GROWTH AND YIELD RESPONSES OF VEGETABLE COWPEA (*VIGNA UNGUICULATA* (L.) WALP.) VARIETIES TO LIME RATES IN ACID SOIL OF SOUTH EASTERN NIGERIA

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ABSTRACT
The amendment of acidic soil with lime application enhances nutrient availability for optimum vegetable cowpea production. Field experiments were conducted in the teaching and research farm of Michael Okpara University of Agriculture, Umudike during 2006 and 2007 cropping seasons to determine the growth and yield responses of three vegetable cowpea varieties, IT93K-915 (white seeded and climbing vines), IT86D-880 (brown seeded and erect vines) and *Akidi ani* (black seeded and spreading vines) to five rates (0, 0.5, 1.0, 1.5 and 2.0 t//ha) of lime ($Ca(OH)_2$). The experiment was laid as a 3 x 5 factorial in randomized complete block design (RCBD) and replicated three times. Liming progressively increased the soil pH, most of the growth and yield attributes, such as percentage germination, number of nodules per plant, number of branches per plant, number of leaves per plant, vine length, fresh pod weight, fresh and dry pod yields, grain yields/ha and 100-seed weight. Lime application at 2.0 t/ha and 0 t/ha performed best and poorest in terms of the growth and yield of the vegetable cowpea respectively. The variety, IT860D-880 produced highest fresh pod and grain yields per hectare whereas IT93K-915 and *Akidi ani* had more number of branches and leaves. The application of 2.0 t/ha lime to IT86D-880 produced heaviest fresh pods, more seeds per pod and highest grain and fresh pod yields in both 2006 and 2007. The combination, therefore, is recommended for farmers in this area as the results suggest that the amendment of the acidic soil with lime application increased the soil pH which could have enhanced nutrient availability for the optimum vegetable cowpea production especially the improved variety, IT86D-880.

Keywords: Vegetable cowpea, lime, variety, fresh pod, grain yield, 100-seed weight.

INTRODUCTION
Cowpea (*Vigna unguiculata* (L.) walp) is a nutritious annual leguminous crop whose role in the tropics in terms of human nutrition, livestock nutrition and soil fertility cannot be overemphasised (Onwerenmadu *et al*., 2003). Two genotypes of vegetable cowpea exist in the farming systems of southeastern Nigeria namely those with climbing habit called *Vigna unguiculata* subspecies *sequipedalis* (Redden, 1981) commonly called "*Akidi enu*" and those with prostrate habit referred to as *Vigna unguiculata* subspecies *dekintiana* and *mensensis* commonly known as "*Akidi ani*" (Steele and Mehra, 1980). Grain type cowpea varieties produce short pods with more number of seeds and mature early whereas vegetable type varieties produce long pods with less number of seeds and mature late and the pods remain tender and soft for longer period. Vegetable cowpea is a cheap source of protein from plant as compared to egg, milk and meat which are costly protein sources from animal. It is also an important source of vitamin B. It constitutes a significant proportion of the total dietary protein intake of Nigerians (Davio *et al*., 1976). Cowpea is also characterized as a soil regenerative crop because it provides its own nitrogen requirements and supplies nitrogen to other succeeding crops through effective nitrogen fixation to the tune of 60-70 kg/ha (Singh and Rachie, 1985). The utilization of vegetable cowpea for leaf and pod consumption may provide nutritional and harvest versatility not available with other vegetative crops like lettuce and cabbage (Bubenheim *et al*., 1990). The fresh vegetable cowpea pods are snapped into small pieces and boiled with the young shoot to a soft consistency and served with yam or any other carbohydrate food and palm oil (Uguru, 1996).

