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Raspberry
Trials
1988-1992

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SUMMARY

Raspberries were compared in two cultivar trials and a cultural practice trial in order to identify means of optimizing production. One cultivar trial compared yields of black and purple raspberries. Although yields of black raspberries were low, due in part to the small fruit size, the fruit were highly prized for their excellent processing quality and the plantings showed excellent vigor. Purple raspberries showed promise as a summer raspberry crop. Although production of purple raspberries was highest in 1991, a season with a mild winter and spring, estimates of dead buds in early spring were no greater in seasons with lower yield. Of six red raspberry cultivars tested, the cultivar 'Heritage', managed as a fall crop, was consistently at or near the top in yield. Except for the cultivar 'Festival', the summer red raspberries showed drastic declines in yield over the period 1989-1991 so yields were not taken in 1992. The flavor of Festival was only fair and the fruit of all the summer red raspberry cultivars were soft and deteriorated rapidly. Trellis configuration and groundcover management had significant effects on yield. Yields were significantly higher in plants grown with wide trellis and "V" trellis configurations than in narrow trellis or linear trellis. Yields in plots with grass sod groundcover in the aisles between rows were superior to plots lacking groundcover.

Raspberry Trials 1988-1992

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Raspberries were once commonly grown on Connecticut farms; however, high establishment and labor costs led to their abandonment. Because raspberries are a highly perishable crop, they are ideally suited to direct local sales through pick-your-own and farm outlet operations popular in Connecticut. In 1986 a survey by John Elliston of the Experiment Station found 33 farmers growing raspberries on approximately 42 acres. The survey showed about 86% were red raspberries (*Rubus idaeus*) with 71% of the red raspberries represented by the "everbearing" cultivar 'Heritage' which was managed for fall production. In order to provide information which Connecticut farmers could use in making cultivar and cultural decisions for new plantings, the Experiment Station embarked on raspberry trials in 1987 (Stephens and Kiyomoto, 1990).

Two recent publications, Bramble Production Guide (Pritts and Handley, 1989) and Raspberry Management (Crandall and Daubeny, 1990), provide comprehensive reviews on the biology, cultural practices, and pests involved in raspberry production. In addition, the Bramble Production Guide provides a chapter on enterprise budgeting which should be considered by potential growers. Initial investments can be high and returns slow. In this bulletin, reference to raspberry biology and management is taken from information provided in the Bramble Production Guide.

Raspberries are perennial plants that produce biennial canes. Canes, normally vegetative the first season, are called primocanes. Primocanes will emerge each year the plant is alive. A primocane will become reproductive, producing flowers and fruit, in its second growing season and is then called a floricanes. The floricanes dies after fruiting. Pruning involves the removal of the dead floricanes and excess primocanes. The most productive floricanes are those of greater diameter and the most fruitful buds are those in the middle 3/5 of the cane. Thus, for high productivity, cultural practices should aim at producing large primocanes and removing the smaller primocanes. Red raspberries (*Rubus idaeus*) have the ability to spread and fill in space between the original plants because they can develop primocanes from root buds. In contrast, black raspberries (*Rubus occidentalis*) arise only from crown buds and therefore tend

to remain where plants were originally set.

One group of red raspberries has the ability to produce fruit on the growing tips of primocanes and has been referred to as "everbearing" or fall raspberries. In this group, the primocanes grow a certain number of nodes that behave in the normal biennial fashion. However, the growing tip will change from the vegetative state to reproductive state so fruit is set at the upper nodes. Since the ability to flower develops late, the fruit are usually produced in late summer or fall. The lower part of the primocane does not become reproductive until the following year when it behaves as a normal floricanes, fruiting in the summer and dying after fruiting. Thus, with a mixture of primocanes and floricanes, a summer and fall crop can be produced. However, in Connecticut the everbearing raspberries are usually managed for fall production because the crop is usually larger and pruning is greatly simplified. Pruning for fall production involves cutting all the canes back to ground level in late winter. Because this removes any future floricanes, all regrowth will be primocanes which will produce a crop in late August until frost.

