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渭北富士苹果拉枝角度与成花量及果实偏斜度的相关性分析

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摘要:为研究富士苹果不同结果枝角度对花芽数量及果实偏斜度的影响,于2015-2016年在渭南市白水县的2个乡镇,以20~23年生乔化富士为试验材料,调查分析结果枝角度、单位成花量、果实着生位置、果实着生角度、果实偏斜度、果形指数的相互关系。结果表明:结果枝的垂直角度与枝条的单位成花量表现出极显著的正相关,相关系数为0.886(n=110,$P<0.01$);结果枝水平角度的绝对值与果实着生角度、果实偏斜度分别存在极显著负相关和正相关,相关系数分别为-0.615、0.434(n=409,$P<0.01$);结果枝的垂直角度与果实偏斜度呈现显著的二元一次线性关系,当结果枝垂直角度为113.75°时,果实偏斜度最低;果实着生角度与果形指数、果实偏斜度都存在极显著正相关,相关分别系数为0.362、0.355(n=409,$P<0.01$);果形指数与果实偏斜度存在显著负相关,相关系数为-0.276(n=409,$P<0.05$);果实着生位置对果实偏斜度的差异性显著,果实顶生的偏斜度最高,背上的偏斜度次之,背下的偏斜度最低。综上所述,苹果拉枝角度对成花量及果实的偏斜度影响显著,随着结果枝角度的增大,成花量增加,而果实偏斜度先减小后增大。结合成花量与偏斜度的因素,富士生产中的拉枝角度以110°~120°为宜,且尽量保留枝条背下果,疏除顶生及背上果。

关键词:苹果;拉枝角度;成花量;果实偏斜度;相关性

陕西渭北黄土高原已逐渐发展成为中国乃至世界最大的优质苹果集中产区之一[1],其中红富士占65%[2]。但富士偏斜果严重的问题降低了果实的商品率,制约着苹果产业的持续发展。据报道,影响果实偏斜的原因主要有种子发育不良和果实内源激素的分布不均匀两种说法[3-4],也有学者认为,除了种子发育不良外,还与果实的着生状态有关[5]。果实的着生状态与结果枝的开张角度存在相关性,为此本文从拉枝角度对成花量及果实偏斜度的影响进行研究,分析渭北富士苹果适宜的拉枝角度,为富士生产管理技术提供依据。

1 材料与方法

1.1 试验地概况

调查试验于2015-2016年连续两年在陕西省渭南市白水县苹果试验站和可仙村进行。白水县是陕西省优质苹果生态区,该区海拔850 m左右,年均气温11.6 ℃,年均降雨量558 mm。

1.2 材料

供试材料为22~23年生乔化栽培富士苹果(*Malus domestica* Borkh,cv.Fuji)。

1.3 方法

1.3.1 结果枝角度 将结果枝的角度分成水平角度和垂直角度,调查结果枝的水平角度时与水平方向的角度向下的角度为正角度,向上的角度为负角度,最大值为90°,最小值为-90°。将水平角度加上90°即为枝条的垂直角度,最大值为180°,最小值为0°。

1.3.2 单位成花量 2015-2016年4月测量不同角度枝条的长度,同时计算各枝条的花朵数量,单位成花量=花朵数量/枝条长度。

1.3.3 果实着生位置 将果实的着生位置分成背上、背下和顶生。

1.3.4 果实着生角度 将果实的中轴线与水平方向的夹角记为果实着生角度。

1.3.5 果实偏斜度与果形指数 将果实的偏斜度分成8个级别,$DD\leqslant 0.05$为0级,$0.05<DD\leqslant 0.1$为1级,$0.1<DD\leqslant 0.15$为2级,$0.15<DD\leqslant 0.2$为3级,$0.2<DD\leqslant 0.25$为4级,$0.25<DD\leqslant 0.3$为5级,$0.3<DD\leqslant 0.35$为6级,$DD>0.35$为7级。

