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INTERFERENCE OF WILD RADISH (*RAPHANUS RAPHANISTRUM* L.) ON CABBAGE

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Abstract. **Two ecological studies determining the competitiveness of wild radish (*Raphanus raphanistrum* L.) in cabbage production were carried out in Gainesville and Live Oak, Florida. One study was the additive study, which used densities of 0, 2, 4, 8, and 16 wild radish plants per meter of cabbage row. In this study, the total density of plants per unit area changes but the crop density remains static. This study mimics growing situations where weeds appear during the growing season at different populations. Cabbage plants were harvested at ground level and weights were taken of the plant with wrapper leaves and without wrapper leaves (a marketable head). Quality factors such as head height, width, and core length were also analyzed. Weeds were harvested and dry weights were taken. The second study was the area-of-influence study. This study demonstrates the competitiveness of one wild radish in relation to the distance from the crop row. The treatments were no wild radish, one wild radish between two cabbage plants, and wild radish 15.24 cm, 20.32 cm, and 25.4 cm from the cabbage row middle (Fig. 1). The plot consisted of three cabbage plant pairs (middle, sub-terminal, and terminal pair). The same yield and quality factors were analyzed. The results of the additive study indicated that even at 16 plants/m^2, there was no reduction in yield or quality of cabbage at Gainesville. At Live Oak, there was a significant difference due to weed density in marketable cabbage (without wrapper leaves) yield. The area-of-influence study showed that there were no differences among treatments, but there were differences among the pair positions of cabbage fresh weight with and without wrapper leaves, head height, and head width at Gainesville. At Live Oak, there were no differences among treatments, but there was a positional effect between the middle, sub-terminal, and terminal pairs of cabbage in fresh weight with wrapper leaves.**

Introduction

Florida vegetable industry is highly dependent on winter vegetable production. A large portion of the winter crop is the production of cabbage (*Brassica oleracea* L. var. *capitata*). Florida is ranked fourth in the U.S. in cabbage production with an estimated 9,400 acres planted and a crop value of 29.7 million dollars during the 1995-1996 growing season (Fla. Agric. Statistics, 1997). A major problem with cabbage production is weed control. There are very few herbicides labeled for use in cabbage, and most are ineffective on particular weeds. Hand weeding is extremely labor intensive, costly, and not practical for growers.

Wild radish (*Raphanu.s raphanistrum* L.) is a major weed pest in Florida cabbage production areas. Selective post-emergent control of several broadleaf weeds in cabbage may be obtained with pyridate, however, this herbicide will not control wild radish. Wild radish is a winter annual broadleaf weed which germinates year-round and the seeds persist in the soil in the dormant state for many seasons (Code and

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Donaldson, 1996). Wild radish is in the same family as cabbage, the Brassicaceae family. Because of this, it can act as an alternate host to many of the same pests that are detrimental to cabbage. Wild radish contains isothiocyanates in all parts of the plant, especially the seeds, which are toxic and can cause health problems in livestock (Miller and Hopen, 1991). Wild radish affects many crops world-wide and has a strong competitive ability (Code and Donaldson, 1996). Seven plants per m^2 reduced yields of wheat crops in north-eastern Victoria province in Australia (Code and Reeves, unpublished in Code and Donaldson, 1996). One wild radish growing close to cabbage has been seen to drastically reduce the size of the cabbage head (Stall, personal observation).

Two studies, an additive study and an area-of-influence study, were conducted to determine the loss of yield and quality of cabbage due to interference caused by wild radish. The additive study is a design in which the density of the weed is increased while the crop density remains the same. This study will imitate the situation of increasing weed pressure in grower's fields. The area-of-influence study determines if one wild radish at different distances from the crop row will have an effect on the yield and/or the quality of the cabbage.