The fruit color of most *R. idaeus* is red, but yellow forms exist (eg., cultivar 'Fall Gold'). Black raspberries (*R. occidentalis*) change color from green to red to black as they mature. Purple raspberries were developed from crosses between red and black raspberries. Their growth habit and color are intermediate between the red and black raspberries, but they mature later than summer red and black raspberries. Generally, red raspberries are more tolerant of winter temperatures than purple raspberries, with black raspberries most sensitive to low winter temperatures. Black raspberries also break dormancy after only 300-600 hours below 40F whereas red raspberries require 800-1600 hours, making the former more susceptible to spring frosts.

The cultivar Heritage grown for a fall crop represents the principal cultivar used by Connecticut growers and gardeners. Trials were planted to test the feasibility of growing summer red, purple, and black raspberries. In this Bulletin, I report yields of fall red, summer red, black, and purple raspberry cultivars and the results of a cultural trial comparing the effects of trellis types and aisle vegetation management on yield in 'Canby' and 'Titan' red raspberries.

METHODS AND MATERIALS

Trials and Cultivars

The raspberry trials consisted of two cultivar trials and one cultural practices trial each planted in a different location at the Lockwood Farm, Hamden, CT. One cultivar trial contained the purple raspberries, 'Brandywine' and 'Royalty', and the black raspberries, 'Haut' and 'Jewel'. The second cultivar trial contained the summer red raspberry cultivars Festival, Canby, 'Taylor', and Titan and the fall red raspberries Heritage and 'Ruby'. The cultural practices trial compared four trellis systems, two inter-row aisle management practices, and performance of the cultivars Canby and Titan. Yields in all trials were determined by harvesting all marketable fruit from two 1-meter sections of row in all treatments at 2-3 day intervals throughout the ripening period. Mean fruit size was determined at each harvest by counting and weighing approximately 50-fruit subsamples. Injury to buds was determined in early spring just as buds were breaking dormancy by counting buds on 10 canes in all treatments and replications.

Culture

Virus-free plants from tissue culture were planted in the field in spring 1987. Losses were replaced in spring 1988. In the cultivar trials rows were spaced 12 feet apart and plants were spaced 30 inches apart within rows for a density of 1344 plants per acre. In the cultural practices trial plants were planted at a spacing of 24 inches within the rows for a density of 1815 plants per acre.

A 4-foot weed-free zone in the planted rows was maintained with single early spring applications of Surflan, spot applications of Roundup, and manual weeding. Fertilizer was broadcast in the weed-free zone at the rate of 700 lb 10-10-10 fertilizer per acre in May 1989. In 1990, 1991, and 1992 fertilizer was applied as a split application of 350 lb per acre at each application in May and early July. No fungicides, nematicides, or insecticides were applied throughout the study. Drip irrigation was used as supplemental irrigation during dry periods.

Pruning and thinning of fruiting canes of summer raspberries was done in two stages. In the fall, dead fruiting

