tant to greenhouse orthezia than the desirable Florida natives, *L. depressa* and *L. involucrata*. Unfortunately, many of the *L. camara* cultivars and similar-looking hybrids are not necessarily suitable for landscape use due to their leggy growth and/or seed production, making them aesthetically unattractive and potentially invasive. For example, the most resistant cultivar in this study, 'Dwarf Pink', is leggy and not particularly attractive in the landscape. However, *L. camara*-type cultivars such as 'Silver Mound', 'White', 'Patriot Dovewings' and 'Patriot Hot Country' are fairly resistant to greenhouse orthezia and are considered by the authors to be attractive and desirable landscape plants.

Due to its wide host range, the results obtained in this study were somewhat surprising considering the breadth of plant diversity upon which greenhouse orthezia feeds. The mechanism of resistance expressed by the various lantana cultivars to greenhouse orthezia is at this time unknown. In general, complex chemical and nutritive plant constituents (Bernays and Chapman, 1994) may be responsible for differences in host selection and colonization by greenhouse orthezia among the various cultivars. It is also possible that differences in physical attributes between lantana cultivars, such are tissue hardness, color, scent, and trichomes are responsible for observed differences.

In summary, in areas where greenhouse orthezia is a problem on cultivated lantanas, many of the *L. camara* cultivars and hybrids are fairly resistant to this pest. *Lantana depressa* and *L. involucrata*, and to a lesser extent, *L. montevidensis* and its hybrids, would be poor choices for use in areas where this pest is present. Care should be taken when selecting *L. camara* type cultivars to prevent the establishment of potentially invasive plants.

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Influence of Nitrogen and Bagging on Fruit Quality and Mineral Concentrations of 'BC-2 Fuji' Apple

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ADDITIONAL INDEX WORDS. fruit wrapping, high-density, *Malus domestica*, mineral nutrition, postharvest

SUMMARY. The influence of three rates of nitrogen (N) and fruit bagging on fruit peel and flesh mineral concentrations and fruit quality in 'BC-2 Fuji' apple (*Malus domestica* Borkh.) trees on Malling 9 (M.9) was studied. Increasing N application decreased fruit peel red color, fruit N, iron (Fe), and manganese (Mn). Fruit from trees receiving 10.72 oz (303.9 g) N per year had higher evolved ethylene and respiration during poststorage ripening tests. Bagging of fruit reduced fruit peel red color, soluble solids concentrations (SSC), and dry weight as compared to nonbagged fruit. Bagged fruit had higher N, potassium (K), and copper (Cu) than nonbagged fruit. Fruit peel had a greater percentage of dry weight, and higher concentrations of all tested minerals compared to fruit flesh.

Authors wish to express their appreciation to the Idaho Apple Commission and Washington State Tree Fruit Research Commission for their financial support of this project. The cost of publishing this paper was defrayed in part by payment of page charges. Under postal regulations, this paper must therefore be marked *advertisement* solely to indicate this fact.

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Fruit quality can be affected by several preharvest orchard cultural practices, particularly N fertilizer application. Neilsen et al. (1984) studied the influence of three regimes of orchard vegetation management and three rates of N fertilizer on fruit quality and leaf mineral concentrations of 'Golden Delicious' apple and reported that tree N was affected more by vegetation management than by rate of N applied. In that study, application of N at 160.8 lb/acre (180 $kg\cdot ha^{-1}$) increased leaf N and Mn, and reduced fruit peel color and firmness at harvest as compared to lower N treatments. Meheriuk et al. (1992) studied the influence of three rates of N fertilizer 26.8, 53.6, or 160.7 lb/acre (30, 60, or 180 $kg\cdot ha^{-1}$) on fruit quality and leaf mineral composition of 'Golden Delicious' and reported that higher rates of N tended to result in greener fruit, higher leaf N, and lower leaf K. Application of high N also increased leaf N, fruit N, fruit green color and internal ethylene in 'Starkspur Golden Delicious' apple in a high-density orchard (Fallahi et al., 1984a, 1984b, 1985a, 1985b). In a recent study with 'Scarlet Gala' apple, Fallahi and Mohan (2000) reported that fruit from trees that received 2.4 oz (68 g) actual N per tree in each year had better color than fruit from trees with higher rates of N.

