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Allelopathic Potential of Purple Nutsedge (*Cyperus rotundus* L.) and Barnyardgrass (*Echinochloa crus-galli* (L.) Beauv.) on Corn (*Zea mays* L. cv. Tainung No.1). II. Weed residue Effects on Corn Emergence and Seedling Growth[1]

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Abstract: Field-grown mature plant residues (debris) of purple nutsedge and barnyardgrass were incorporated into the soil to determine their allelopathic potential on the emergence and seedling growth of corn. Influence of temperature on the magnitude of weed residue effects was also investigated. It was found that soils incorporated with weed residues reduced both the cumulative and the maximal emergence rates of corn at 20 and 25°C but not at 33°C of purple nutsedge treatment. Plant height of corn was enhanced by the increasing temperatures but was retarded in the weed residue-incorporated soils. After one week from planting, high temperature increased plant growth, and hence the total plant and root weights. Effects of weed residue on plant weight, as on plant height, depended on residue percentage in the soil in both weeds-a descending trend with the increasing amount of weed rseidues, while a reverse fashion was found on root weight. It was further confirmed from the results of root/shoot weight ratio (r/s ratio) that shoot growth was more stimulated than root growth by higher temperatures. The r/s ratio was increased when the amount of weed residues in the soil was raised. The results suggested that the best strategy to reduce the effects of residues of purple nutsedge and barnyardgrass on corn emergence and seedling growth was to apply the weed control practices before planting.

Key words: allelopathic potential, purple nutsedge, barnyardgrass, corn, weed residue effect, temperature, emergence, seedling growth

Introduction

In the earlier report of this series of studies, extracts of field-grown mature plants of purple nutsedge and barnyardgrass were shown to inhibit germination of corn seeds (Yang, 1991). Whether plant residues of these weed species incorporated into the soil affect

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corn emergence and its early growth yet to be known, which would present the strongest evidence for the allelopathic potential of these weeds on corn. Knowledge of such weed interference on crop emergence and growth is also required for developing effective weed management programs. Friedman and Horowitz (1971), Horowitz and Friedman (1971) and Singh et al. (1970) found that purple nutsedge tubers produced phytotoxic substances inhibiting the growth of other plants in the neighboring areas. Elmore (1985) also pointed out that radish was affected by live, growing purple nutsedge. In a field study, Bhowmik and Reddy (1988) found that barnyardgrass reduced marketable fruit number and fruit weight of tomato. Additionally, barnyardgrass was found as a prevalent weed in some row and forage crops (Dawson, 1963). Many weed species such as palmer amaranth (*Amaranthus palmeri* S. wats.), broadleaf signalgrass (*Brachiaria platyphylla* Griseb. Nash), fall panicum (*Panicum dichotomiflorum* Michx.), crimson clover (*Trifolium incarnatum* L.) and quack-grass (*Agropyron repens* (L.) Beauv.) were found to exhibit the allelopathic effects on crops growth (Johnson III and Coble, 1986 ; Menges, 1987, 1988 ; Weston and Putnam, 1986 ; White *et al.*, 1989).

The purpose of this research was to investigate the effects of plant residuse of purple nutsedge and barnyardgrass on corn emergence and seedling growth. The influences of temperature and rseidue percentage in the soil were also evaluated.

Materials and Methods

Field-grown mature plants of purple nutsedge and barnyardgrass were collected from the experimental plot at Taiwan Agricultural Research Institute (TARI, 24°02′ N, 120°40′ S, elevation 85 m) and were oven dried at 80°C for 96 h and chopped. The soil, contained 50.8% silt, 31.3% sand, and 17.9% clay and a pH of 5.2, was a silt loam sampled from TARI, the site of which had no herbicide application or crops growth for 12 months. Soil was oven dried at 120°C for 48 h and screened to pass a 2-mm sieve.

Certified commercial corn seeds were obtained from Taiwan Seed Service (Ta-nan village, Shinshieh, Taichung, Taiwan, ROC) and were sterilized by soaking in a 5% (v/v) sodium hypochlorite solution for 3 min to reduce fungal infection. The sterilized seeds were then rinsed with double distilled water for 1 min three times and allowed to air-dry before planting.

Oven-dried and chopped weed debris was incorporated into the soil at rates of 0, 1.75, 2.5 and 5% on w/w basis, respectively. The plastic containers used were 45 cm×35 cm×13 cm (L×W×D). Fifteen seeds of corn were planted with evenly spaced into the soil with a planting depth of 2 cm. The containers were placed in the growth chambers with circulated ambient air, an average photosynthetic photon flux density (PPFD) of 500 μ mole $m^{-2}s^{-1}$ and photoperiod of 12 h at constant temperature of 20, 25, and 33°C, separately, and were watered daily to moisten the soil. The emerged seedling number, plant height, and plant weight (oven dried at 80°C for 72 h) were recorded, and the root/shoot weight ratio was calculated from the dry weights of root and shoot (leaf plus stem). Treatments were replicated 4 times using a randomize complete block and the standard errors of the means were computed.

Results

Cumulative emergence rates of corn seeds planted in the soils incorporated with mature plant residues (debris) of purple nutsedge and barnyardgrass under different temperatures were shown in Figs. 1 and 2, respectively. As indicated the seedling emergence was stimulated by higher temperatures in all cases, while the residues modifies its performance. It took about 6 days for 20°C and 25°C treatments to reach the climax of emergence but about 3 days for 33°C treatment. Soils incorporated with weed residues reduced both the calculated cumulative and the maximal emergence rates at 20 and 25°C but not at 33°C of purple nutsedge treatment.

