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TOLERANCE OF 'SUNRISE' PAPAYA (Carica papaya) TO POSTEMERGENCE HERBICIDES

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ABSTRACT. Trials were conducted under controlled conditions to determine the tolerance of young papaya plants (15 cm tall) to postemergence herbicides. Initial screen trials included paraquat (1.68 Kg ai/Ha), MSMA (2.24 Kg ai/Ha), 2,4-D (4.26 Kg ai/Ha), bromoxynil (0.28 Kg ai/Ha), atrazine (2.24 Kg ai/Ha), cyanazine (1.12 Kg ai/Ha), dimethenamid (1.12 Kg ai/Ha), endothal (0.56 Kg ai/Ha), imazameth (0.067 Kg ai/Ha), imazethapyr (0.028 Kg ai/Ha), acifluorfen (0.28 Kg ai/Ha), lactofen (0.12 Kg ai/Ha), oxyfluorfen (0.03 Kg ai/Ha), and bentazon (1.12 Kg ai/Ha) as well as an untreated control. Atrazine, bentazon, cyanazine, imazethapyr, imazameth and dimethenamid caused low toxicity at the rates used and dry weights of treated plants were equal to the untreated control. Other herbicides caused severe injuries followed by total death at 10 days after treatment. In the herbicide rate trails, these six screened herbicides were tested along with metribuzin (0.25 Kg ai/Ha), linuron (0.75 Kg ai/Ha) and DCPA (9.00 Kg ai/Ha) at ½, 1, 2 and 4X rates. Imazameth when applied over-the-top did not significantly reduced papaya weight at the 2X rate when measured 21 days after treatment, whereas 4X rate reduced shoot dry biomass in approximately 40%.

INTRODUCTION

Crop nutrition and protection against diseases, pests and weeds are factors of major importance in papaya production. Little experimental information is available about vegetative biomass or yield losses caused by weed interference with papaya. In nursery containers, purple nutsedge (Cyperus rotundus) significantly reduced the growth of papaya seedlings, with higher dry matter reductions as the weed density increased (Morales-Payan and Stall 1997). Based on observations of papaya performance under field conditions, this crop is considered to be a weak competitor against weeds, specially during the early growth period (50-75 days after transplanting). Papaya plant height, leaf area, biomass accumulation and yield are substantially reduced in weedy plots (Morales-Payan 1997).

Early weed control is usually performed by mechanical means (hoeing, cultivation, hand pulling), which is either expensive, time consuming or injurious to the shallow root system of papaya plants. Chemical weed control is restricted to a small number of herbicides that are not phytotoxic to papaya, and in some cases, to an even smaller number of herbicides labeled for use on this crop. Herbicides known to be selective to papaya include diuron as a preemergence treatment in established papaya (Nishimoto and Yee 1980), oryzalin in direct seeded and early post-transplanting and preforan in preemergence in direct seeded papaya (Nishimoto 1981). Pendimethalin in early seeded papaya and early post-transplant has shown marginal selectivity (Nishimoto 1981). When applied directed to the stem base of the crop 4 months after transplanting, ametryn (up to 9 Kg active ingredient/Ha), dalapon (4.5 Kg ai/Ha), diquat (1 Kg ai/Ha), diuron (up to 9 Kg ai/Ha), eptam (4.5 Kg ai/Ha), paraquat (1 Kg ai/Ha), prometryne (4.5 Kg ai/Ha), tillam (up to 6 Kg ai/Ha) and trifluralin (4.5 Kg ai/Ha) did

not cause injury to papaya plants, whereas atrazine (4.5 Kg ai/Ha) reduced yields (Romanowski et al. 1972).

Because of early toxicity problems, herbicide use in papaya is restricted to established papaya (starting at least 2 months after transplanting), and even at that crop stage only a few herbicides are used. In the USA (Hawaii and Florida), herbicide usage in papaya is mainly restricted to diuron and paraquat, and in Caribbean countries like the Dominican Republic the herbicides most commonly utilized are paraquat, diuron and oxyfluorfen (Morales-Payan 1997). There are no reports on the tolerance of young (less than 60 days old) papaya plants to traditional herbicides or relatively new chemicals such as the imidazolinones. The objective of this study was to determine the tolerance of 30-day old 'Sunrise' papaya seedlings to selected postemergence herbicide applications.