Bagging apples for enhancing uniform pinkish-red color has been practiced in the last decades in Japan (Mink, 1973; Robinson, 1974). Bagging 'Fuji' apple has been practiced in a small portion of the apple industry in the Pacific northwestern United States for export market in the last decade. The bags used in these studies have an outer layer that is a light-blocking paper and an inner layer that is translucent green or red paper. The bags are put on the fruit about 2 months after full bloom. The outer layer is removed about 2 to 3 weeks before harvest and inner layer is removed 4 to 7 d later. Bagging has been reported to reduce fruit SSC and anthocyacnin in apples (Kume and Kudo, 1982; Proctor and Lougheed, 1976). Fan and Mattheis (1998) reported that fruit bagging delayed the increase in internal ethylene at the onset of fruit ripening, and increased the respiration rate early in the bagging period. Perring and Clijsters (1974) reported that bagging reduced fruit calcium (Ca) content in 'McIntosh' apple.

'Fuji' apple has gained popularity among consumers in recent years because of its pleasant taste and the ability of fruit to maintain firmness over a long period both in controlled-atmosphere and regular cold storage. 'Fuji' constitutes a growing portion of the new apple plantings in the Pacific northwestern United States. However, very limited information is available on the impact of N and fruit bagging on fruit quality and mineral concentrations in 'Fuji' apple. Therefore, the objective of this research was to study the influence of three ground applications of N and fruit bagging on fruit quality and maturity attributes (fruit size, color, SSC, firmness, ethylene evolution, and respiration), and fruit peel and flesh mineral concentrations of 'BC-2 Fuji' trees.

Materials and methods

The experimental orchard was located at the University of Idaho Parma Research and Extension Center, Parma, Idaho. The orchard site was not cultivated previously and had a fairly uniform soil profile. Soil type was a sandy loam with a pH of about 7.5.

Soil was plowed down to 20 inches (50.8 cm) prior to planting. Random soil samples indicated that no harmful nematodes were present. Uniform size [0.5 inches (1.27 cm) trunk diameter] 'BC-2 Fuji' apple trees on M.9 were obtained from C & O Nursery, Inc. (Wenatchee, Wash.) and planted at a 9 × 18 ft (2.74 × 5.49 m) spacing on 4 Apr. 1991. A microjet sprinkler irrigation system was installed with one riser per tree, located midway between every two trees. The orchard was irrigated based on monitoring soil moisture with water sensors.

A trellis system was installed and bamboo poles were used to support trees. Trees were topped at 28 inches (71 cm) from the ground after planting. The central leader was bent in June of every year in a zigzag pattern. Lateral branches were bent with strings and fastened to the main trunk at about 55° angle from vertical to initiate flower bud initiation.

Native soil of this orchard was very low in N, and the annual N release through mineralization was only about 0.1 oz (3 g) per tree. Therefore, 1.69 oz (48 g) of actual N per tree (as urea) was applied to all trees in a 2-ft (61-cm) radius around the trunk on 10 July 1991 (about 3 months after planting). Nitrogen was applied in a circle around the tree trunk with 2 ft radius in 1992 and 1993, 2.5 ft (76 cm) radius in 1994, and 3 ft (91 cm) radius in 1995 and 1996. Three rates of N (as urea) were applied in late October of every year during 1992 through 1996. In 1992, these rates were 0.96, 2.72, or 8 oz (27.2, 77.1, or 226.8 g) N per tree. In 1993 through 1996 the N rates were 1.12, 3.52, or 10.72 oz (31.8, 99.8, or 303.9 g) of N per tree in each year. In order to refer to the rates of N, only N rates of 1993 through 1996 will be mentioned throughout this manuscript.

Zinc-50 [(a zinc-containing compound 50% zinc (Zn)] was sprayed in the late dormant season (late March) every year at a concentration of about 0.38 oz/gal (3.1 $g\cdot L^{-1}$) to runoff. A 5-ft (1.52-m) herbicide strip was maintained along the tree rows. Other cultural practices were similar to those used in commercial apple orchards.

Experimental design was a split-split plot complete randomized design with three rates of soil applied N as main plots and two types of fruit cover (bagged or nonbagged) as subplots with 14 individual trees as replications (blocks).