Changes of plant height of corn after planting were illustrated in Figs. 3 and 4. It showed that plant height of corn was enhanced by the increasing temperatures and was also retarded in the weed residue-incorporated soils. Reduction of plant height of corn depended on the amount of weed residues in the soil. To further delineate temperature and weed residue effects, plant heights measured at 1, 2 and 3 weeks after planting were graphed in Figs. 5, 6 and 7, respectively. It appeared that temperature effect on plant height was significant, especially at 33°C.

Alterations of plant and root dry weights of corn after planting were plotted in Figs. 8 and 9 and the results of root/shoot (leaf + stem) weight ratio were listed in Table 1. In general, high temperature increased plant growth, and hence the total plant weight and root weight, but not in the first week after planting (Figs. 8 and 9). Effects of weed residue on plant weight were varied. In both weed species, higher residue percentages in the soil reduced the total plant dry weight from 1 to 3 weeks after planting. On the other hand, root dry weight was increased by weed residues treatment. Higher percentages of residues were found to stimulate root growth of corn. The root/shoot weight ratio was increased when the amount of weed residues in the soil was raised, whereas high temperature resulted in decreasing of the ratio (Table 1).

Discussion

Purple nutsedge and barnyardgrass inhibit crop growth and yield in the field (Bhowmik and Reddy, 1988 ; Elmore, 1985 ; Keeley, 1987 ; Kondap *et al.*, 1982 *; Meissner et al.*, 1977, 1982 ; *Stauber et al.*, 1991*)*. None of them, however, demonstrated these weeds' effect on corn emergence and seedling growth, which is one of the important evidence support the existence of allelopathic interference of these weeds on corn.

In this research, results indicated that soils incorporated with plant residues (debris) of purple nutsedge and barnyardgrass affect corn emergence rate. At 33°C, corn seeds emerged from purple nutsedge-incorporated soil reached nearly 100% but not in barnyardgrass-treated soil. Toxic substances released from the residues of both weeds inhibit corn emergence, as well as germination (Yang, 1991), and temperature above 20°C help to compensate the inhibition effect caused by weed residues. At temperature of 33°C, it may surpass weed residue effect in purple nutsedge-incorporated soil.

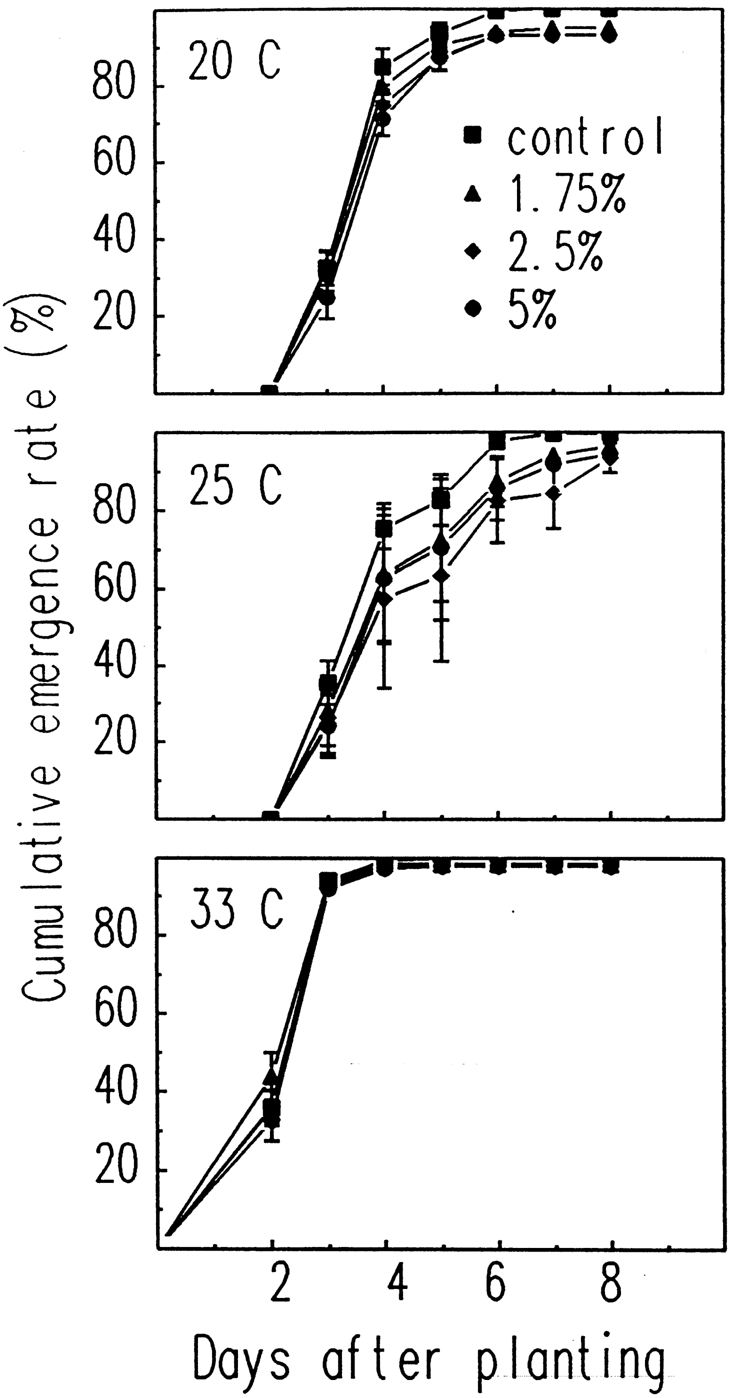

Fig. 1. The cumulative emergence rate of corn treated with field-grown mature plant residues of purple nutsedge under different temperatures. Standard errors of the means are included.