Materials and Methods

Additive Study. Two additive studies were carried out, one at the Horticultural Research Unit, Gainesville, FL, and the second at the Suwannee Valley Research and Education Center in Live Oak during the spring of 1997. The trials were carried out in Gainesville on a Kanapaha sand soil (Loamy siliceous, hyperthermic, Grossarenic, Paleaquult, with pH 5.6). The soil at Live Oak was a Lakeland fine sand (sandy siliceous, Thermic, Coated, Typic Quartzipsamments, with pH 5.8). The field at Gainesville was prepared by forming beds 0.625 m wide with row middles 1.25 m apart. Beds in Live Oak were 0.625 m wide and on 1.56 m centers. Beds were treated with methyl bromide/chloropicrin (98:2) and fertilizer was applied under black plastic mulch. Fertilizer was applied according to soil analysis and IFAS recommendations for both locations. Plastic was removed before transplanting crops. Five week-old "Cecile" transplants were planted in a single row at both locations. Cabbages were planted in Gainesville on 26 March, 1997 and on 27 March in Live Oak. Weed seeds of wild radish (ordered from Valley Seed Co. Fresno, CA) were soaked overnight and planted on 29 March in Gainesville and 28 March in Live Oak. Cabbage transplants were planted at 30.5 cm spacings according to vegetable production practices (Hochmuth and Maynard, 1995). Five to ten wild radish seeds were planted per hole at a distance of 20.32 cm from the cabbage row middle. Wild radishes were planted along both sides of the cabbage row in staggered pattern according to the treatment density. Overhead irrigation was applied at both locations to insure adequate soil moisture. The experiment was a randomized complete-block design with five treatment densities of wild radish and five replications. Densities used in this study were 0, 2, 4, 8, and 16 plants per m of bed. A randomized complete block design was also set up in Gainesville to determine the intraspecific competition of wild radish without cabbage competition. Four treatments, 2, 4, 8, and 16 wild radish plants per m of cabbage row were planted in the same fashion as the cabbage trial. Plots were 3 m in length by 0.625 m wide. A side dressing of 36 $kg \cdot ha^{-1}$ N was applied on 15 May and 16 May at Gainesville and Live Oak, respectively. Cabbages and wild radishes were harvested on 16 June in Gainesville, and on 10 May in Live Oak. All plants were cut at soil level. Total fresh weight of cabbages per plot, and total weight of cabbages without wrapper leaves (marketable product) were measured. Three heads from each plot were then halved longitudinally to record head width, head length, core length, and percent of core length to total head height. Wild radish plants were harvested, oven dried, and weighed. Data were subjected to analysis of variance and regression.

Area-of-Influence Study. The area-of-influence study was a randomized complete block design with five treatments and six replications. The treatments were no wild radish, and one wild radish 15.24 cm between cabbages, 15.24 cm, 20.32 cm, and 25.4 cm from the cabbage row middle (Fig. 1). Plot size was 3 m long, 0.625 m wide, and rows were spaced on 1.25 m per bed centers. Cabbage spacing was 30.5 cm apart in a single row. The experiments were conducted in the same locations and were prepared and treated the same as the additive study mentioned previously. Fresh weight of heads with wrapper leaves, fresh weight without the wrapper leaves, head length, head width, and core length were taken on the cabbages. Three pair of cabbages from the weed placement were harvested for data; these were from the middle, sub-terminal, and terminal pairs (Fig. 1). Wild radish plants were dried and weighed. All data were subjected to analysis of variance and regression analysis was preformed.

Results and Discussion

Additive Study. In Gainesville, there were no significant differences among treatments for head weight with wrapper leaves or without wrapper leaves, head height, width, and core length. Wild radish dry weight was significantly affected by treatments ($p > 0.0001$). Comparing mean dry weight of wild radish in the intraspecific study to dry weight of wild radish grown with cabbage showed that cabbage was much more competitive and drastically reduced dry weight of the wild radish (Fig. 2).

In Live Oak, there was severe insect pressure due to diamondback moth larvae in both cabbage and wild radish. However, there were no significant differences among treatments for head height, width, core length, and percent of core length to the height of cabbage. There was no effect of treatment on weight of cabbage heads with wrapper leaves. There was a significant weed density effect on cabbage without wrapper leaves (1% level). Cabbage average head weight

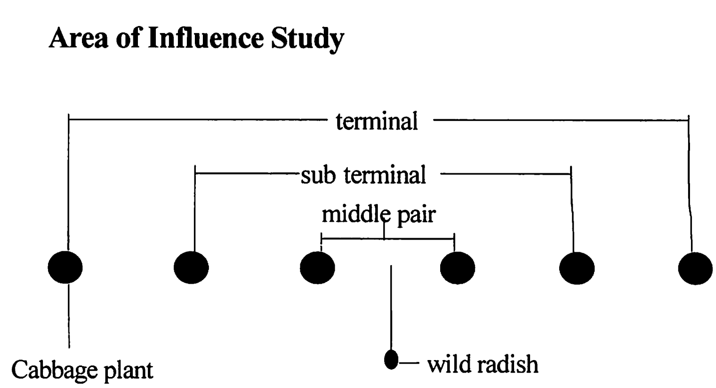

Figure 1. Experimental design of the area-of-influence study.