Low intake of vegetable protein is one of the most serious defects of dietary protein in the South Eastern States of Nigeria. Ezueh and Nwoffia (1984) reported that about 5 g per person per day is taken in the western States of Nigeria while daily intake in the east is less than 2 g per person, far below the daily requirement of the vegetable protein which is over 100 g. Most of the information on cowpea in Nigeria is on the grain cowpea. Vegetable cowpea belongs to the group called "neglected legumes". They are grown by resource-poor farmers I South Eastern. Information on the crop is scarce and mostly on the agronomy (Udealor, 2002 and Ano, 2006).

Under the characteristically intense rainfall and rapid mineralization as experienced in the South Eastern Nigeria, the organic matter level of the soil falls drastically and consequently there is loss of some nutrients, especially the cations which lowers the soil pH (Uduma and Eka, 2006). Soil acidity has effect on nutrient availability because many soil elements change form that may be unavailable to the crop roots. For example, soil acidity causes the fixation of phosphorus by the oxides of aluminum and iron to form a complex that is insoluble (Lee *et al*., 2007). Acid soil inhibits the growth of most organisms including many bacteria and earthworm thus acid soil slows many important activities carried on by soil microbes including nitrogen fixation, nitrification and organic matter decay (Ahmed and Tan, 1986). Yield of some crops including cowpea are reduced in acid soils (Chandhari and Das, 1994). When lime is applied to an acid soil, the liming material react with the acid soil, with calcium and magnesium ions and raises the percentage base saturation of colloidal complex and the pH of the soil increases correspondingly (Brady, 1990).

Optimum liming rate for different soil and crop is necessary for profitable farming to avoid wastage of lime or reduction in crop yield (IITA, 1988). There is a dearth of information on the effects of liming rates on the growth and fresh pod yield and yield components response of vegetable cowpea. The objectives of the study therefore, are: (a) to determine the optimum rate of lime for the growth and yield of three vegetable cowpea varieties (b) to determine the variety that gives the highest fresh pod and seed yields.

MATERIALS AND METHODS

The experiment was carried out in the teaching and research farm of Michael Okpara University of Agriculture, Umudike during 2006 and 2007 cropping seasons. Umudike is located at 05° 29´ latitude, 07° 33´ longitudes and 122 m altitude. The soil was a sandy loam ultisol derived from coastal plain sand with acidic reaction and low soil fertility (low total nitrogen, phosphorus, moderate potassium and low organic matter) (Table 1).The experimental sitet is within the tropical rainforest agro-ecological zone of Nigeria with average rainfall of 2200 mm per annum.

Three vegetable cowpea varieties, IT93K-915 (white seeded and climbing), IT86D-880 (brown seeded and erect) and *Akidi ani* (local improved, black seeded and spreading) were used for the study. The improved varieties were obtained from the International Institute of Tropical Agriculture (IITA), Ibadan, Oyo State, Nigeria whereas the local variety was obtained from the University of Nigeria, Nsukka, Enugu State, Nigeria.

In both the first and second cropping seasons, the experimental sites were ploughed and harrowed. Soil samples from ten different spots, at a depth of 0-15 cm, were collected from the plots. They were bulked into a composite sample for physicochemical analysis. The experiment was laid out as a 3 x 5 factorial in randomized complete block design (RCBD) replicated three times. The varieties (IT93K-915, IT86D-880 and *Akidi ani*) and lime, $Ca(OH)_2$ rates (0, 0.5, 1.0, 1.5 and 2.0 t//ha) represented the factors. The lime rates were applied to the plots, after which the three vegetable cowpea varieties were sown according to the treatment allocation. The plant spacing was 60 cm x 30 cm which gave a plant population of 55, 555 plants per hectare although two seeds were actually sown per stand and later thinned to one plant per stand.

Weeding was done manually using hoe at 4 and 8 weeks after planting (WAP). Rodents were controlled by fencing the plots with roofing metal sheet to a height of 50 cm in both cropping seasons. Karate 2.5EC was

sprayed at 2 mls per litre of water at 3 and 5 WAP to control *Ootheca mutabilis*, a leaf eating beetles which attacked the crops.