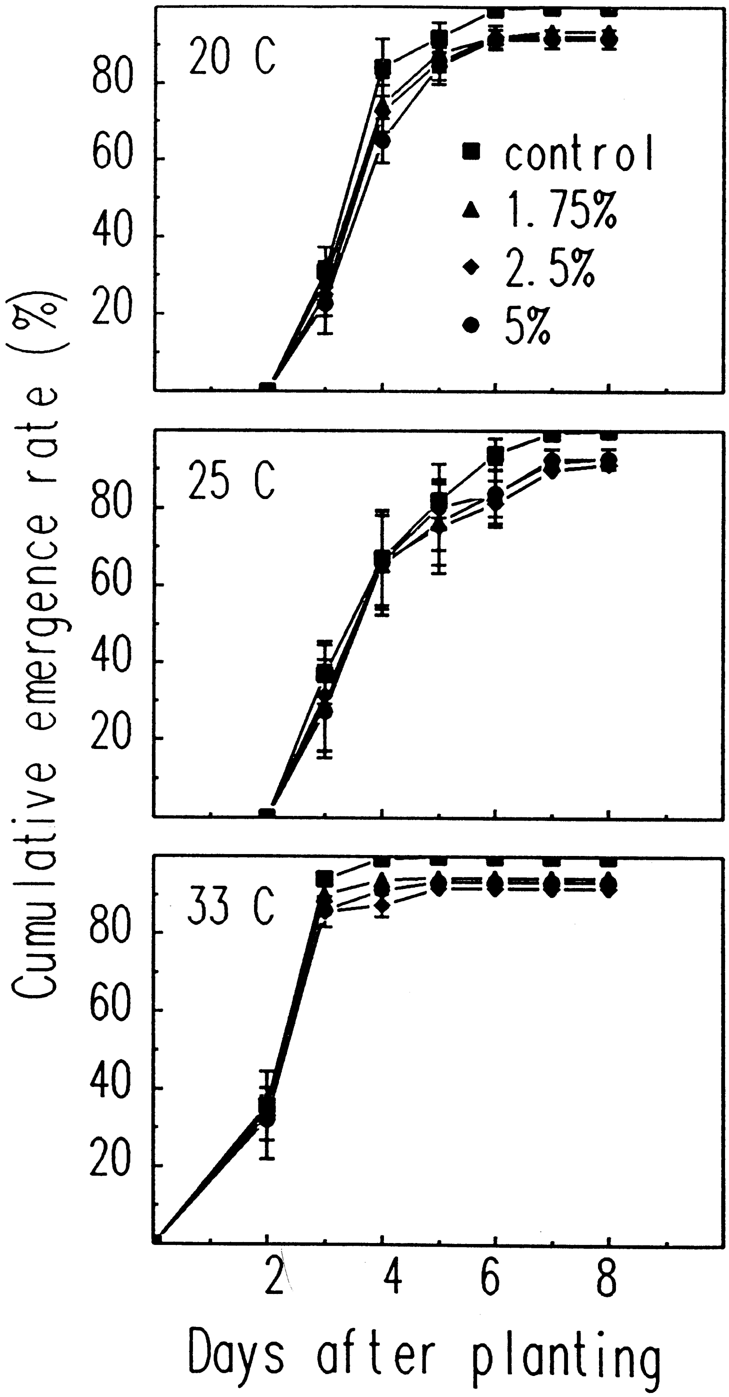

Fig. 2. The cumulative emergence rate of corn treated with field-grown mature plant residues of barnyardgrass under different temperatures. Standard errors of the means are included.