Fourteen fruit from each tree were bagged with double-layer paper bags (Kobayashi Bag Manufacturing Co., Iida, Japan) in late June (about 2 months after full bloom). The outer layer of the bags was gray outside and black inside, whereas the inner layer of the bags was red. Bags on the bagged fruit remained on the fruit until harvest time. Both bagged and nonbagged fruit were harvested at commercial harvest (17 Oct.). Fruit were weighed and placed in perforated polyethylene bags. Fruit were stored at 30.2 °F (–1 °C) for 5 months and evaluated for quality and mineral analyses.

Eight fruit from each replication were used for quality evaluation and mineral analysis. Fruit color was rated visually on a scale of 1 = green, progressively to 5 = pinkish-red. Fruit firmness was measured on three peeled sides of each fruit by a penetrometer (Facchini, Alfonsine, Italy). These fruit then were cut equatorially. Stem-end half of the fruit at harvest was dipped in I–KI solution and the starch degradation pattern (SDP) for each fruit was recorded by comparison with the SDP standard chart developed for apples (Bartram et al., 1993). In this procedure, immature fruit have a SDP of 1.2 and very mature fruit have a SDP of 6.0. One wedge from the calyx-end half of each fruit was juiced, and SSC was measured by placing three to four

Table 1. Effects of three rates of nitrogen (N) on quality parameters and mineral concentrations of 'BC-2 Fuji' apples.[z]

Actual N [oz/tree (g/tree) each year]	Avg wt (g)	Color[y] (1–5)	Soluble solids concn (%)	Firmness (N)	Dry wt (%)	N [dry wt (%)]	K[x] [dry wt (%)]	Ca [dry wt (%)]	Mg [dry wt (%)]	Fe ($\mu g \cdot g^{-1}$)	Zn ($\mu g \cdot g^{-1}$)	Mn ($\mu g \cdot g^{-1}$)	Cu ($\mu g \cdot g^{-1}$)
1.12 (31.8)	212.25 a	2.27 a	13.58 a	67.17 a	16.30 a	0.26 b	0.76 a	0.057 a	0.045 a	5.76 b	2.03 a	2.35 b	3.84 a
3.52 (99.8)	189.13 a	2.00 b	13.44 a	65.61 a	16.15 a	0.32 ab	0.69 a	0.053 a	0.042 a	6.07 b	1.98 a	3.53 b	3.26 a
10.72 (303.9)	202.13 a	1.58 c	12.95 a	63.57 a	15.67 a	0.36 a	0.66 a	0.057 a	0.045 a	8.60 a	2.03 a	5.80 a	3.43 a

[z]Mean separation within columns by LSD at $P \leq 0.05$; 28.4 g = 1.0 oz, 1.00 $\mu g \cdot g^{-1}$ = 1.00 ppm.
[y]Fruit color: 1 = green progressively to 5 = pinkish red.
[x]K = potassium; Ca = calcium; Mg = magnesium; Fe = iron; Zn = zinc; Mn = manganese; Cu = copper.

drops of juice on a hand held, temperature-compensated refractometer (Atago N1, Tokyo, Japan). The rest of calyx end-half was washed in a mild solution of liqui-nox detergent, rinsed with deionized water three times, and peeled. Core area of the fruit was removed and remaining flesh tissue was cut in small pieces. Both peel and flesh tissues were weighed and dried to a constant weight in a forced-air oven at 149 °F (65 °C). Peel and flesh samples were reweighed after drying, and percent dry weight was calculated. Fruit dry tissues were ground to pass a 40-mesh screen, and were analyzed for N by the micro-Kjeldahl method (Schuman et al, 1973). Analyses for K, Ca, magnesium (Mg), Fe, Zn, Mn, and Cu in fruit tissues were conducted by dry ashing at 932 °F (500 °C), digesting with 10% HNO_3, and using an atomic absorption spectrophotometer (Perkin-Elmer B1100, Norwalk, Conn.) as described by Chaplin and Dixon (1974) and Jones (1977).

