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Short Communication

Do fruiting habit traits affect green fruit yield and its component traits in chilli (*Capsicum annuum* L.)?

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Abstract

In chilli, farmer preferences for fruiting habit traits, namely fruit orientation (pendant erect) and fruits node^{-1} (solitary cluster), vary from region to region. For increased acceptability by farmers/consumers, cultivars should be bred with preferred fruiting habit traits in high green fruit yielding background. An investigation was carried out to study the influence of fruiting habit traits on green fruit yield and its component traits during the 2016 and 2017 rainy seasons. The F_2, backcross populations and near-isogenic lines (NILs) derived from crosses involving parents differing for single or both the fruiting habit traits were grouped into fruiting habit classes (single and cluster fruiting; and clustered erect, clustered pendant, single erect and single pendant). Significance of differences in fruit yield and its component traits between/among different fruiting habit trait classes were examined using '*t*'/'*F* tests. The significance of '*t*'/'*F* tests was regarded as pieces of evidence for considerable effects of fruiting habit traits on fruit yield and its component traits. While results-based on F_2 and backcross generations indicated a lack of effects, those based on NILs indicated significant effects of fruiting habit traits on fruit yield and its component traits. The plants bearing pendant fruits (irrespective of whether they are clustered or single) produced a large number of heavier and longer fruits than those bearing erect fruits. The results are discussed about the strategies to develop high yielding cultivars with farmer preferred fruiting habit traits.

Keywords: fruit orientation, fruiting habit traits, fruits per node, green fruit yield

Introduction

Chilli is one of the most important commercial and spice crops in India. Hence, India emerged as the foremost producer and exporter of chilli contributing one-fourth in the world market. In chilli, fruits are the harvestable, marketable and consumable economic products. Chilli produces fruits with varying orientations and numbers. The fruit orientation and fruit number node^{-1} are referred to as fruiting habit traits. The fruit orientation is either pendant or erect (Lee *et al.*, 2008) and the number of fruits at a node is either one (solitary) or more than one (clustered). The fruit orientation is inherited as a recessive gene (*up*) in chilli (Lee, 1994).

Farmer/producer and consumer preferences for fruiting habit vary from region to region. For example, cultivars bearing small erect fruits are more preferred over other types in Thailand (Milerue *et al.*, 2016). Hence, green fruit yield, the harvestable and consumable economic product need to be maximized under preferred fruiting

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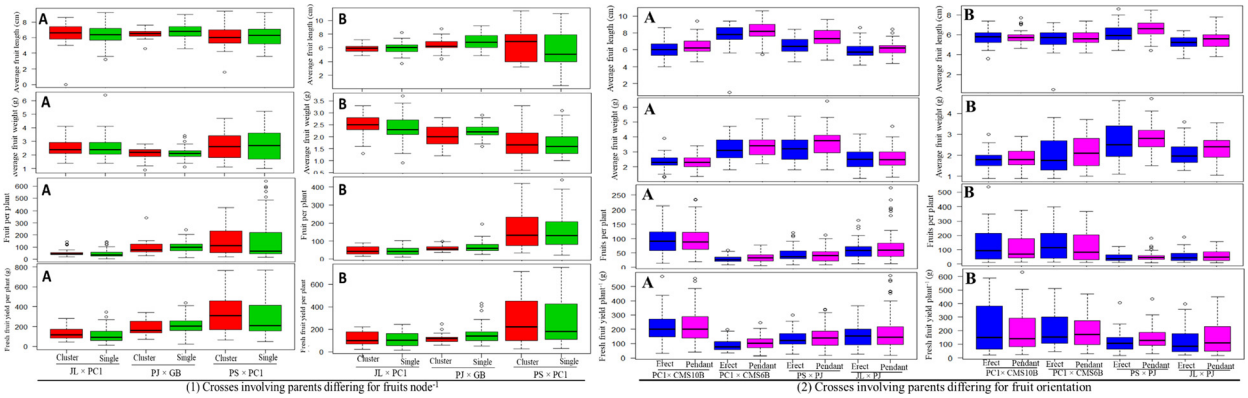


Fig. 1. Box-Whisker plots depicting the effect of (1) fruits node^{-1} and (2) fruit orientation on fruit yield and its component traits in A. F_2 population and B. Back cross populations derived from crosses involving parents contrasting fruits node^{-1} and fruit orientation in chilli.

habit background. We hypothesize that the green fruit yield in chilli is not affected by fruiting habit traits and hence, it should be possible to develop high green fruit yielding cultivars with a preferred combination of fruiting habit traits. This study was carried out to test this hypothesis.

Experimental

Eight genotypes [CMS6B, CMS10B, CMS8B, Phule Jyothi (PJ), Pusa Sadabahar (PS), Pant C-1 (PC1), Japani Long (JL) and Gowribidanur local (GB)] with four distinct fruiting habit traits – solitary erect (SE), solitary pendant (SP), clustered erect (CE) and clustered pendant (CP) (online Supplementary Table S1) (Anilkumar *et al.*, 2018) were chosen for the study.