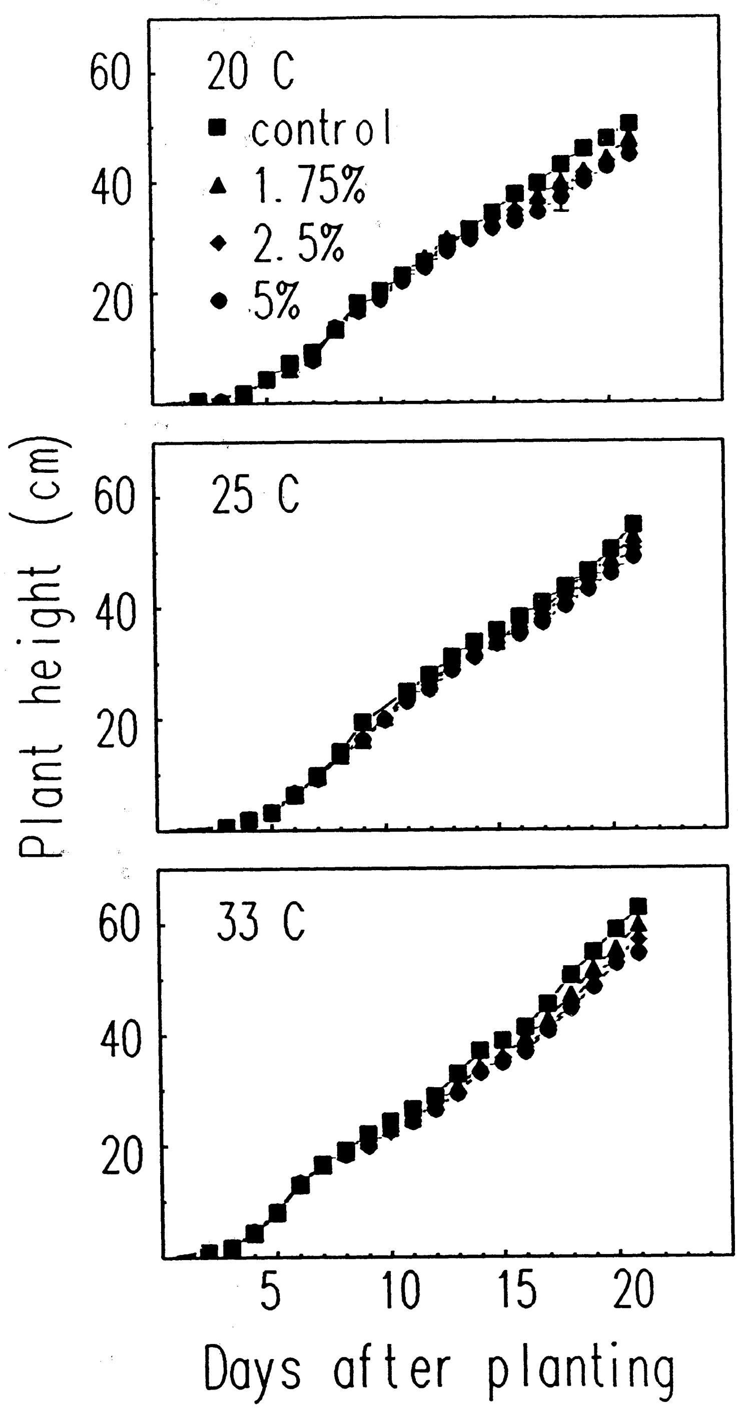

Fig. 3. Plant height of corn treated with field-grown mature plant residues of purple nutsedge under different temperatures.

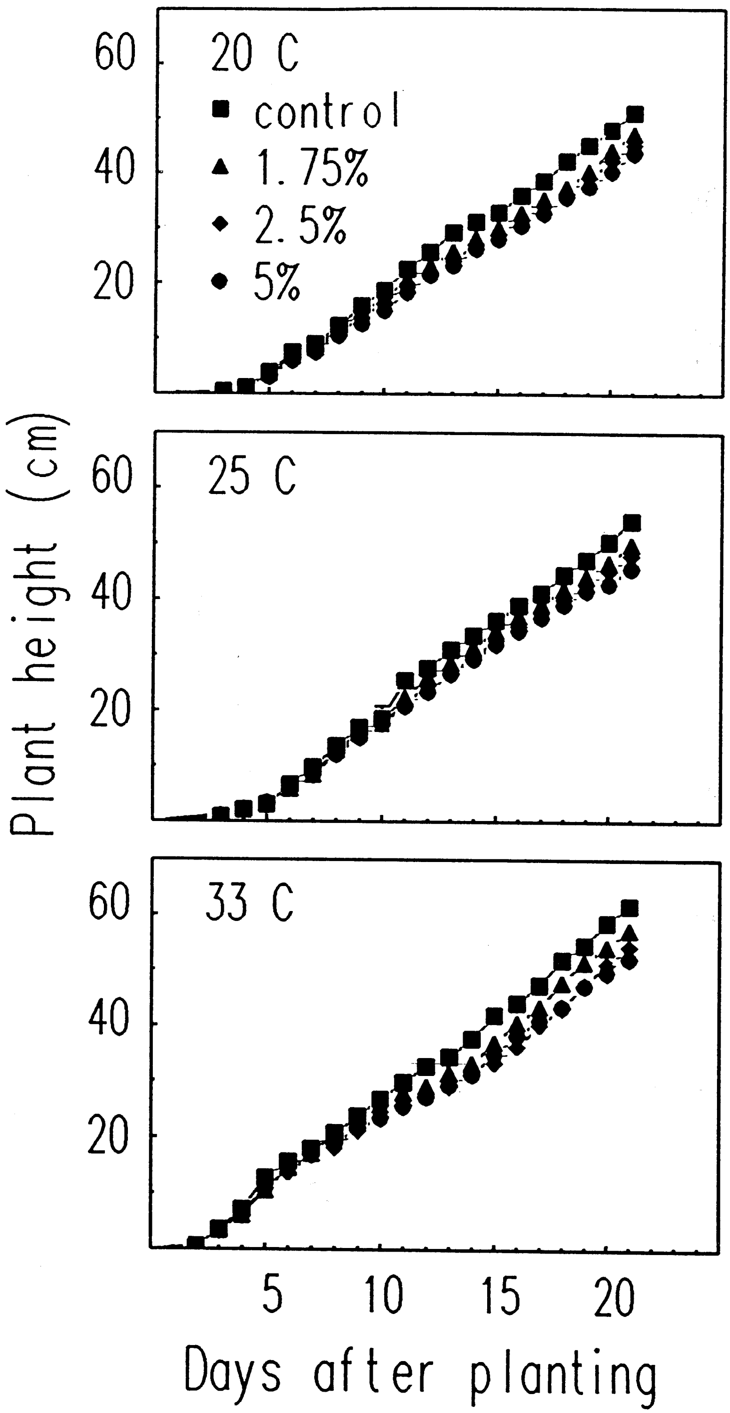

Fig. 4. Plant height of corn treated with field-grown mature plant residues of barnyardgrass under different temperatures.