Soil samples were collected from the various plots four (4) weeks after lime application and analyzed to determine the lime effects on soil pH (Table 3). Eight plants from the two middle rows were randomly selected, out of which four plants were further selected for fresh pod yield data and the remaining four plants for the dry pod yield parameters. The data collection included germination percentage, days to 50% flowering, number of branches per plant, number of branches per plant at 10 WAP, number of nodules per plant at 6 WAP, total leaf and nodule dry weight at 10 and 6 WAP, respectively, number of fresh pods per plant, pod length, fresh pod weight per plant and fresh pod yield per hectare. Harvesting of fresh pods was done fortnightly starting from 8 WAP. The dry pod harvesting was done when the pods had become physiologically ripe and turned brown. The following dry pods parameters were taken – number of dry pods per plant, number of seeds per pod, 100-seed weight and grain yield per hectare. Three plants per plot were randomly selected from the border row each plot for dry matter yield determination and were wrapped in envelop and oven dried at 70°C for 48 hours to obtain the total dry weight. Statistical analysis was performed each year on the data according to the procedures for factorial experiment in RCBD using GENSTAT (2003). Comparison of treatment means for significance was done using Least Significance Difference (LSD) procedure at 5% probability level.

RESULTS AND DISCUSSION

Effect of liming on soil pH

There was a progressive increment in soil pH with increase in lime rate in both 2006 and 2007 (Table 2). Liming at 2.0 t/ha however, significantly increased the soil pH (6.72 and 6.53 in 2006 and 2007 respectively) more than the other liming rates. The pH increment were 12.86% and 13.70% with 2.0 t/ha lime application respectively in 2006 and 2007 compared to no lime application. The pH increments in 2006 and 2007 fall within the medium to neutral pH range recommended for cowpea growth and yield in the tropics (Udo *et al*., 2005) because rhizobia that fix nitrogen do best on neutral pH soils. Ikeorgu (1999) noted that liming application and fertilizer supply are important options for farmers to adopt to improve yield in most soils of South Eastern Nigeria. Liming is associated with phosphorus availability which consequently promotes root development, nitrogen metabolism, initiation of generative organs and grain formation.

Effect of lime on cowpea growth characteristics

The percentage germination, number of nodules per plant, nodule dry weight per plant, days to 50% flowering and number of leaves per plant varied significantly ($p<0.05$) with lime rate in both 2006 and 2007 cropping seasons (Table 3). The percentage germination, number of nodules per plant, nodule dry weight per plant, number of branches per plant, number of leaves per plant and vine length increased progressively with lime application up to 2.0 t/ha across the cowpea varieties. It took more days for the crops to reach 50% flowering at 0 t/ha lime application. Amarasiri and Olsen (1973) observed that liming creates suitable non-toxic soil environment which enhances the solubility and availability of essential nutrients for enzyme reactions, root development and seed germination. This soil conditions would have eventually enhanced healthy vegetative growth of the crop. Howieson *et al*. (1993) also noted that liming increased the nodulation and growth of nodules in leguminous plants. However, the high number of nodules even when lime was not applied suggested the availability of infective rhizobia in the experimental soil. All these explained while liming rate significantly increased the vegetative characteristics of the vegetable cowpea varieties.

Effect of variety on the growth characteristics of vegetable cowpea

In both cropping seasons, the variety, IT86D-880 (erect) performed significantly best among the varieties with respect to percentage germination, number of nodules per plant, and nodule dry weight per plant (Table 3). The number of nodules per plant in IT86D-880 was 11.41 and 16.03% higher than the mean number of nodules of the three varieties in 2006 and 2007 respectively. In 2007, IT93K-915(climbing) and *Akidi ani*

used more days (57 days in both cropping seasons) in all levels of liming to attain 50% flowering. However, the local variety, *Akidi ani* (spreading) produced more branches per plant, leaves per plant and longer vines in the two cropping seasons while IT86D-880 had the least branches, leaves and shortest vines. The difference in flowering days, number of leaves per plant and vine length might be due to the varietal differences.