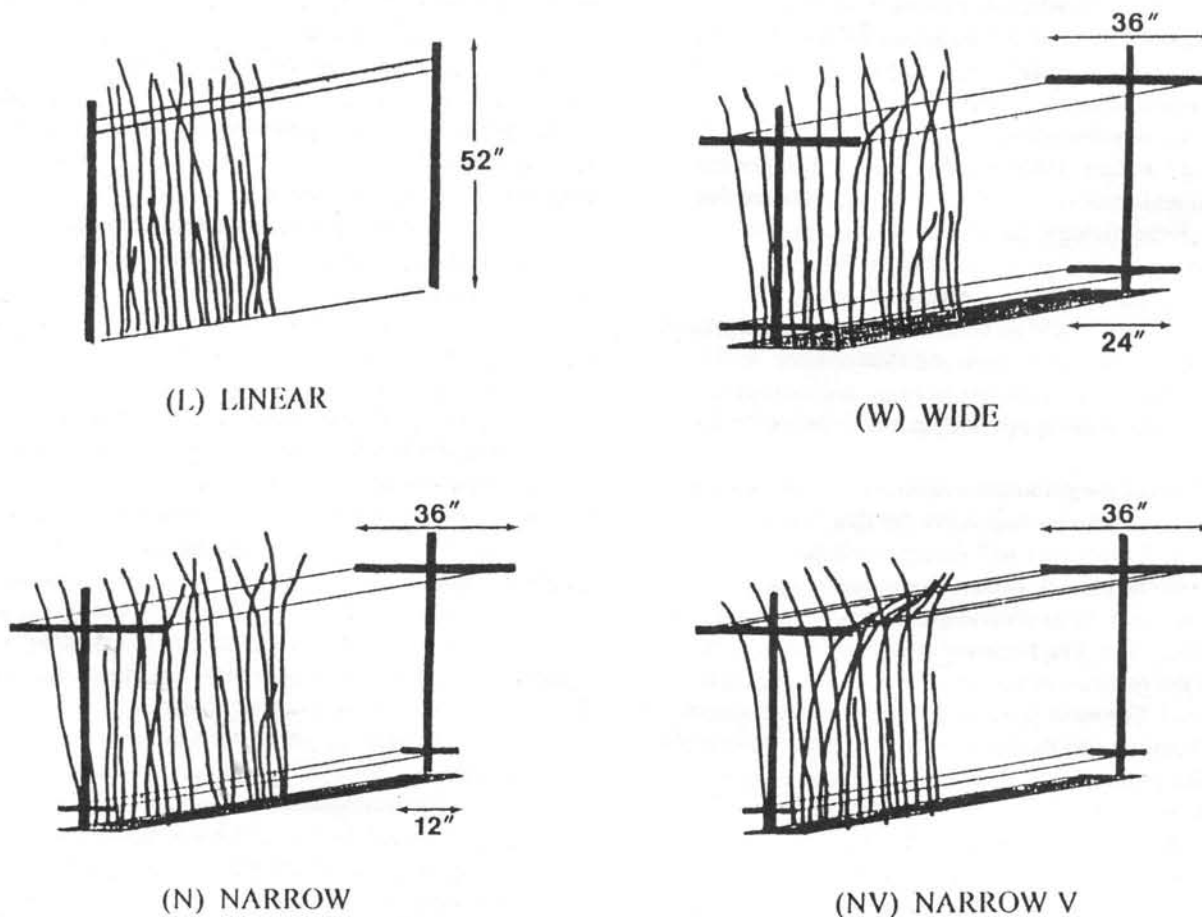


Figure 1. Configuration and dimensions of trellis systems compared in the cultural practices trial.

canes and small diameter, diseased, and broken primocanes were pruned at ground level and removed from plots. In late winter or early spring before bud break, fruiting canes were thinned to three to five large diameter canes per linear foot of row. Purple and black raspberries were similarly thinned and in the late summer, tall primocanes were headed back to approximately 6 feet. Heritage and Ruby were managed for a fall crop by cutting all canes at ground level in late winter or early spring. All cut canes were removed from plots.

Cultural Trial

Four trellis arrangements were compared in the cultural practices trial (Fig. 1). The Linear Trellis (LT) is used to produce a smaller number of larger berries. LT is a simple system composed of posts with no cross arms and a double wire at 24-30 in and a single wire at 48-54 inches above ground. The double wires are approximately 1 inch apart, and developing primocanes are trained to grow between the wires and are tied to the upper wire.

The Narrow Trellis (NT) has endposts with a cross arm at 24-30 inches above ground which holds a pair of wires 24 inches apart. A second crossarm at 48-54 inches above ground, holds a pair of wires 36 inches apart. At the base of the planting the hedge is only allowed to grow to a 12 inches width. Primocanes growing outside these limits are mowed or pruned off during the season. In the NT fruiting canes and primocanes intermingled. The developing primocanes are shaded and harvest is more difficult because fruiting occurs throughout the hedge.