After 5 months of storage, five fruit of each replication were weighed and placed in a ripening chamber with a constant air flow rate of 80 $mL \cdot min^{-1}$ (0.021 gal/min), and evolved ethylene and respiration were measured over several days with a gas chromatograph (H.P. 5890 Series II; Hewlett Packard, Avondale, Pa.), equipped with flame ionization detector (FID) and methanizer.

Assumption of normality was checked by computing univariate analysis, and all parameters in this study had normal distributions. Analyses of variance were conducted by GLM procedure, using SAS (SAS Institute, Cary, N.C.), and means were compared by least significant difference (LSD) at $P \leq 0.05$. Since no major interaction between N rate and type of fruit cover (bagged and nonbagged) was observed in this study, only effects of treatments are reported here.

Results and discussion

EFFECTS OF NITROGEN TREATMENTS. Fruit color was reduced with every incremental increase in N application (Table 1). Trees receiving N at 10.72 oz per tree in each year had higher fruit N and poorer fruit color than those with 1.12 oz per tree (Table 1). The inverse relationship between fruit color and rate of N is consistent with the results of Raese and Drake (1997). Fruit with higher N perhaps contain higher chlorophyll, leading to greener fruit skin color. Fruit size, SSC, firmness, and percentage of dry weight were not affected by different rates of applied N (Table 1). Fruit K, Ca, Mg, Zn, and Cu were not affected by the rate of N, whereas fruit Fe and Mn in the trees receiving annual N at 10.72 oz per tree were higher than those with lower rates of N (Table 1). Simultaneous increase in leaf Mn as a result of N application was also reported in leaf tissue of 'Fuji' (Fallahi et al., 2001), which could be due to lower soil pH in the sites with repeated application of high rates of urea (Mengel and Kirby, 1979).

Evolved ethylene and respiration of fruit from every treatment showed a classic climacteric pattern, rising after 6 d and declining after 8 d in the ripening chambers (Figs. 1 and 2). This pattern suggested that fruit were at preclimacteric stage at the time of harvest. There was a significantly greater amount of ethylene release (Fig. 1) and higher respiration (Fig. 2) in fruit from the high N treatment as compared to low N. This finding has a major impact on harvest strategy of apples. When fruit are too green to be harvested, many growers delay harvest to gain red color. If the green color of fruit is due to excess N application, internal maturity of fruit as determined by ethylene and respiration, would increase, leading to an increased chance of internal breakdown in the storage. Therefore, monitoring evolved ethylene and respiration, together with other maturity and quality attributes, is essential to determine proper harvest time.

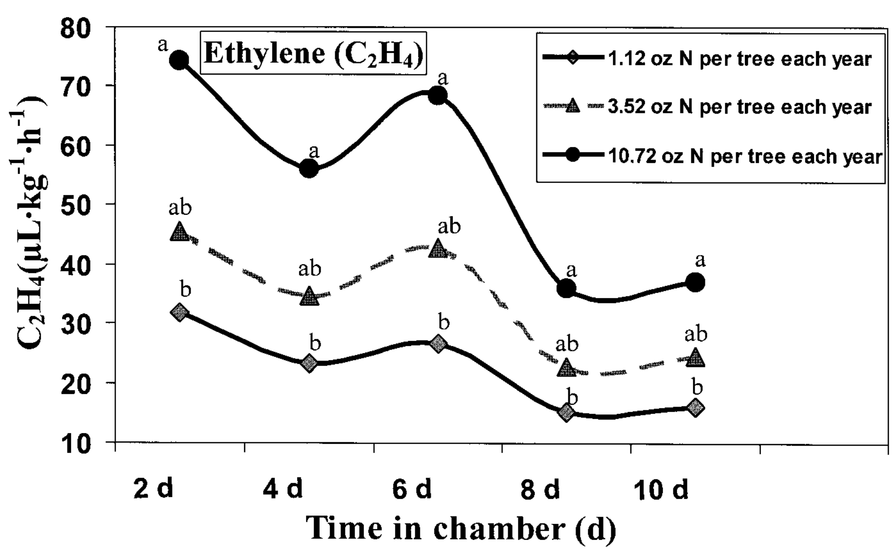

Fig. 1. Effect of nitrogen (N) on fruit-evolved ethylene (C_2H_4) in 'BC-2 Fuji' apples. Means within each day in the chamber for ethylene or respiration were separated with LSD at $P \leq 0.05$; 1.00 oz = 28.4 g.