Effect of lime on fresh pod yield and yield components of vegetable cowpea

There were variations in the fresh pod yield and yield components of vegetable cowpea as influenced by lime rates (Table 4). The number of fresh pods yield per hectare, fresh pod weight per plant, pod length, number of dry pods per plant, number of seeds, per pod, 100-seed weight, grain yield and total dry matter increased with increase in the lime rate. Lime application at the rate of 2.0 t/ha significantly produced highest fresh pod yield and yield components whereas plants that received no lime had lowest yield. For instance, the number of fresh pods per plant, number of seeds per pod and the fresh pod yield per hectare when 2.0 t/ha lime was applied respectively were 22.17 and 17.61, 13.00 and 12.78, 3.71 and 3.43 t/ha respectively in 2006 and 2007 cropping seasons whereas vegetable cowpea that received no lime respectively produced 15.94 and 14.86, 8.67 and 7.67, 1.35 and 1.25 t/ha for the number of fresh pods per plant, number of seeds per pod and the fresh pod yield per hectare in 2006 and 2007 respectively.

Effect of variety on fresh pod yield and yield components of vegetable cowpea

The improved variety, IT86D-880 produced heavier fresh pods per plant (50.60 and 47.60 g), more seeds per pod (14.30 and 13.43), longer pods (16.93 and 24.77 cm) as well as higher fresh pods (2.78 and 2.62 t/ha) and grain (0.97 and 0.83 t/ha) yields per hectare in 2006 and 2007 than the other varieties (Table 4). The number of fresh pod per plant was greatest in *Akidi ani*. The heaviest 100-seeds and higher total dry matter accumulation were produced by IT93K-915. This variety produced fewer branches, leaves, fresh and dry pods than the IT86D-880 and *Akidi ani*, hence there may not have been intra competition of photoassimilate which could have resulted in the accumulation of highest total dry matter.

Effect of lime rate x variety interaction on the growth, yield and yield characteristics of vegetable cowpea

There were interaction effects of lime rate and variety on nodules dry weight per plant in 2006 and 2007 (Table 5). Nodules dry weight across varieties increased as lime rate increased. Lime applied at 2.0 t/ha to IT86D-880 had the highest nodules dry weight of 1.47 g and 0.67 g in 2006 and 2007 respectively. In 2006, the 2.0 t/ha lime application to *Akidi ani* produced more leaves per plant (71) and longest vine length (227.83 cm). This combination also produced more branches per plant only in 2007.

All the fresh and dry yield parameters of vegetable cowpea were significantly influenced by the interaction of lime rate and variety (Table 6\). In 2006 and 2007, the fresh pod weight, number of seeds per pod, grain and fresh pod yield per hectare were highest when lime was applied at the rate of 2.0 t/ha to the IT86D-880. This could be as a result of its efficient partitioning of photoassimilates to the grains in view of its comparative fewer number of leaves and branches. The higher foliage volume of IT93K-915 and *Akidi ani* might probably have created intense intra plant competition for the assimilate at the expense of grain formation. The study was in corroboration with the report of Okpara *et al*. (2007) on the increased number of seeds per pod from the interaction of lime with soyabean varieties. Similarly, Nnoham (1986) reported increased in grain yield as lime was increased except that yield erratically decreased when 0.5 t/ha lime was applied but increased to nearly a tonne per hectare with 2.0 t/ha liming. Kang (1988) also reported significant increase in cowpea grain yield at liming rate of 0.25 to 1.0 t/ha whereas high rate of liming at 5.0 t/ha reduced nodulation and grain yield.