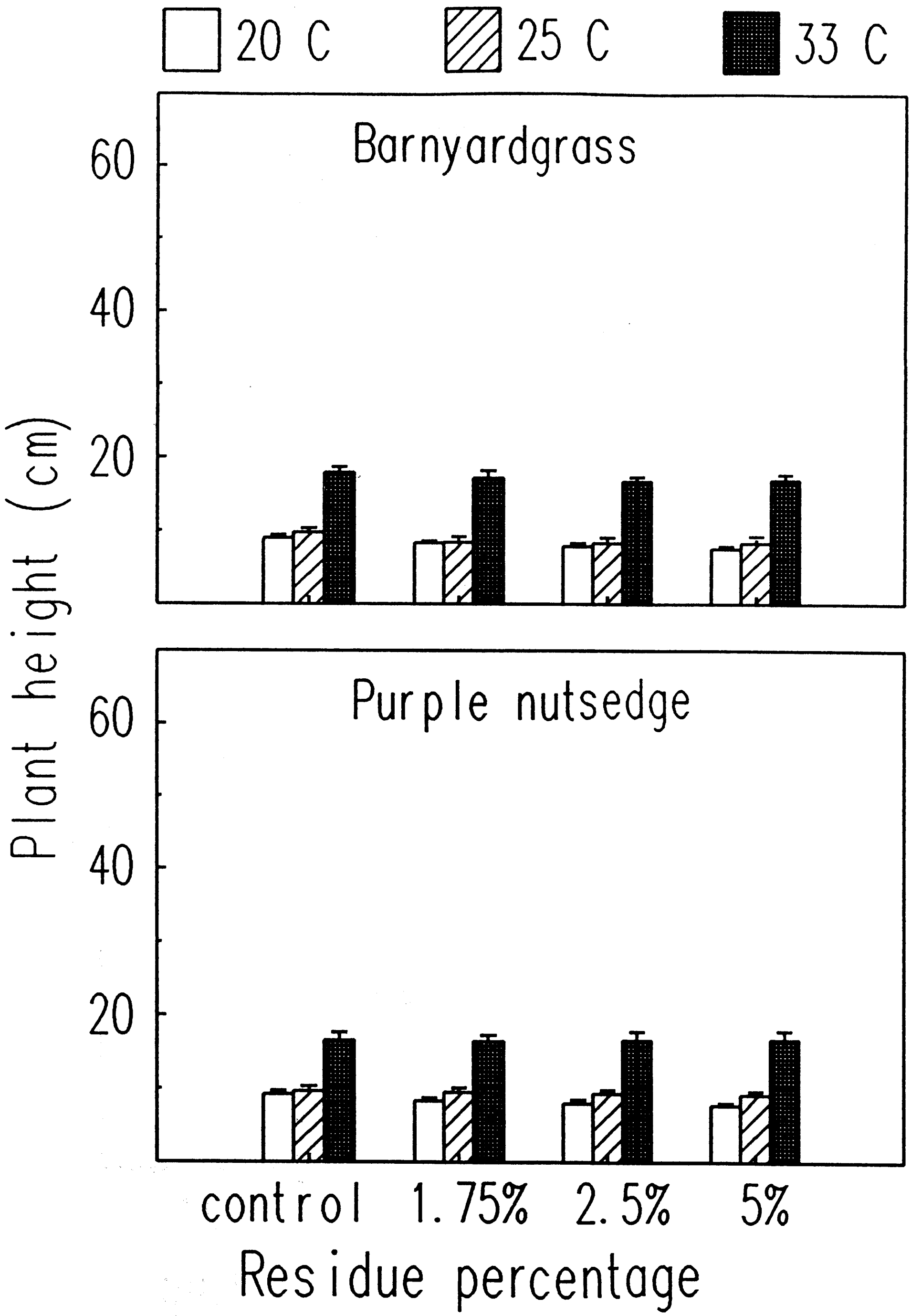

Fig. 5. Plant height of corn (1 wk after planting) treated with weed rseidues under different temperatures.