MATERIALS AND METHODS

Herbicide screen trials: Greenhouse herbicide trials were carried out during summer and fall 1996 at the University of Florida, Gainesville. 'Sunrise' papaya plants were planted in multi-cell flats (3 cm^3/cell) filled with a commercial potting mix composed of 50% vermiculite, 30% perlite and 20% spaghnum peat. Once seedlings reached the two-true leaf stage (approximately 15 days after seeding), they were transplanted to 0.5 l plastic containers were filled with the same potting medium previously described. One plant per container was transplanted. Plants were grown under a 12-hour photoperiod with an average photosynthetic photon flux density of 1650 $\mu mol \cdot m^2 \cdot sec$ with an average day/night temperature of 24/18°C.

Paraquat (1.68 Kg ai/Ha), MSMA (2.24 Kg ai/Ha), 2,4-D (4.26 Kg ai/Ha), bromoxynil (0.28 Kg ai/Ha), atrazine (2.24 Kg ai/Ha), cyanazine (1.12 Kg ai/Ha), dimethenamid (1.12 Kg ai/Ha), endothal (0.56 Kg ai/Ha), imazameth (0.067 Kg ai/Ha), imazethapyr (0.028 Kg ai/Ha), acifluorfen (0.28 Kg ai/Ha), lactofen (0.12 Kg ai/Ha), oxyfluorfen (0.03 Kg ai/Ha), and bentazon (1.12 Kg ai/Ha) were spayed to the foliage when plants reached 15 cm tall. A non-treated control was also established. Papaya toxicity was estimated 10 days after application, using a 0 to 10 scale where 0 indicates no damage and 10 represents total plant death. A completely randomized design with 5 replications was used. Herbicides showing toxicity of 4 or less were chosen for herbicide rate trials.

Herbicide rate trials: Atrazine (1.12, 2.24, 4.48 and 8.96 Kg active ingredient/Ha), bentazon (0.56, 1.12, 2.24 and 4.48 Kg ai/Ha), cyanazine (0.56, 1.12, 2.24 and 4.48 Kg ai/Ha), imazethapyr (0.014, 0.028, 0.056 and 0.012 Kg ai/Ha), imazameth (0.034, 0.067, 0.134 and 0.268 Kg ai/Ha), dimethenamid (0.56, 1.12, 2.24 and 4.48 Kg ai/Ha), metribuzin (0.12, 0.25, 0.50 and 1.00 Kg ai/Ha), linuron (0.38, 0.75, 1.50 and 3.00 Kg ai/Ha), and DCPA (4.50, 9.00, 18.00 and 36.00 Kg ai/Ha) were sprayed to papaya foliage in aqueous solution with a manual sprayer calibrated at 300 l/Ha at when plants were 10 cm tall (30 days after seeding). No adjuvant was added to the spaying solutions. Trials were conducted during spring and summer 1997.

Three weeks after treatments, papaya plants were rated for toxicity and shoots were clipped to ground level and dry weights were determined. The toxicity scale described above was utilized for herbicide rating. The effect of herbicides on growth was assessed by

calculating I_{20} values, which provided the level at which herbicides inhibited 20% of shoot dry matter as compared to the control.

Four replications per treatment in a completely randomized design were established. In order to test treatment effects analysis of variance (ANOVA) was carried out at the 5% significance level. If significant differences were found, standard errors were used to separate treatment means and to compare to I_{20} values.

RESULTS AND DISCUSSION

Herbicide screen trials: Phytotoxicity observations taken 10 days after treatment showed slight leaf margin burning, spotting and plant stunting (level 3) by atrazine (2.24 Kg ai/Ha), cyanazine (1.12 Kg ai/Ha), dimethenamid (1.12 Kg ai/Ha) and bentazon (1.12 Kg ai/Ha). Imazameth (0.067 Kg ai/Ha) and imazethapyr (0.028 Kg ai/Ha) produced the lowest toxicity (level 1) among all herbicides tested. Other herbicides either severely injured papaya or caused total plant death.