The local variety, *Akidi ani* had more fresh and dry pods per plant when it received 2.0 t/ha lime. The numbers of fresh and dry pods per plant respectively were 34.67 and 32.08 in 2006 and 24.58 and 29.00 in 2007. The heaviest 100-seed, however, was associated to IT93K-915 with 2.0 t/ha lime application in both

2006 and 2007. In a related study, Nwofia (2004) observed significant genotype differences in 100-seed weight of cowpea varieties.

CONCLUSION

The study showed that most growth and yield parameters across the different vegetable cowpea increased with increase in lime levels up to 2.0 t/ha. For optimum fresh pod and dry grain yield of vegetable cowpea especially in the characteristic acidic nature of Umudike area, the application of 2.0 t/ha lime to the IT86D-880 (improved variety with erect vines and brown seeds) were recommended.

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Table 1: Physicochemical properties of the study site for 2006 and 2007 cropping seasons.

Physical properties	**2006**	**2007**
Sand	72.80	70.80
Silt	8.70	10.70
Clay	18.50	18.50
Textural class	Sandy loam	Sandy loam
Chemical properties		
pH(H2O)	5.21	4.67
Nitrogen (%)	0.11	0.10
Organic carbon (%)	1.21	1.03
Organic matter (%)	2.09	1.77
Calcium ($cmolkg^{-1}$)	1.60	1.60
Magnesium ($cmolkg^{-1}$)	0.80	0.80
Potassium ($cmolkg^{-1}$)	0.29	0.16
Sodium ($cmolkg^{-1}$)	0.31	0.10
Phosphorus (ppm)	14.50	12.25
Exchangeable acidity	3.20	4.00
ECEC	6.20	6.66
Base saturation (%)	48.39	39.88

Table 2: Effect of lime treatment on soil pH (H_2O) in 2006 and 2007 cropping seasons.

	Soil pH (H_2O)		pH (H_2O) increase per rate of lime applied		
Lime rate (t/ha)	2006	2007	2006	2007	Mean
0	5.21	4.67	-	-	-
0.5	5.33	4.92	0.12	0.25	0.19
1.0	5.63	5.32	0.30	0.40	0.35
1.5	6.05	5.88	0.42	0.56	0.49
2.0	6.72	6.53	0.67	0.64	0.66
$LSD_{0.05}$	0.06	0.04			

Table 3: Effect of lime treatment and variety on the growth characteristics of vegetable cowpea in 2006 and 2007

	Percentage germination (%)	Number of nodules/plant	Nodule dry weight/plant (g)	Number of days to 50% flowering	Number of leaves/plant	Number of branches/plant	Vine length (cm)
	2006 cropping season						
Lime rate (t/ha)							
0.0	75.00	29.00	0.58	57.88	44.83	3.33	129.86
0.5	74.44	42.06	0.73	57.55	45.69	3.97	132.21
1.0	79.44	47.67	0.91	57.78	46.97	4.06	135.43
1.5	81.67	49.58	0.97	57.77	48.81	4.22	139.22
2.0	84.44	54.08	1.23	57.22	59.86	4.39	143.51
$LSD_{0.05}$	3.97	2.38	0.05	ns	1.24	0.40	3.11
Variety							
Akidi ani	79.67	36.65	0.62	57.87	55.45	4.80	211.79
IT86D-880	88.67	49.22	1.03	57.33	37.47	3.17	49.02
IT95K-915	68.67	46.67	1.01	57.73	54.78	4.02	147.33
$LSD_{0.05}$	3.08	1.84	0.04	ns	0.96	0.31	2.41
	2007 cropping season						
Lime rate (t/ha)							
0.0	85.56	28.61	0.26	57.78	37.67	3.81	99.64
0.5	86.11	42.33	0.39	57.56	39.89	3.81	101.36
1.0	87.22	44.44	0.43	56.89	42.36	3.78	103.70
1.5	87.22	47.03	0.46	55.67	44.83	4.19	106.80
2.0	88.89	51.86	0.56	56.44	50.64	4.47	109.61
$LSD_{0.05}$	Ns	1.54	0.02	0.52	2.86	0.27	2.32
Variety							
Akidi ani	86.33	33.93	0.31	57.20	46.65	4.57	142.45
IT86D-880	90.33	49.73	0.52	56.33	38.06	3.18	38.74
IT95K-915	84.33	44.90	0.44	57.27	44.97	4.28	131.48
$LSD_{0.05}$	2.37	1.20	0.02	0.40	2.22	0.21	1.80

Table 4: Effect of lime treatment and variety on the fresh pod yield and yield components of vegetable cowpea in 2006 and 2007.