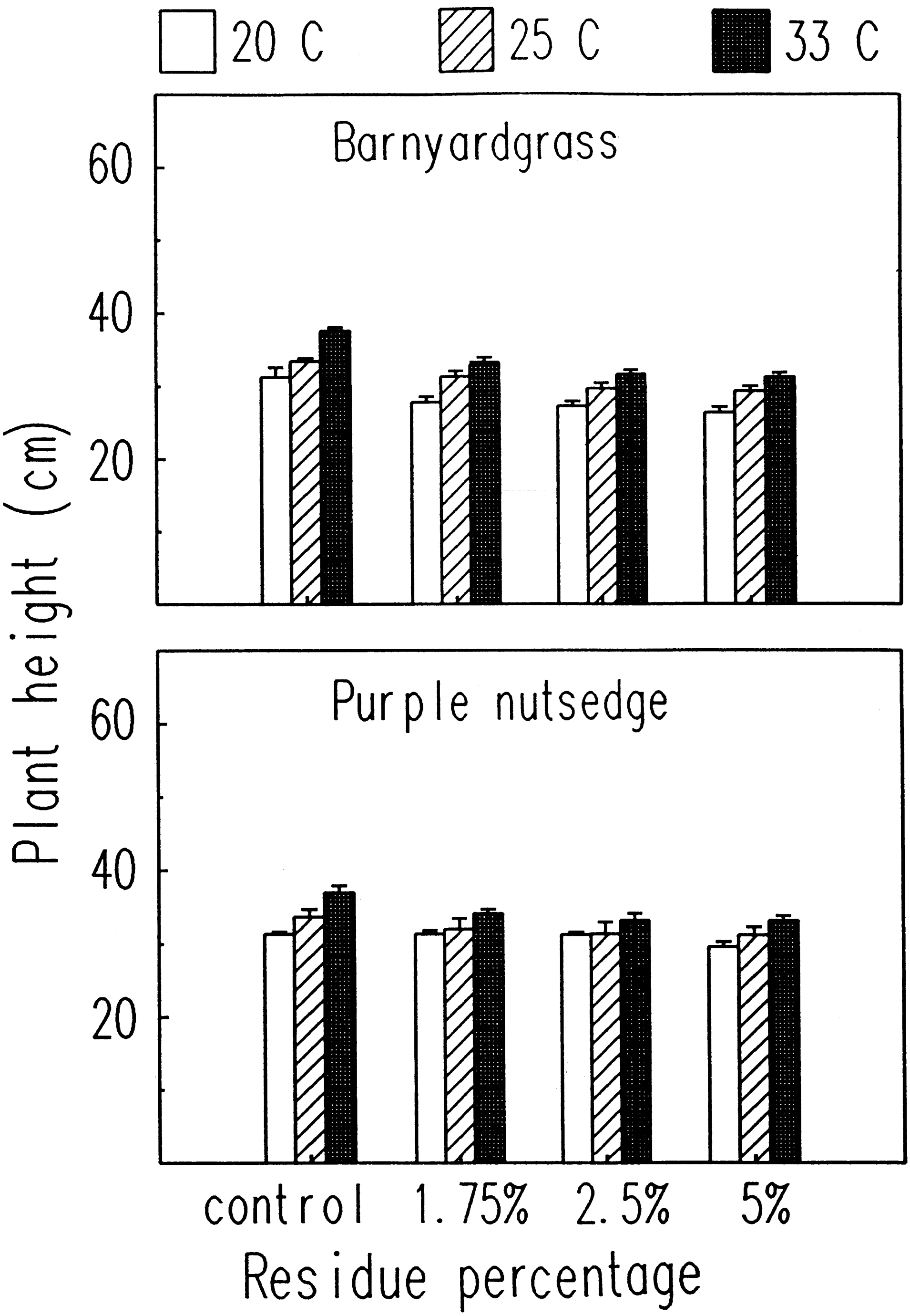

Fig. 6. Plant height of corn (2 wk after planting) treated with weed residues under different temperatures.

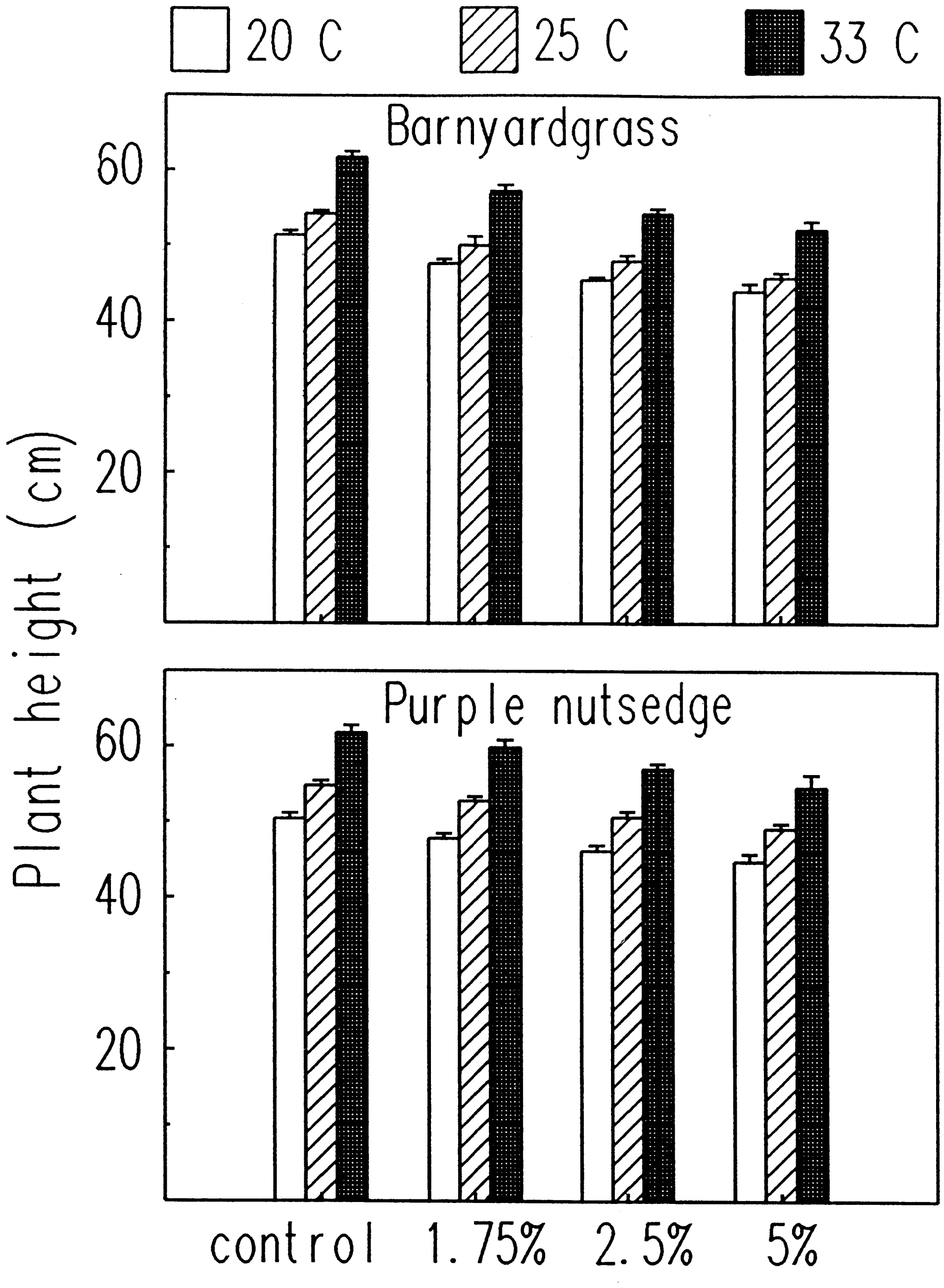

Fig. 7. Plant height of corn (3 wk after planting) treated with weed residues under different temperatures.