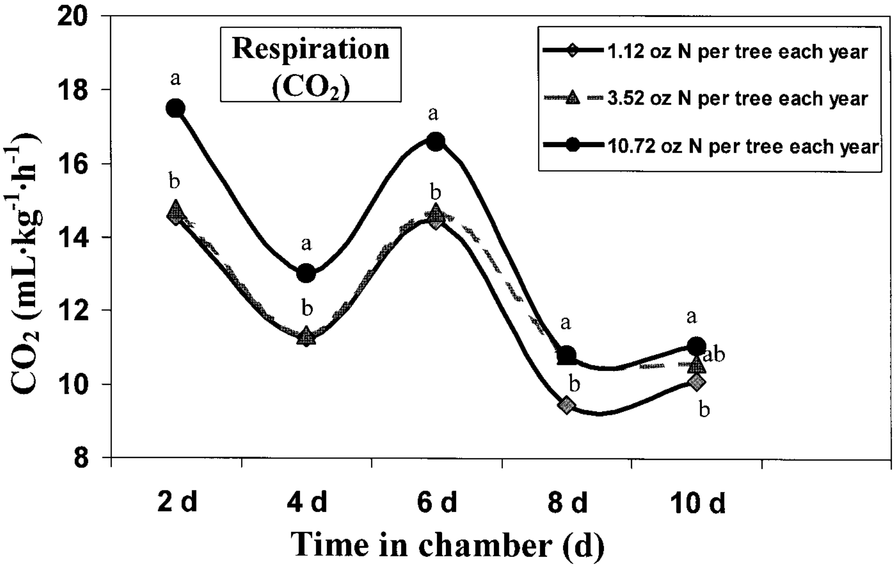

Fig. 2. Effect of nitrogen (N) on fruit respiration (CO_2) in 'BC-2 Fuji' apples. Means within each day in the chamber for ethylene or respiration were separated with LSD at $P \le 0.05$; 1.00 oz = 28.4 g.

EFFECTS OF FRUIT BAGGING. Bagged fruit had greener color and lower SSC and percentage of dry weight than nonbagged fruit (Table 2). However, fruit size and firmness were not affected by fruit bagging. Fruit N in bagged fruit was (about 18%) higher than nonbagged fruit, which could have contributed to the lack of red pigment development in the bagged fruit. After five months of cold storage, bagged fruit always had lower evolved ethylene than nonbagged in growth chambers although differences were not statistically significant (data not shown). This result is similar to that of a previous report by Fan and Mattheis (1998). Bagging did not influence fruit respiration after cold storage (data not shown).

Fruit K and Cu concentrations in bagged fruit were higher than those of nonbagged fruit. Fruit bagging did not affect other fruit minerals.

Fruit bagging is a labor-consuming practice and is only justified when market demand is high and return offsets the expenses.

EFFECTS ON FRUIT TISSUE. Fruit peel had a higher percentage of dry matter and higher concentrations of all tested mineral elements than flesh tissue (Table 3), which is in agreement with previous results in 'Delicious' and 'Granny Smith' apples (Drake et al., 1997). Based on this result, it would be better to analyze peels separate from the flesh tissue when testing for potential nutrient deficiency of minerals, particularly Ca and N. Fruit disorders such as loss of firmness and bitter pit could be better correlated with the flesh than peel tissues. We suggest that combining flesh with peel could lead to misinterpretation of mineral analysis results. Presence of higher concentrations of minerals in the peel also suggests that consuming apples with the peel would be more nutritious than eating only the flesh part.