The "V" Trellis (VT) has the same dimensions as the NT, but two additional movable wires are installed in the upper crossarm 1.5 inches inside the first set of wires. The movable wires are used to pull fruiting canes against the outer wires. This opens the center of the hedge to form a "V". The wires sandwich the fruiting canes to the outside of the hedge. Thus, fruit are confined to the outside of the hedge, a benefit to harvesting and spraying, and developing primocanes grow up the middle where they do not have to compete with the floricanes for sunlight.

The Wide Trellis (WT) is similar to NT except the hedge is allowed to spread to a width of 24 inches at the ground, and the wires on the lower crossarm are 30 inches apart. The wider spacing permits wider spacing of floricanes and better air movement within the hedge.

The second cultural treatment investigated was the effect of inter-row aisle vegetation. Sod, established by seeding to mixed grasses, was compared to a bare aisle maintained weed-free by periodic disking. Under conditions of adequate moisture, the grass groundcover was mowed every 2 weeks. Plots were planted in a randomized complete block arrangement with three replications. Groundcover treatments formed the main plots, trellis the sub plots, and cultivars the sub-sub plots. Yield data were subjected to analysis of variance over the 3 years 1989-1991.

Cultivar Trials

The black and purple cultivar trial and the red raspberry cultivar trial were grown as a narrow hedge supported by a "V" trellis (Fig. 1). Aisles were managed as a grass sod. In each trial, cultivars were randomized in two complete blocks or replications. Yields were compared by analysis of variance by considering each year of study a replication and data from the two blocks as repeat measurements for a cultivar.

RESULTS AND DISCUSSION

Black and Purple Raspberry Cultivar Trial

The results of the black and purple raspberry trial are summarized in Table 1. The purple cultivars, Brandywine and Royalty, were significantly higher yielding than the black cultivars Haut and Jewel, but within each group there were no significant differences in yield. Yields were greatest in 1991 which was characterized by a mild winter and warm spring and summer. The lower yields in 1992 are probably due to the cool, moist weather experienced throughout the growing season. Overall, the vigor of the plants is outstanding with no apparent decline from 1989-1992.

Although the black cultivars show a low yield, the fruit are highly desirable for processing as preserves. Small fruit size and small numbers of flowers per flower lateral are partly responsible for the low yield of the black raspberries (Table 2). The purple raspberries were not outstanding for yield, but results in 1991 showed they had the highest yield potential of any raspberry in trial. The purple raspberries were among the largest in fruit size (Table 2). Both the purple and black raspberries showed occasional cane die-back due to winter injury, but the percentage of dead buds per cane in early spring ranged from 17% to 26% while as many as 38% to 47% of the buds of the red raspberries Titan and Canby were dead (Table 3). When considering any raspberry planting it is best to locate the planting in a fashion that would reduce the risk of injury due to low temperatures.

Summer Red Raspberry Cultivar Trial

In the summer red raspberry trial no cultivar combined good yield, flavor, holding-quality, and fruit size. In general, summer-harvested red raspberries break down rapidly. This is mainly attributed to the warmer fruit and higher rates of fruit respiration. Festival was outstanding for yield (Table 4), but its fruit size was small (Table 2) and its flavor was not noteworthy. Yields of Canby and Titan progressively declined from 1989-1991. The decline in yield may be due to greater injury sustained by buds (Table 3). The red raspberry cultivar trial was planted in a well-drained, shallow soil which may also explain part of the decline in yield. However, the cultural practices trial was planted in a deep sandy loam soil and the same decline in yield and degree of bud damage were observed in Canby and Titan. It is doubtful

Table 1. Yield of purple and black raspberries, 1989-1992.

Year	Yield (lb/acre)			
	Purple Raspberries		Black Raspberries	
	Brandywine	Royalty	Haut	Jewel
1989	3989	3772	2959	2575
1990	3199	3368	1600	1241
1991	7350	7866	4291	2394
1992	3281	3769	1839	2251
MEAN	4454 a	4694 a	2672 b	2115 b

a Numbers followed by the same letter in a row are not significantly different by Duncan's Multiple Range Test (P = 0.05).