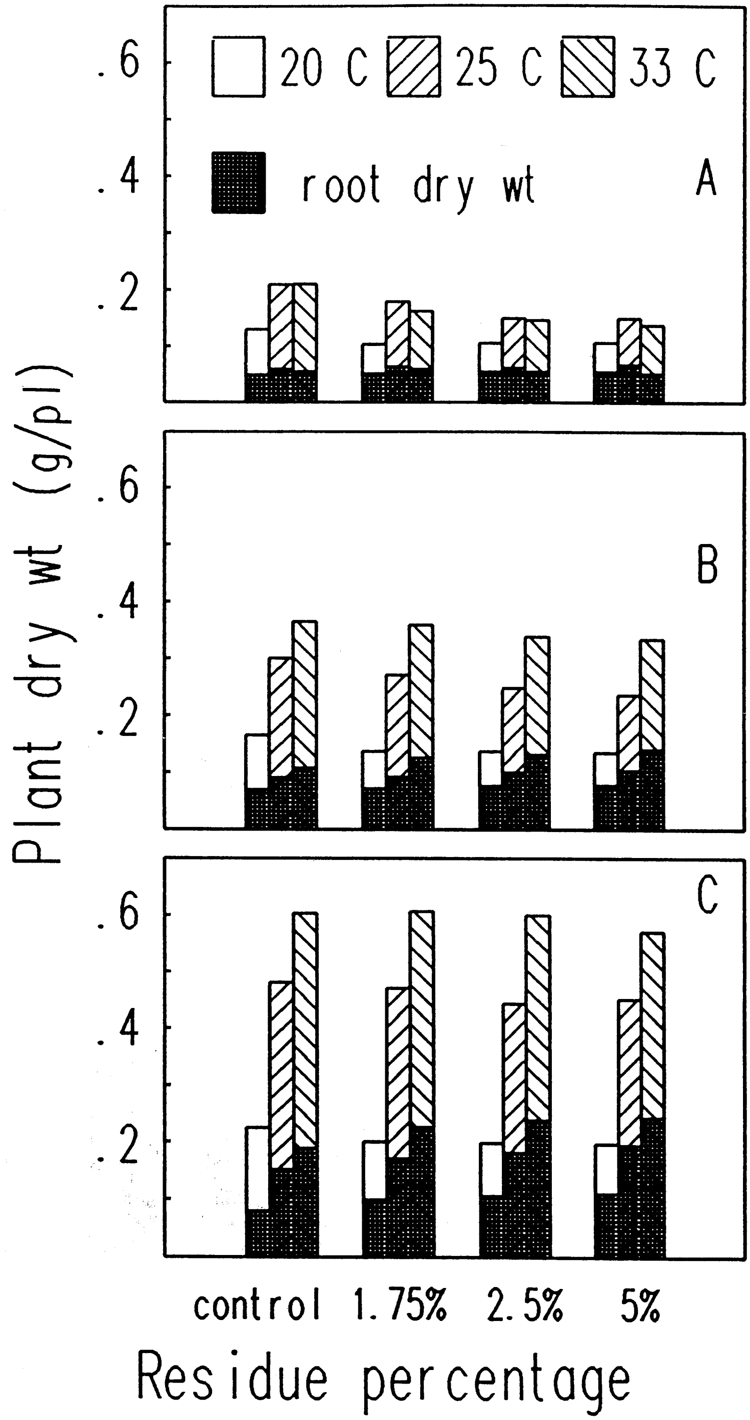

Fig. 8. Total plant and root dry weights of corn at 1(A),2(B) and 3(C) wks after planting as treated with plant residues of purple nutsedge under different temperatures.