$$DD=\frac{2(H\times R-h\times r)}{(H\times R+h\times r)}$$

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果形指数$=\frac{H+h}{2(R+r)}$

式中,DD 表示果实的偏斜指数;H 和 R 分别表示果实大面果实高和大果面至果心距离;h 和 r 相应表示小面果高与小果面至果心距离。

1.3.6　**数据分析**　使用 Excel 2003 和 SPSS 19.0统计软件对试验数据进行相关比较与分析。

2　结果与分析

2.1　结果枝垂直角度对单位成花量的影响

从表 1 可以看出,结果枝的垂直角度与枝条的单位成花量表现出极显著正相关,相关系数为 0.886(n=110)。并将结果枝的垂直角度与单位成花量拟合曲线,结果显示两者之间存在极强的线性关系,回归方差为 0.982 2(图 1),可以看出,平均成花量随着结果枝垂直角度的不断增大而增多。

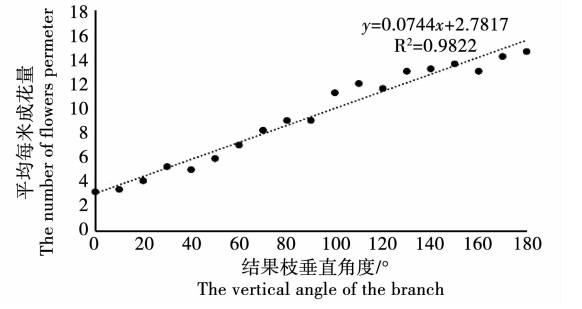

图 1　果实着生角度与成花量回归曲线

Fig. 1　The regression curve between the angle of fruit setting and the number of flowers

表 1　结果枝水平角度的绝对值与各指标的相关性

Table 1　The correlation between the absolute value of the horizontal angle of the branch and other indicators

指标 Index	结果枝水平角度绝对值 The absolute value of the horizontal angle of the branch	果实着生角度 The angle of fruit setting	果形指数 Fruit shape index	果实偏斜度 Fruit deflection rate
结果枝水平角度绝对值 The absolute value of the horizontal angle of the branch	-	−0.615**	−0.058	0.434**
果实着生角度 The angle of fruit setting	−0.615**	-	0.362**	0.355**
果形指数 Fruit shape index	−0.058	0.362**	-	−0.276*
果实偏斜度 Fruit deflection rate	0.434**	0.355**	−0.276*	-

* 表示显著性 $P<0.05$;** 表示显著性 $P<0.01$。

* represent statistical significance at 0.05 level;** represent statistical significance at 0.01 level.

2.2　结果枝水平角度绝对值与各指标的相关性

从表 1 可以看出,结果枝水平角度的绝对值与果实着生角度存在极显著负相关,相关系数为 −0.615(n=409,$P<0.01$);结果枝水平角度的绝对值与果实偏斜度存在极显著正相关,相关系数为 0.434(n=409,$P<0.01$);果实着生角度与果形指数存在极显著正相关,相关系数为 0.362(n=409,$P<0.01$);果实着生角度与果实偏斜度存在极显著正相关,相关系数为 0.355(n=409,$P<0.01$);果形指数与果实偏斜度存在显著负相关,相关系数为-0.276(n=409,$P<0.05$)。

2.3　结果枝垂直角度对果实偏斜度的影响

将结果枝垂直角度与果实偏斜度拟合曲线(图 2)可以看出,结果枝的垂直角度与果实偏斜度呈现显著的二元一次线性关系,回归方程为:$y=0.000\ 2x^2-0.045\ 5x+3.720\ 5$,回归方差为 0.931 2。果实偏斜度随着结果枝垂直角度的增大呈现出先降低后增加的趋势,计算回归曲线的极值,当果实偏斜度为最小值时,得出结果枝垂直角度为 113.75°。