Atrazine, cyanazine, dimethenamid, bentazon, imazameth and imazethapyr showed to be the most promising herbicides out of the 14 active ingredients tested. Therefore, herbicide trials at various rates were conducted to assess papaya tolerance and I_{20} levels.

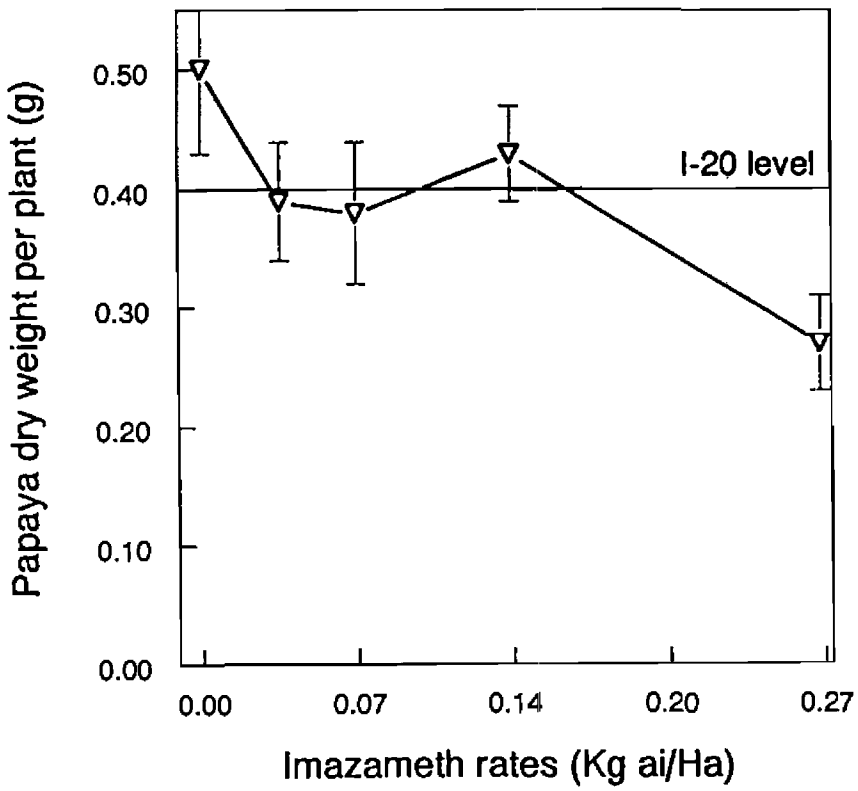

Figure 1. Papaya (Carica papaya) dry biomass accumulation as affected by imazameth rates.

Herbicide rate trails: Significant herbicide effects were observed on papaya dry weight and toxicity rates. Imazameth treatments at rates of 0.034, 0.067 and 0.134 Kg ai/Ha were not different to the untreated control when applied to the foliage of 10 cm tall plants (Figure 1). Application of 4X rate (0.268 Kg ai/Ha) reduced shoot dry biomass in approximately 40%. When evaluated 21 days after spraying, no visible injury symptoms were observed on papaya leaves applied with imazameth at ½, 1 and 2X rates (level 1). However, even though mild stunting occurred during the second week after application, papaya plants recuperated their vigor thereafter. I_{20} values indicate that none of these treatments caused less than 20% dry biomass accumulation on young papaya plants.

At 21 days after application, other herbicides severely injured plants by either causing irreversible stunting and leaf burning at the 1X rate (level 6: atrazine, linuron, dimethenamid and metribuzin), total death at the 2X rate (level 10: cyanazine) or moderate stunting at all rates (level 4: bentazon, imazethapyr and DCPA).

Based on the data collected, young 'Sunrise' papaya plants (10 cm tall) seemed to be tolerant to the herbicide imazameth at rates of 0.034, 0.067 and 0.134 Kg ai/Ha. Further research should include other herbicide families (i.e. dinitroanilines and sulfonylureas) to observe the tolerance of papaya plants to foliage and basal applications at various rates, as well as field research on the efficacy of imazameth to selected weed populations and its performance on papaya growth.

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