	Number of fre pod/plant	Fresh pod weig (g)	Pod length (cm)	Number of dry pods/plant	Number of seeds/pod	100-seed wei (g)	Grain yiel (t/ha)	Fresh po yield (t/h
				2006 cropping season				
Lime rate (t/ha)								
0.0	15.94	24.50	11.50	14.81	8.67	7.83	0.47	1.35
0.5	17.14	30.44	12.24	15.58	9.67	8.34	0.61	1.68
1.0	18.83	38.06	13.13	17.14	10.64	8.80	0.75	2.09
1.5	20.14	47.25	14.27	18.17	11.72	9.47	0.93	2.60
2.0	22.17	67.50	16.16	19.83	13.00	10.50	1.24	3.71
$LSD_{0.05}$	0.42	2.51	0.88	0.35	0.63	0.44	0.05	0.14
Variety								
Akidi ani	29.18	33.08	7.67	27.08	6.83	6.03	0.64	1.82
IT86D-880	16.37	50.60	16.93	16.17	14.30	8.37	0.97	2.78
IT95K-915	10.98	40.97	15.78	9.85	11.08	12.57	0.79	2.25
$LSD_{0.05}$	0.33	1.94	0.68	0.29	0.48	0.34	0.04	0.10
				2007 cropping season				
Lime rate (t/ha)								
0.0	14.86	22.81	15.64	13.58	7.67	7.05	0.36	1.25
0.5	16.14	29.53	16.83	14.50	9.03	7.72	0.36	1.62
1.0	17.47	35.78	18.44	15.81	10.08	8.28	0.49	1.97
1.5	18.39	44.19	19.83	16.89	10.86	8.99	0.63	2.43
2.0	17.61	62.28	21.87	18.72	12.78	10.20	0.78	3.43
$LSD_{0.05}$	ns	2.41	0.90	0.69	0.63	0.44	0.05	0.13
Variety								
Akidi ani	24.58	29.00	14.15	24.77	6.87	6.05	0.59	1.63
IT86D-880	15.52	47.60	24.77	13.46	13.43	7.98	0.83	2.62
IT95K-915	10.58	39.55	16.65	9.47	9.95	11.32	0.68	2.16
$LSD_{0.05}$	2.86	1.87	0.70	0.54	0.49	0.34	0.04	0.15

Table 5: Interaction effect of lime rate x variety on nodule dry weight, number of leaves, branches, fresh pods/plant and vine length of vegetable cowpea in 2006 and 2007 cropping seasons