Table 2. Mean fruit size in oz/100 berries of red, black, and purple raspberries.

Summer Red*		Cultural*		Fall Red*		Black and Purple*	
Cultivar	Size/100	Cultivar	Size/100	Cultivar	Size/100	Cultivar	Size/100
Taylor	6.9 a**	Canby	9.1 a	Heritage	5.9 a	Haut	5.1 a
Canby	7.3 a	Titan	13.0 b	Ruby	8.2 b	Jewel	6.8 b
Festival	7.8 a					Brandywine	9.2 c
Titan	10.1 b					Royalty	11.4 d

* Summer Red Raspberry and Cultural Trial data for 1989-1991. Fall Red Raspberry Trial data for 1988-1992; and Black & Purple Raspberry Trial data for 1989-1992.

** Numbers followed by the same letter in a column are not significantly different by Duncan's Multiple Range Test (P = 0.05).

Table 3. Percentage of dead buds in early spring in red, purple, and black raspberries, 1990-1992.

Black/Purple		Summer Red		Cultural Trial	
Cultivar	Dead Buds	Cultivar	Dead Buds	Cultivar	Dead Buds
Haut	16.5% a	Festival	10.5% a	Canby	41.6% a
Jewel	20.8% a	Taylor	20.0% b	Titan	46.0% b
Brandywine	21.2% a	Titan	37.8% c		
Royalty	26.2% a	Canby	47.2% d		

a Numbers in a column followed by the same letter are not significantly different by Duncan's Multiple Range Test (P = 0.05).

Table 4. Yield of summer red raspberries, 1989-1991.

Year	Yield (lb/acre)			
	Festival	Canby	Taylor	Titan
1989	6563	6141	4357	2894
1990	5314	2491	2162	1595
1991	7958	1711	2772	358
MEAN	6611 a	3450 b	3097 b	1616 c

a Numbers followed by the same letter in a row are not significantly different by Duncan's Multiple Range Test (P = 0.05).

Table 5. Yield of fall red raspberries, 1988-1992.

Year	Yield (lb/acre)	
	Heritage	Ruby
1988	7729	5780
1989	3645	1657
1990	6174	2778
1991	8999	4973
1992	6002	1878
MEAN	6510 a	3412 b

a Numbers followed by the same letter in a row are not significantly different by Duncan's Multiple Range Test ($P = 0.05$).

the plots suffered excessive drought stress as supplemental irrigation was supplied during the growing season. Indeed, the summer red raspberry study and cultural practice trial were terminated in 1991 because the vigor of Canby and Titan were so poor. Festival had the lowest bud damage (10%) of any summer raspberry and its yield was consistently high. Taylor had 20% dead buds and showed lower reductions in yield than Canby and Titan. These results suggest bud hardiness is important in sustaining summer red raspberry yields.

Fall Red Raspberries

The results of the fall red raspberry trial in which the cultivars were randomized with the summer red raspberries showed why Heritage is the main cultivar grown in Connecticut (Table 5). It performed well where most

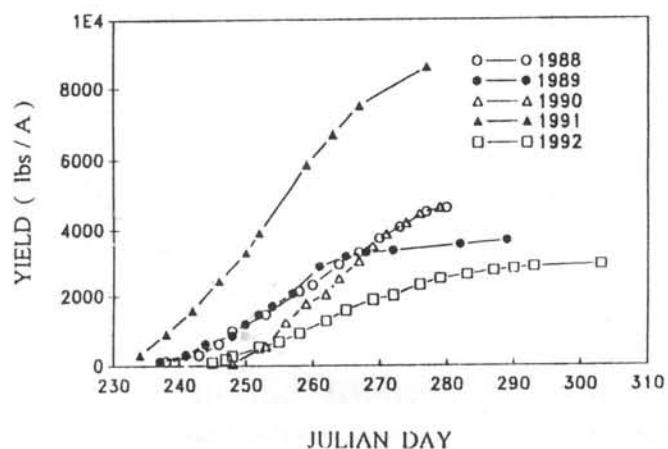


Figure 2. Cumulative yield of fall-harvested Heritage red raspberry over 5 years.

summer red raspberry cultivars failed. The cultivar Ruby did not perform well in this trial. The yield of Heritage is to a great extent controlled by the prevailing weather. The length of the harvest season and overall yield in the fall (Fig. 2) are influenced by weather in the late summer and fall.