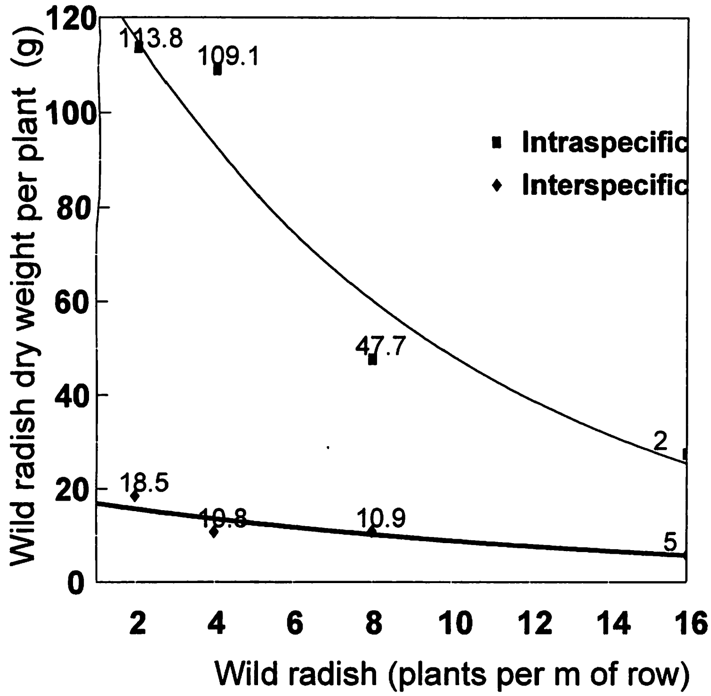

Figure 2. Dry weights of wild radish as affected by density treatments with interspecific competition ($y = 18.1e^{-0.07x}$) and intraspecific competition ($y = 142 e^{-0.107x}$)the additive study at Gainesville.

dropped from 1.06 kg per head to 0.83 kg by adding two wild radish plants per m of crop row. However, as wild radish densities increased from 2 to 16 weeds per m of crop row, there were no further reductions in average head weight; 0.83 - 0.89 kg per head. Wild radish dry weight per plant was significantly reduced by cabbage growth (Fig. 3).

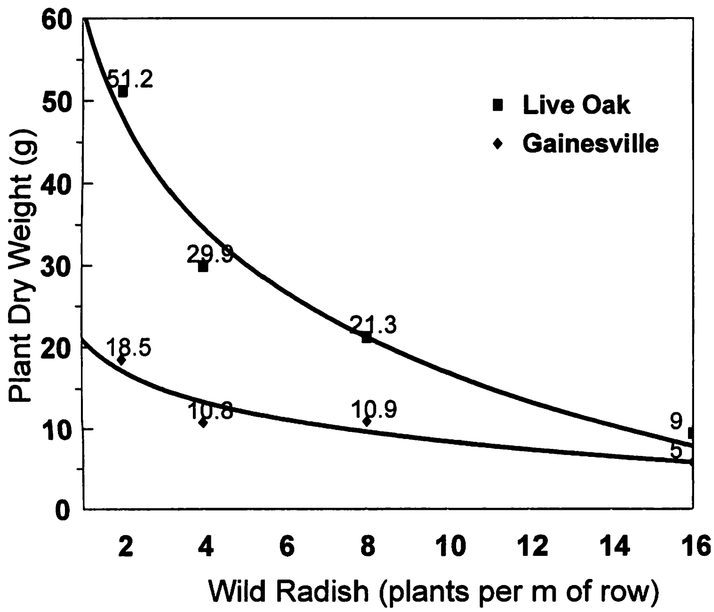

Figure 3. Dry weights of wild radish as affected by density treatments in the additive experiments at Gainesville ($y = 18.1e^{-0.07x}$) and Live Oak ($y = 61.4 - 19.3 \ln x$).

Table 1. Significance of main effects and interaction from the area-of-influence studies.

	Cabbage head weight		Cabbage head		Core
	with wrapper	without wrapper	height	width	length
Gainesville					
Treatment	NS[z]	NS	NS	NS	NS
Position	* *	*	*	NS	*
Treatment × position	NS	NS	NS	NS	NS
Live Oak					
Treatment	NS	NS	NS	NS	NS
Position	*	NS	NS	NS	NS
Treatment × position	NS	NS	NS	NS	*

[z]*, **Denotes significance at the 0.05, 0.01, probability levels respectively. NS denotes not significance.

Area of Influence Study. In Gainesville, there was no treatment effects on fresh weight of cabbage with or without wrapper leaves, head width, head height, or core length (Table 1). There were differences in fresh weight with and without wrapper leaves, head height, and head width among the pairs harvested. Fresh weight with wrapper leaves among cabbage pairs ranged from the terminal pair (3.92 kg), sub-terminal pair (3.47 kg), and the middle pair (3.21 kg). Fresh weight without wrapper leaves per cabbage pair ranged from the terminal pair (2.28 kg), the sub-terminal pair (2.00 kg), and the middle pair (1.86 kg). Head height per cabbage also differed significantly among pairs with measurements of the terminal pair (14.4 cm), subterminal pair (14.06 cm), and the middle pair (13.32 cm). Head width per cabbage differed among pair position with the terminal pair (12.71 cm), the sub-terminal pair (12.06 cm), and the middle pair (11.59 cm). In Live Oak, there were no treatment effects on fresh weights, head height, head width and core length. Head weight with wrapper leaves differed from middle, subterminal, and terminal pairs, with weights of 3.36, 3.52, and 3.76 kg, respectively. Weights of pairs without wrapper leaves differed from the middle pair (1.69 kg) sub-terminal (1.97 kg), and terminal (1.91 kg) per pair of cabbages.