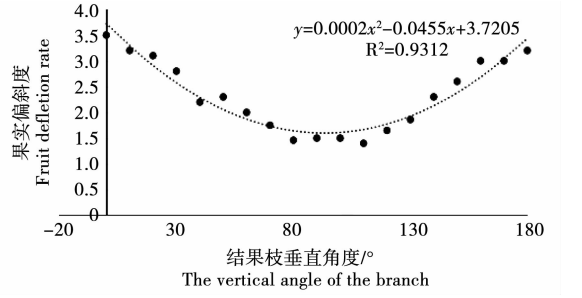

图 2　结果枝垂直角度与果实偏斜度回归曲线

Fig. 2　The regression curve correlation between vertical angle of the branch and fruit deflection rate

2.4 果实着生位置对果实偏斜度的影响

果实着生位置对果实偏斜度的影响较大(图3),果实顶部、背上、背下着生的平均偏斜度分别为5.32、3.26和1.54,其中果实顶生的偏斜度最大,背下着生的偏斜度最小。

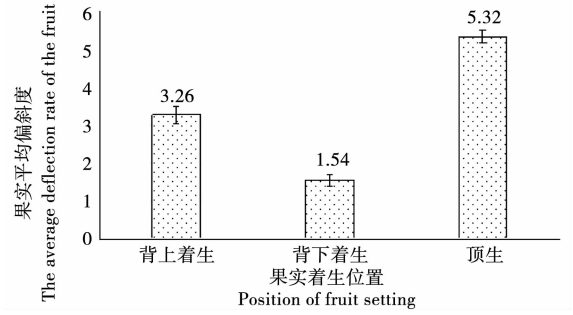

图3 果实不同着生位置的平均偏斜度

Fig. 3 The average deflection rate of the fruit different from the position of fruit setting

3 结论与讨论

拉枝是果树整形改造中经常采用的方法,拉枝可以改善树体通风透光条件,缓解树势,直接影响着树体生理特性和果实品质,对提高富士苹果产量和品质具有十分重要的意义,是解决富士成花率低,挂果困难的重要措施[6-7]。拉枝角度小,光合产物自留量少,外运数量多,成花难,结果少;角度开张的枝,导水率降低,利于成花和结果[8];开张角度过大,不利于树体结构的形成,且易造成树势衰弱[9]。汶学斌等[10]研究结果表明,随着拉枝角度的增加,各类结果枝的成花率不断增加。本研究结果与前人结果一致,随着拉枝角度的增大单位成花量越大。

孙建设等[4]研究指出,枝背下的下垂果偏斜度明显低于侧生状态的果实偏斜度,用拉枝等人为方式可改变果实着生状态,能明显降低果实偏斜指数。尚念科[11]认为,果实着生状态与果实的偏斜度存在显著相关性。陈小明等[12]指出,梨果实由顶生状态转向下垂状态是控制果实非对称生长的关键时期。本研究得出结论与前人结论相近。汶学斌[10]和李宏建[13]等的研究报导,拉枝角度增大后,端正果型,果实纵横比增大,果形指数提高。但本研究结果表明,拉枝角度与果型指数没有显著相关性,但此结论与杜荣等[14]的研究结果相一致。

本研究表明结果枝的垂直角度与枝条的单位成花量表现出极显著的正相关,相关系数为0.886(n=110,$P<0.01$);结果枝水平角度的绝对值与果实着生角度、果实偏斜度分别存在极显著负相关和正相关,相关系数分别为-0.615、0.434(n=409,$P<0.01$);结果枝的垂直角度与果实偏斜度呈现显著的二元一次线性关系,当结果枝垂直角度为113.75°时,果实偏斜度最低;果实着生角度与果形指数、果实偏斜度都存在极显著正相关,相关分别系数为0.362、0.355(n=409,$P<0.01$);果形指数与果实偏斜度存在显著负相关,相关系数为-0.276(n=409,$P<0.05$);果实着生位置对果实偏斜度的差异性显著,果实顶生的偏斜度最高,背上的偏斜度次之,背下的偏斜度最低。综上所述,苹果拉枝角度对成花量及果实的偏斜度影响显著,随着结果枝角度的增大,成花量增加,而果实偏斜度先减小后增大。结合成花量与偏斜度的因素,富士生产中的拉枝角度以110°~120°为宜,且尽量保留枝条背下果,疏除顶生及背上果。