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Table 2. Effect of bagging on quality parameters and mineral concentrations of 'BC-2 Fuji' apples.[z]

Fruit cover	Avg wt (g)	Color[y] (1–5)	Soluble solids concn (%)	Firmness (N)	Dry wt (%)	N [dry wt (%)]	K[x]	Ca	Mg	Fe ($\mu g \cdot g^{-1}$)	Zn	Mn	Cu
Bagged	205.35 a	1.00 b	12.95 b	65.79 a	15.50 b	0.34 a	0.77 a	0.057 a	0.048 a	6.57 a	2.00 a	4.18 a	3.72 a
Nonbagged	199.56 a	2.93 a	13.71 a	65.21 a	16.60 a	0.28 b	0.65 b	0.055 a	0.042 a	7.03 a	2.03 a	3.47 a	3.36 b

[z]Mean separation within columns by LSD at $P \le 0.05$; 28.4 g = 1.0 oz, 1.00 $\mu g \cdot g^{-1}$ = 1.00 ppm.
[y]Fruit Color: 1 = green progressively to 5 = pinkish red.
[x]N = nitrogen; K = potassium; Ca = calcium; Mg = magnesium; Fe = iron; Zn = zinc; Mn = manganese; Cu = copper.

Table 3. Effects of fruit tissue on mineral concentrations of 'BC-2 Fuji' apples.[z]

Fruit tissue	Dry wt (%)	N[y] [dry wt (%)]	K	Ca	Mg	Fe ($\mu g \cdot g^{-1}$)	Zn	Mn	Cu
Peel	17.45 a	0.34 a	0.77 a	0.093 a	0.069 a	11.05 a	3.19 a	6.70 a	5.10 a
Flesh	14.65 b	0.28 b	0.64 b	0.018 b	0.014 b	2.53 b	0.84 b	0.96 b	1.98 b

[z]Mean separation within columns by LSD at $P \le 0.05$; 1.00 $mmg \cdot g^{-1}$ = 1.00 ppm.
[y]N = nitrogen; K = potassium; Ca = calcium; Mg = magnesium; Fe = iron; Zn = zinc; Mn = manganese; Cu = copper.

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The Effect of School Gardens on Children's Interpersonal Relationships and Attitudes Toward School

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ADDITIONAL INDEX WORDS. **gardening, environmental education, children's horticulture, horticultural therapy, elementary education, outdoor education**

SUMMARY. **Children's gardens are receiving increased attention from communities and schools. Educators recognize that gardens provide beauty, produce and education, and serve as an outlet in which gardeners may gain personal benefits. The objectives of this research study were to evaluate whether children participating in garden activities benefited by an improvement in interpersonal relationships and attitudes toward school. No significant differences were found between pre- and posttests and the control and experimental group comparisons. However, demographic comparisons offered interesting insight into trends in the data. Female students had significantly more positive attitudes towards school at the conclusion of the garden program compared to males. The results also showed that there were differences in interpersonal relationships between children depending on grade level in school. In addition, childrens' attitudes toward school were more positive in schools that offered more intensive individualized gardening.**

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Nature and gardening have been thought to have physical and psychological benefits for decades (Watson and Burlingame, 1960). Research has shown that gardens provide adults with psychological benefits (Kaplan, 1973; Shoemaker, 1982; Soleri, 1986), yet research on children has focused more towards outdoor environments in the form of nature camps. This research has indicated outdoor environments can enhance mental health of youth (Dressner and Gill, 1994; Hanson, 1977; Kaplan, 1977). However, research in the area of gardening and its effect on children and adolescents is limited.

The purpose of this research was to determine if the integration of the Project GREEN school garden program (Waliczek and Zajicek, 1996) into school curriculum positively influenced interpersonal relationships and attitudes toward school of participating students.

Materials and methods

GARDENING ACTIVITIES. The Project GREEN Activity Guide: Book 1, Math and Science (Waliczek and Zajicek, 1996) was developed for elementary and junior high math and science school teachers to integrate into the classroom curriculum. It was divided into six units that each consisted of an introduction and individual learning experiences with several objectives and a variety of activities (Skelly and Zajicek, 1998). The activities did not build upon each other, and their use as supplemental material within lesson plans was left up to the discretion of each participating teacher.

POPULATION. The study was conducted during the 1995–96 school term. The research was in collaboration with schools in Texas and Kansas. Seven schools and 598 students were included in the study. The participating students volunteered and were from grades two through eight. The experiment consisted of both a control and an experimental group. Students in the experimental group participated in the Project GREEN garden program throughout the spring semester 1995. These students were pretested at the start of the spring semester in January and posttested at the end of the gardening season in May. Students in the control group were obtained from the norming population of the testing instrument used in the study.

INSTRUMENTATION. The Behav-