Wild radish population had no effect on the quality and the yield of cabbage in our trials. Cabbage was much more competitive than wild radish. Interspecific cabbage-wild radish competition was greater than intraspecific wild radish-wild radish competition. At the higher wild radish densities, the intraspecific competition of wild radish was higher than the interspecific wild radish-cabbage competition. This may be due to the delay of emergence of the weed from the time of planting. The emergence of wild radish from planted seeds was about nine days. In this time the transplanted cabbage had time to establish and partially shade the weed seedlings. This created a delay in radish growth that was only exaggerated as the season progressed. It has been shown that wild radish plant development is related to environmental factors. For instance, time of emergence to time of flowering is mainly controlled by heat units accumulated (Reeves, 1981). Therefore, weeds growing in cooler weather will take longer to flower and may have different competitive abilities. Future research will focus on time of planting of the cabbage crop and weeds to determine if this will have an effect on cabbage yield and quality factors.

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WATERMELON TOLERANCE TO HALOSULFURON APPLIED PREEMERGENCE AND POSTEMERGENCE

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Abstract. **Watermelon yield response to the application of the herbicide halosulfuron was evaluated over three seasons (1995-1997) for control of commonly occurring weeds. In the 1995 season, preemergence (PRE) and postemergence (POST) treatments were applied at 9, 18, 27, 36, 54, 72, and 108 g·ha^{-1} to watermelons. In 1996, PRE treatments were evaluated at 18, 27, 36, 72, 108, and 144 g·ha^{-1}, early postemergence (EPOST) and POST were evaluated at 18, 27, 36, 72, and 108 g·ha^{-1}. In 1997, POST treatments were applied at four timings with rates of 27 and 36 g·ha^{-1}. Watermelon exhibited excellent tolerance (observed melon vigor >80%) and little negative response (observed phytotoxicity <30%) to halosulfuron applied at any PRE rates. POST applications in all years showed decreased yields and tolerance to halosulfuron. In 1997, watermelon exhibited excellent tolerance, and comparable yields to that with the untreated watermelons from POST applications of 27 g·ha^{-1}, 35 days after emergence (DAE).**

Introduction

Watermelons (*Citrullus lanatus* L.) comprise a major portion of the Florida vegetable industry. In Florida they ranked 4th and 7th in terms of acreage and value respectively during the 1995-96 growing season (Fla. Agric. Stat. Serv., 1997). Nationally the Florida watermelon industry, ranked 3rd and 1st in terms of acreage and value respectively in 1996 (USDA Statistics, 1997).

Spring watermelon planting begins in south Florida in the middle of December and progresses northward until early April. The subtropical climate of Florida allows for the early planting of warm season crops. These conditions also allow for potential yield losses from increased pest, disease, and weed pressures. With the exception of "double cropping", watermelon fields are disked and cultivated prior to planting. Cultivating can create a competitive advantage for weeds that rapidly grow early in their life cycle. Florida vegetable fields are commonly infested with pigweed (*Amaranthus* spp.), nightshade (*Solanum* spp.), lambsquarter (*Chenopodium album* L.), goosegrass (*Eleusine indica* L.), and nutsedge (*Cyperus* spp.). Weeds compete with crops for light, nutrients, water, gases, and/or space. Cultural practices such as fertilizing, disease control, and harvesting can be hindered by weeds. Inefficiencies in cultural practices arise when the potential value of a chemical or service falls short of the value gained. Inefficiencies occur when weeds interfere with spray deposition, fertilizer placement, and harvesting. Watermelons compete poorly with weeds early in their life cycle, and total yield loss can occur if weeds are left uncontrolled (Stall, 1992). Compounding the problem of weed control is the low tolerance of watermelons to herbicides. Currently there are only eight herbicides labeled for use in watermelons, and five are for postemergence (POST) weed control (Stall, 1997). Of the five, three can be sprayed over the crop, but one of these, DCPA will be withdrawn from registration. Growers will only have two options for POST control of weeds in beds. All of the currently labeled herbicides provide poor control of yellow nutsedge (Stall, 1997).

Halosulfuron is a relatively new herbicide that is a member of the sulfonylurea family, which inhibits the enzyme acetolactate synthase. Halosulfuron applied preemergence (PRE) or POST has provided excellent (90% or greater) control of yellow nutsedge (*Cyperus esculentus* L.) (Vencill et al., 1995). The objective of this research was to establish watermelon tolerance to halosulfuron applied PRE and POST, under Florida conditions.

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