c	5.44d
Weed free	0.00f	0.00g	0.00g	0.00f
Pretilachlor	12.67b	11.33bc	5.52cd	6.87bc
Oxadiazon	10.33c	10.67c	5.32de	6.18c
Pretilachlor+ one hand weeding	5.67e	5.00f	2.83e	2.70e
Oxadiazon + one hand weeding	6.33de	6.67e	2.07ef	2.86e
BRRI dhan46				
Weedy check	32.00a	38.00a	8.18a	9.35a
One hand weeding	24.33b	32.00b	7.32b	5.77b
Two hand weeding	19.30c	29.33bc	5.31c	5.14bc
Weed free	0.00g	0.00h	0.00f	0.00f
Pretilachlor	13.33d	19.00d	6.02bc	4.68c
Oxadiazon	10.30e	15.67e	5.44c	4.89cd
Pretilachlor+ one hand weeding	2.79f	5.00f	3.87d	3.76d
Oxadiazon + one hand weeding	3.67f	7.33g	2.38e	3.29de
S(x)	0.85	0.47	0.15	0.18
CV (%)	14.90	7.58	12.72	8.52
LS	**	**	**	**

** Significantat 1% level, S(x)= standard error, CV= Co-efficient of variation, LS= Level of significant

Weed control efficacy (%)

The efficiency of different weed control treatments with grades of weed control and degree of weed susceptibility have been presented in Table 5. Data of both BRRI dhan31 and BRRI dhan46 revealed that pretilachlor or oxadiazon with one hand weeding performed the best in controlling weeds where weeds were highly susceptible over single use of both herbicides and two hand weeding. Single weeding by hand control weeds poorly while there was no weed control in weedy check treatment. Hundred per cent weeds were controlled in wed free treatment. This might be due to degree of weed susceptibility of the treatments. Weeds were completely resistant to weedy check, poorly susceptibility to single hand weeding, moderately susceptible to two hand weeding and single use of each herbicide. The highly susceptible weeds were found in herbicides with single hand weeding. Ravisankar *et al.* (2013) found the similar results concluding the highest weed control efficacy of chemicals with manual hand weeding. This finding is the support of finding of Hossain *et al.* (2014c).

Table 5. Weed control efficacy (%) weed control treatments

Treatments	Weed control efficacy (%)			Grade of weed control	Degree of weed susceptibility
	20 DAT	40 DAT	Mean		
BRRI dhan31					
Weedy check	0	0	0	NC	CR
One hand weeding	41	37	39	PC	PS
Two hand weeding	67	71	69	FC	MS
Weed free	100	100	100	CC	CS
Pretilachlor	62	57	59	FC	MS
Oxadiazon	63	55	59	FC	MS
Pretilachlor+ one hand weeding	87	82	85	GC	HS
Oxadiazon + one hand weeding	72	75	73	GC	HS
BRRI dhan46					
Weedy check	0	0	0	NC	CR
One hand weeding	37	39	38	PC	PS
Two hand weeding	60	64	62	FC	MS
Weed free	100	100	100	CC	CS
Pretilachlor	67	53	60	FC	MS
Oxadiazon	70	59	65	FC	MS
Pretilachlor+ one hand weeding	73	53	63	FC	MS
Oxadiazon + one hand weeding	76	71	74	GC	HS

GC= Good control, NC= No control, PC= Poor control, FC= Fair control, CC= Complete control, CR=Completely resistance, PS= Poorly susceptible, MS=Moderate susceptible, CS=Completely susceptible, HS= High susceptible

Phyto-toxicity of herbicides

Toxicity of herbicides was observed visually and graded according to the rating level (Table 6). The results showed pretilachlor caused to slight yellowing of leaf tip and oxadiazon caused to slight browning to leaf. In both cases toxicity level is *Slightly Toxic* which recovered within two weeks of application and did not hampered the crop growth. Zahan *et al.* (2014) found the similar symptoms of same herbicides of different trade names concluding non-hazardous effect of herbicides on crop production.

Effects of weed control practices on yield attributes and yield of rice

Weed control practices exerted significant effect on all the plant characters except 1000-grain weight and harvest index of both BRRI dhan31 and BRRI dhan46 (Table 7). The tallest plant was recorded from weed free while the shortest from the weedy check. Pretilachloror Oxadiazon with one hand weeding produced the identical height and ranked the second followed by the single use the both herbicides. One hand weeding and two hand weeding produced the identical plant. The highest number of total tillers hill-1, effective tillers hill^{-1} and fertile grains panicle^{-1} was recorded from weed free treatment followed by pretilachlor or oxadiazon with one hand weeding. Single application of both herbicides produced the identical values followed by two hand weeding which was identical to single hand weeding. The weedy check produced the lowest values for both the plant characters. The highest values for the number of non-effective tillers hill^{-1} and sterile grains panicle^{-1} was recorded from weedy check followed by one and two hand weeding. Application of Pretilachlor and Oxadiazon produced the similar values which was identical to two hand weeding. The weed free produced the lowest values followed by Pretilachlor or Oxadiazon with one hand weeding. The weed free treatment yielded the highest grains while Pretilachlor or Oxadiazon with one hand weeding ranked the second.