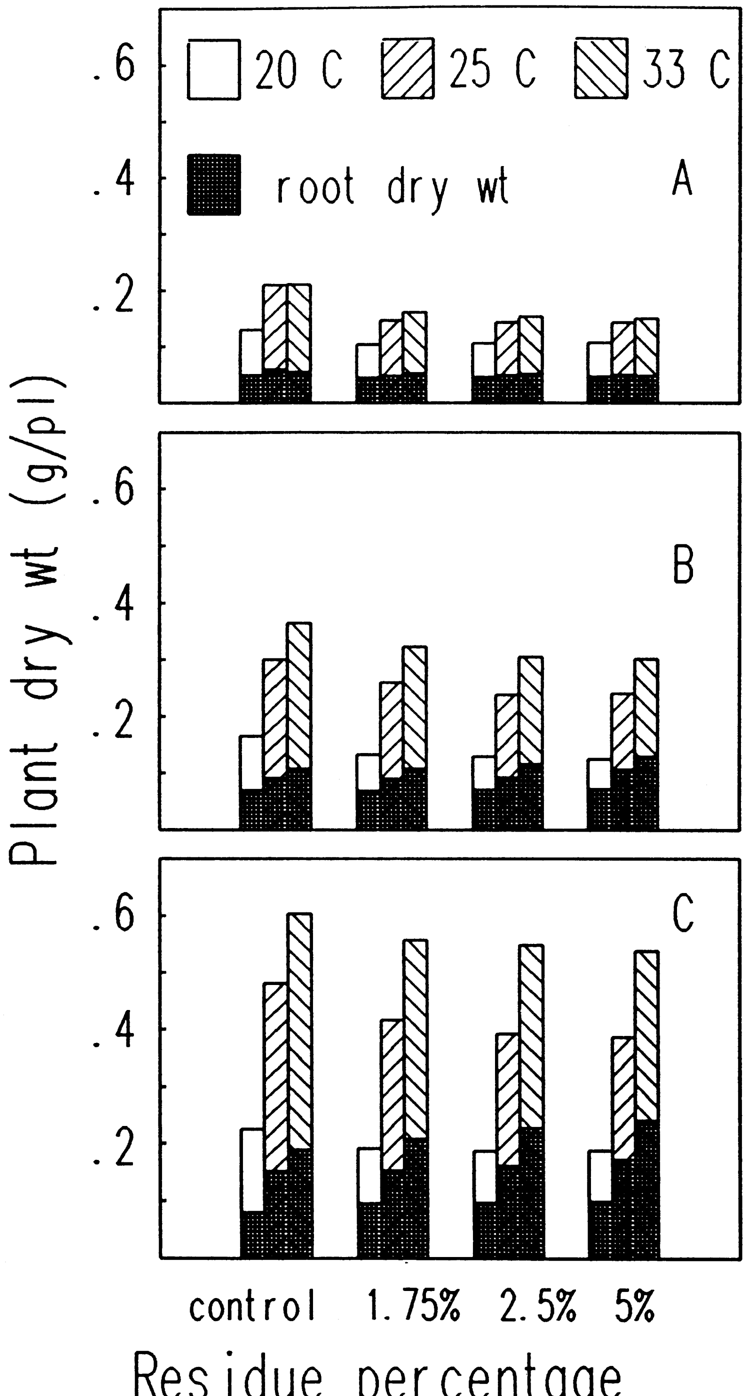

Fig. 9. Total plant and root dry weights of corn at 1 (A), 2 (B) and 3 (C) wks after planting as treated with plant residues of barnyardgrass under different temperatures.

Table 1. The root/shoot weight ratio of corn at 1, 2 and 3 weeks after planting as affected by temperature and weed residues.

Week	Temperature	Residue percentage			
		control (0)	1.75%	2.5%	5%
Purple nutsedge					
1 wk	20C	0.605	1.017	1.064	1.101
	25C	0.388	0.545	0.691	0.802
	33C	0.348	0.569	0.594	0.610
2 wk	20C	0.717	1.072	1.220	1.360
	25C	0.436	0.515	0.672	0.778
	33C	0.423	0.536	0.633	0.725
3 wk	20C	0.552	0.978	1.143	1.261
	25C	0.464	0.575	0.692	0.769
	33C	0.458	0.598	0.662	0.747
Barnyardgrass					
1 wk	20C		0.911	0.996	0.958
	25C		0.493	0.527	0.543
	33C		0.478	0.496	0.476
2 wk	20C		1.074	1.185	1.346
	25C		0.525	0.632	0.786
	33C		0.502	0.612	0.754
3 wk	20C		0.998	1.088	1.127
	25C		0.586	0.698	0.807
	33C		0.599	0.709	0.814

Weed residue effects on seedling growth of corn were evaluated by the increments of plant height and plant weight. In the time period of 3 weeks after planting, the advance of plant height was impaired by weed residues incorporated into the soils. A descending trend was shown in the increase of residue percentages one week after planting, though high temperature exerted a reverse effect. Barnyardgrass showed a stronger inhibition effect than purple nutsedge. Total plant weight was also showing suppressive fashion by increasing weed residues under all temperature treatments. Since root dry weight was increased, it is clearly that shoot growth was restrained by residues. Thus, the root/shoot weight ratio was increased when the amount of weed residues in the soil was raised. In contrast, from the results of root/shoot weight ratio, it was further confirmed that shoot growth was more stimulated than root growth by high temperature. Again, both root and plant weights were inhibited more in barnyardgrass treated soils than in purple nutsedge ones.

In their residual effect experiments, Meissner *et al.* (1982) reported that growth of barley and grain sorghum and other vegetable crops were impaired when grown in soil previously heavily infested with purple nutsedge. Both root and shoot growth were reduced. In other study (Bhowmik and Reddy, 1988), tomato shoot dry weight, fruit number and fruit weight were decreased in the field infested with barnyardgrass. Barnyardgrass interference also reduced rice yield and plant dry weight (Stauber *et al.*, 1991).

As a result, corn emergence and seedling growth was manipulated by the amount of test weed residues incorporated into the soil under the influence of temperature. It is therefore suggested that the best strategy to reduce the effects of plant residues of purple nutsedge and barnyardgrass was to apply the weed control practices before planting. Season-long influence of these two weeds to the yield of corn plants, however, need to be further studied.

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香附子（*Cyperus rotundus* L.）與稗草（*Echinochloa crus-galli*（*L.*）Beauv.）殘株對玉米（*Zea mays* L. cv. Tainung No. 1）之相剋效應 (二)雜草植株殘留物對玉米幼苗出土率及幼苗生長之影響[1]

張 富 洲[2]　　楊 純 明[2]

摘　要

本研究旨在探討土壤分別混以香附子與稗草之成熟植株對於玉米（臺農一號）幼苗出土及幼苗生長之相剋效應，並瞭解不同溫度條件（20、25、及33°C）下此兩種雜草植株殘留物之差異影響。結果顯示，除了香附子殘留物處理在33°C狀況下之外，兩種雜草殘留物在設定之溫度範圍內均降低玉米出土率及出土百分比。再者，玉米株高雖隨溫度上升而增加，經與對照組相較仍受到土壤中雜草殘留量之限制。幼苗出土一週後，高溫促進玉米植株乾重及根重之累積，而雜草殘留物效應則開始顯著影響：植株乾重隨雜草殘留量累增而遞減，根重則呈相反趨勢。經進一步分析根／稈（莖＋葉）比值後發現，地上部生長較根部者受高溫度促進，根／稈比值則隨雜草殘留量增加而升高。綜此結果比較，稗草植株殘留物對於玉米幼苗出土及幼苗生長之相剋效應大於香附子者，而降低此兩種雜草殘留物對玉米幼株出土及生長之相剋控制之最佳方法，乃在玉米播種前即實施雜草防除措施以減少土壤中香附子與稗草之植株殘留。

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