		Nodule dry weight (g		Number of leaves/plant		Number of branches/plant		Vine length (cm		Number of fresh pods/plant	
Variety	Lime rate (t/ha	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Akidi ani	0.0	0.41	0.19	49.58	38.67	4.17	4.08	198.8	137.1	24.00	22.42
	0.5	0.59	0.29	50.83	41.58	4.67	4.00	204.0	138.7	25.92	23.75
	1.0	0.64	0.31	52.00	44.67	4.67	4.00	209.8	140.8	29.50	26.25
	1.5	0.67	0.35	53.50	47.83	5.00	4.92	218.4	145.4	31.83	27.92
	2.0	0.77	0.39	71.33	55.50	5.50	5.58	227.8	150.0	34.67	22.58
IT86D-880	0.0	0.67	0.35	34.42	34.25	2.50	3.33	47.70	35.50	14.25	13.08
	0.5	0.81	0.48	35.00	36.08	3.33	3.00	47.95	37.12	15.17	14.58
	1.0	1.05	0.54	36.92	38.17	3.50	3.00	48.72	38.82	16.33	15.58
	1.5	1.12	0.56	38.42	39.58	3.17	3.25	49.74	40.20	17.08	16.42
	2.0	1.47	0.67	42.58	44.92	3.33	3.33	51.00	42.05	17.08	17.92
IT93K-915	0.0	0.65	0.24	50.50	40.08	3.33	4.00	143.0	126.2	9.58	9.08
	0.5	0.80	0.41	51.25	41.92	3.92	4.17	144.6	128.2	10.33	10.08
	1.0	1.03	0.44	52.00	44.25	4.00	4.33	147.7	131.4	10.67	10.58
	1.5	1.10	0.48	54.50	47.08	4.22	4.42	149.5	134.7	11.50	10.83
	2.0	1.46	0.64	65.67	51.50	4.39	4.50	151.7	136.7	11.50	12.33
$LSD_{0.05}$		0.09	0.03	2.14	ns	ns	0.47	5.39	ns	0.73	ns

Table 6: Interaction effect of lime rate x variety on nodule dry weight, number of leaves, branches, fresh pods/plant and vine length of vegetable cowpea in 2006 and 2007 cropping seasons.

		Fresh pod weight/plant (g)		Number of dry pods/plant		Number of seeds/pod		100-seed weight (g)		Grain yield (t/ha)		Fresh pod yield (t/ha)	
Variety	Lime rate (t/ha)	2006	2007	2006	2007	2007	2007	2006	2007	2006	2007	2006	2007
Akidi ani	0.0	19.58	17.33	22.75	20.92	5.67	5.55	5.17	5.07	0.37	0.31	1.08	0.95
	0.5	23.08	22.92	24.00	22.33	6.00	6.33	5.70	5.60	0.48	0.44	1.27	1.26
	1.0	32.50	27.67	27.33	24.92	7.00	6.83	6.07	6.00	0.64	0.56	1.79	1.52
	1.5	38.83	32.92	29.25	26.67	7.50	7.25	6.40	6.47	0.77	0.69	2.14	1.81
	2.0	51.42	47.17	32.08	29.00	8.00	8.58	6.83	7.10	0.96	0.97	2.83	2.59
IT86D-880	0.0	31.83	30.17	12.92	11.75	12.17	10.83	7.33	6.92	0.63	0.48	1.75	1.66
	0.5	38.42	37.08	13.50	12.50	13.00	12.25	7.83	7.40	0.76	0.63	2.11	2.04
	1.0	45.00	43.42	14.50	13.33	14.00	13.25	8.00	7.75	0.88	0.75	2.47	2.39
	1.5	55.00	54.42	14.33	14.08	15.00	14.17	8.83	8.18	1.08	0.90	3.03	2.99
	2.0	82.75	72.92	15.00	15.65	17.33	16.67	9.83	9.67	1.51	1.39	4.55	4.02
IT93K-915	0.0	22.08	20.92	8.75	8.08	8.17	6.83	11.00	9.17	0.43	0.28	1.21	1.15
	0.5	29.83	28.58	9.25	8.67	10.00	8.50	11.50	10.17	0.58	0.41	1.64	1.57
	1.0	36.67	36.25	9.75	9.17	10.92	10.17	12.13	11.08	0.72	0.57	2.00	1.99
	1.5	47.92	45.25	10.25	9.92	12.67	11.17	13.17	12.33	0.94	0.75	2.64	2.49
	2.0	68.33	66.75	11.25	11.50	13.67	13.08	14.83	13.83	1.25	1.14	3.76	3.67
$LSD_{0.05}$		4.34	4.17	0.65	1.20	1.08	1.09	0.76	0.77	0.09	ns	0.24	0.23