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Correlation Analysis of the Branch Angle and Flowers and the Fruit Degree Skewness of Fuji Apple in Weibei Area

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Abstract: In order to study the effect of branch bending angle of Fuji apple on the number of flowers and the deflection rate of the fruit, we investigated and analyzed the relationship of branch bending angle, flowers, position and the angle of fruit setting, deflection rate, and fruit shape index in 20-30 years old standard Fuji apple in 2 towns throughout Baishui county of Weinan city from 2015 to 2016. The results showed that the vertical angle of the branch and the flowers had a significant positive correlation, and the correlation coefficient was 0.886 ($n=110$, $P<0.01$), the absolute value of the horizontal angle of the branch had a significantly negative correlation with the angle of fruit setting and positive correlation with the deflection rate of the fruit, and the correlation coefficient was −0.615 and 0.434 ($n=409$, $P<0.01$), deflection rate of the fruit and the vertical angle of the branch were significant two-variable linear relationship, arrived to the least point when the angle of branch was 113.75°, the angle of fruit setting had significant positive correlations with fruit shape index and the deflection rate of the fruit, and the correlation coefficient were 0.362 and 0.355 ($n=409$, $P<0.01$), fruit shape index had a significant negative correlation with fruit deflection rate, and the correlation coefficient was −0.276 ($n=409$, $P<0.05$), the position of fruit setting had a significant positive correlation with fruit deflection rate, the deflection rate of the fruit on the top of the branches were the highest, followed the fruit up the branch and the fruit down the branch. To sum up, the branch bending angle had a significant effect on flowering and the deflection rate of the fruit, the number of flowers increased with the increase of branch bending angle, and the deflection rate of the fruit was increased after decreased with the increase of branch bending angle. Combining the factor of flowering and the deflection rate of the fruit, the suggested branch bending angle were 110°-120°, and tried to reserve the fruit down the branches, and thin the fruit on the top and up the branches in the production of Fuji apple.

Keywords: apple; bending angle; flowers; deflection rate; correlation

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Effects of Foliar Fertilizer Comprised with Different Growth Regulator on Lettuce Growth

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Abstract: In order to promote lettuce growth, the experiment with Italian heat-resistance bolting lettuce varieties were taking as experimental material, and planted in energy-saving sunlight greenhouse environment, we studied the effects of different foliar fertilizer on plant height, stem diameter, aboveground's dry and fresh weight, underground's dry and fresh weight, leaf area, and chlorophyll content of lettuce. The results showed that, the treatment A (20% fulvic acid potassium + a large number of elements 25%[N8%, P5%, K12%]) was most beneficial to dry matter accumulation, the underground part and leaves' growth of lettuce. The treatment B(20% fulvic acid potassium+a large number of elements 25%[N8%, P5%, K12%] plus 10% DA-6) best promoted the increase of stem diameter and aboveground fresh weight of lettuce and treatment C(20% fulvic acid potassium + a large number of elements 25%[N8%, P5%, K12%]+5% sodium nitrophenolate) significantly promoted the plant high of lettuce, and was not conducive to the synthesis of chlorophyll in leaves of lettuce, but the inhibition effect was not significant. 5% sodium nitrophenolate combinates with 10% DA-6 could reduce the promoting effect of distribution of foliar fertilizer on lettuce. In conclusion, regulators in this study were all have a significant promoting role for the growth of lettuce, and 20% fulvic acid potassium plus a large number of elements 25%(N8%, P5%, K12%) plus 10% DA-6 had the best effect, and it's unfavorable for phenol sodium nitrate mixed with DA-6.

Keywords: lettuce; foliar fertilizer; fulvic acid potassium; DA-6; sodium nitrophenolate