In 1991 yields were exceptional as the warm autumn temperatures and the long length of harvest combined to give an excellent yield. In contrast, in 1992 it was cool and moist throughout the summer and fall. The harvest interval in 1992 was long, but the cool, moist summer and fall did not favor good flowering. In more normal years, it is usually the first hard frosts that terminate harvest of the fall crop.

The results show that Heritage is the best among the red raspberry cultivars tested. However, a cultivar which ripens a few weeks earlier than Heritage would probably increase yield by extending the harvest season and offsetting loss due to early frosts. In addition, Heritage suffers from small fruit size (Table 2) so an ideal cultivar would also have larger fruit size while maintaining at least the same yield potential as Heritage.

Cultural Practices Trial

In the cultural practices trial yield and plant stand of the cultivar Titan progressively declined from 1989-1991. Canby also declined, but to a lesser degree than Titan (data not shown). The yield for the two cultivars in 1989, 1990, and 1991 averaged 6011, 2874, and 1285 lbs/A, respectively. However, there was no significant difference in yield between cultivars over the 3 years of study (Table 6). Among the trellises, yields were significantly lower in LT than NT, VT, and WT. The greatest average yield was produced on WT, indicating lower cane density somehow influenced yield. It is possible that the lower cane density resulted in larger canes which would have increased the yield potential. Yields were also significantly greater in the grass groundcover treatment than in the bare soil treatment. This may be due to two effects: (1) Fewer fruit are damaged by splashing soil with a grass groundcover, and (2) since drip irrigation was used, the grass groundcover never competed for moisture to a degree which would stress the raspberry plants.

Trellis configuration had no significant effect upon fruit size with LT, NT, VT, and WT trellises producing mean fruit weights of 11.3, 10.7, 11.4, and 10.8 oz/100 berries, respectively. However, trellis configuration had a significant effect upon frequency of dead buds (Table 6). Linear and narrow trellises produced the greatest bud damage. The degree of bud death correlates well with the trend in yield. That is, the greater the bud death, the lower the yield. These data do not tell how trellis is related to bud death, but one can speculate that the wide trellis and V trellis may have produced stronger primocanes which could better resist winter injury.

Table 6. Effect of trellis and inter-row aisle vegetation on summer red raspberry yields and bud survival, 1989-1990.

Trellis	Yield (lb/A)	Dead Buds (%)	Aisle	Yield (lb/A)	Cultivar	Yield (lb/A)
L	2695 a	49 b	Bare	3127 a	Canby	3363 a
N	3258 b	44 ab	Grass	3654 b	Titan	3417 a
NV	3660 c	42 ab				
W	3948 c	41 a				

a Numbers followed by the same letter in a column are not significantly different by Duncan's Multiple Range Test ($P = 0.05$).

REFERENCES

Crandall, P.C. and H.A. Daubeney. 1990. Raspberry management. pp 157-213. *In*: Galletta, G.J. (ed.) Small fruit crop management. Prentice Hall, Englewood Cliffs, NJ.

Pritts, M. and D. Handley (eds.). 1989. Bramble production guide. NARES-35. Northeast Regional Agricultural Engineering Service, Ithaca, NY.

Stephens, G.R. and R. K. Kiyomoto. 1990. Raspberries: a revived crop for Connecticut farms. Conn. Agr. Expt. Sta., New Haven. *Frontiers of Plant Science* 43(1):2-4.



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