Pretilachlor and Oxadiazon yielded the similar grains which was identical to two hand weeding. Weedy check treatments yielded the lowest grains followed by one hand weeding. More or less same results were found by Hossain *et al.* (2014a and 2014b) and Zahan *et al.* (2014) concluding the application of an herbicide with single hand weeding performed better over single application herbicides even one or two hand weeding and ranked after the weed free. The highest grain yield obtained from the weed free might be attributed from the highest values total and effective tillers, fertile grains and the lowest values of non-effective tillers and sterile grains. This statement supports the finding of Hossain *et al*. (2014c).

Conclusion

From the above stated results it might be concluded that, application of an herbicide performed better compared to single hand weeding but similar to two hand weeding. As the world is facing huge labour crisis for manual weeding, so herbicide might be the better alternative to manual weeding. Although keeping fields weed free is the best, it is not practical. Application of an herbicide with one hand weeding might be best weed control practice to obtain higher grain yield.

Table 6. Phyto-toxicity of herbicides in different treatments in transplant *aman* rice

Treatments	Rating	Symptoms observed on the crop foliage	Toxicity level
Weedy check	1.0	No symptom	NT
One hand weeding	1.0	No symptom	NT
Two hand weeding	1.0	No symptom	NT
Weed free	1.0	No symptom	NT
Pretilachlor	2.3	Slight yellowing of leaf tipwhich recovered within 7-9 days and regained normal color and growth	ST
Oxadiazon	3.2	Slight browning of leaves which recovered within 9-11 days and regained normal color and growth	ST
Pretilachlor+ one hand weeding	1.0	Slight yellowing of leaf tip which recovered within 7-9 days and regained normal color and growth	ST
Oxadizon+ one hand weeding	2.0	Slight of leaves which recovered within 7-10 days and regained normal color and growth	ST

NT= Non Toxic; ST= Slightly Toxic

Table 7. Effect of weed control practices on yield attributes and yield of BRRI dhan31 and BRRI dhan46

Treatments	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Non - effective tillers hill^{-1} (no.)	Fertile grains panicle^{-1} (no.)	Sterile grains panicle^{-1} (no.)	1000- grain weight (g)	Grain yield (t ha^{-1})	HI (%)
BRRI dhan31									
Weedy check	101.74^{de}	8.31^{hi}	5.52^{hi}	3.79^{a}	134.97^{h}	20.88^{a}	25.56	3.06^{f}	41.99
One hand weeding	107.77^{cd}	10.93^{ef}	7.31^{f}	3.62^{abc}	142.30^{g}	18.72^{ab}	25.74	3.58^{e}	42.68
Two hand weeding	109.28^{bc}	10.93^{ef}	7.21^{f}	2.72^{bc}	152.55^{de}	16.13^{bcd}	25.82	4.13^{cd}	44.68
Weed free	115.69^{a}	14.62^{a}	11.49^{a}	1.83^{cd}	179.57^{a}	9.11^{ij}	26.04	5.41^{a}	47.41
Pretilachlor	115.77^{a}	12.13^{cde}	9.38^{de}	2.76^{bc}	159.67^{c}	15.03^{cde}	26.17	4.32^{bcd}	44.49
Oxadiazon	115.95^{a}	13.08^{bc}	9.95^{cd}	2.73^{bc}	158.76^{cd}	14.53^{def}	26.14	4.38^{bcd}	45.11
Pretilachlor + one hand weeding	115.69^{a}	14.29^{ab}	11.12^{ab}	1.77^{d}	178.37^{ab}	9.43^{hij}	26.08	5.28^{a}	47.51
Oxadiazon + one hand weeding	113.07^{ab}	11.13^{def}	8.73^{e}	1.70^{d}	173.73^{ab}	10.43^{hij}	26.10	5.17^{a}	45.72
BRRI dhan46									
Weedy check	102.00^{e}	7.61^{i}	5.06^{i}	3.55^{a}	117.01^{i}	17.99^{abc}	25.72	2.92^{f}	40.28
One hand weeding	102.14^{e}	8.22^{hi}	6.12^{gh}	3.10^{abc}	145.60^{fg}	15.00^{ghij}	25.95	4.00^{d}	43.78
Two hand weeding	103.90^{e}	8.95^{gh}	7.15^{f}	2.80^{bc}	144.99^{fg}	12.43^{eh}	25.63	4.18^{cd}	44.03
Weed free	111.31^{bc}	13.02^{bc}	10.80^{abc}	1.71^{bc}	173.46^{ab}	8.08^{j}	25.57	5.08^{a}	46.55
Pretilachlor	106.85^{de}	10.07^{fg}	7.00^{fg}	3.07^{ab}	150.26^{ef}	12.88^{efg}	26.35	4.28^{bcd}	42.32
Oxadiazon	104.37^{de}	9.93^{fg}	7.59^{f}	2.94^{ab}	148.43^{efg}	11.43^{fi}	26.27	4.62^{b}	45.75
Pretilachlor + one hand weeding	111.31^{bc}	12.33^{cd}	10.11^{bcd}	1.62^{bc}	171.88^{b}	8.43^{ij}	26.07	5.07^{a}	46.03
Oxadiazon + one hand weeding	109.10^{bc}	11.47^{de}	8.71^{e}	1.76^{bc}	157.80^{cd}	9.00^{hij}	26.24	4.95^{ab}	43.50
S(x)	1.77	0.59	0.37	0.25	1.98	0.99	0.15	0.10	0.77
CV (%)	2.00	6.66	6.96	12.56	2.35	13.10	1.57	4.59	2.61
LS	**	**	**	*	**	**	NS	**	NS

** Significant at 1% level, * Significant at 5% level, S(x) = standard error, CV= Co-efficient of variance, LS= Level of significant

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