Eight genotypes were crossed to generate ten F_1 crosses of six types (CE × SE, CP × SP, CE × CP, CE × SP, CP × SE and SE × SP) in the poly-house during the 2015 rainy season. F_1 plants were selfed to develop F_2 and backcrossed to their respective recessive parents (Anilkumar and Mohan Rao, 2018; Anilkumar *et al.*, 2020) to develop backcross populations during the 2016 summer at the experimental plots of the Department of Genetics and Plant Breeding (GPB), University of Agricultural Sciences (UAS), Bangalore, India.

Out of 10 crosses, one representing the cross involving parents differing for fruit orientation [PS × PJ] and one representing the cross involving parents differing for both fruits node^{-1} and fruit orientation [JL × CMS10B] were selected for the development of near-isogenic lines (NILs). A pair of NILs for fruit orientation from PS × PJ (PS – clustered erect and PS – clustered pendant) and three pairs of NILs for both fruits node^{-1} and fruit orientation from JL × CMS10B (JL:clustered erect and JL:clustered pendant, JL:clustered erect and JL:single erect and, JL:clustered erect and JL:single pendant) were developed by three cycles of backcrosses to PS and JL, respectively. The F_2, backcross populations and four pairs of NILs constituted the experimental material.

F_2 and backcross populations were evaluated during the 2016 and 2017 rainy seasons and four pairs of NILs were evaluated during the 2017 rainy season. Data were recorded on fruit length (cm), fruits plant^{-1}, average fruit weight (g) and green fruit yield plant^{-1} (g). Plants in each F_2, backcross and NILs were grouped into different fruiting habit classes (online Supplementary Table S2) based on visual assessment. The significance of fruit yield and its component traits among different fruiting habit classes were examined using two samples '*t*' test and '*F*' test (Fisher, 1950) as appropriate. All the analyses were performed using RStudio version 1.2.133 (RStudio team, 2019).

Discussion

In both F_2 and backcross generations evaluated during the 2016 and 2017 rainy seasons, average fruit length, fruits plant^{-1}, average fruit weight and green fruit yield plant^{-1} were comparable among plants producing either single/cluster fruits or pendant/erect fruits (Fig. 1). Similarly, in F_2 and backcross generations derived from crosses involving parents differing for both fruits node^{-1} and fruit orientation, fruit length, fruits plant^{-1}, average fruit weight and green fruit yield plant^{-1} were comparable among the plants producing any fruiting habit trait combinations, namely SP, SE, CP and CE as indicated by '*F*' test during both the seasons (online Supplementary Tables S3 & S4). These results suggest a lack of either desirable/undesirable effects in favour of any fruiting habit trait concerning green fruit yield and its component traits. Although individuals belonging to F_2 and backcrosses share comparable genetic backgrounds, they do not share a similar background. Hence, the chances of the confounding effect of genetic background on the differences between fruiting habit

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Table 1. Relationship of fruits node^{-1} and fruit orientation with fruit yield and its component traits in NILs in chilli

Crosses	Phenotypic classes	Fruit length (cm)			Fruits plant^{-1}			Average fruit weight (g)			Green fruit yield plant^{-1} (g)		
		Mean	'*t*'/*F* statistic	Prob	Mean	'*t*'/*F* statistic	Prob	Mean	'*t*'/*F* statistic	Prob	Mean	'*t*'/*F* statistic	Prob
Pus sadabahar (PS) × Phulee Jyothi (PJ)	PS (clustered erect)	4.52	0.21	0.83	60.47	0.56	0.58	2.64	0.55	0.58	159.56	0.87	0.39
	PS (clustered pendant)	4.48			56.47			2.57			143.43		
Japani Long (JL) × CMS 10B	JL (cluster erect)	6.37	9.37	0.00	123.56	17.23	0.00	3.02	33.57	0.00	375.45	6.10	0.00
	JL (cluster pendant)	6.70			116.79			3.47			393.74		
	JL (single erect)	6.23			158.72			2.70			431.65		
	JL (single pendant)	6.22			190.45			2.78			514.79		

classes for green fruit yield and its component traits in F_2 and backcross generations cannot be ruled out. The chances of the confounding effect of genetic background are minimized when NILs are used for investigating the effect of fruiting habit traits on green fruit yield.

In one of the four pairs of NILs derived from PS × PJ (differing only for fruit orientation), the estimates of fruit length, fruits plant^{-1}, average fruit weight and green fruit yield plant^{-1} were comparable between cluster-erect and cluster-pendant fruiting habit classes as indicated by '*t*' statistic (Table 1). In other three pairs of NILs (derived from JL × CMS10B) differing for both the fruiting habit traits, fruits plant^{-1} and green fruit yield plant^{-1} were higher in the single-pendant fruiting habit class than those in single-erect class; while average fruit weight and fruit length were higher in cluster-pendant class than those in cluster-erect fruiting habit class as indicated by significant '*F*' test (Table 1). Thus, the results from NILs indicate that plants bearing pendant fruits (irrespective of whether they are clustered or single) produce a large number of heavier and longer fruits than those bearing erect fruits. NILs share isogenic genetic background except for fruiting habits. Whereas F_2 and backcrosses share a genetic background from both parents accounting for differences in results.

Non-significant differences between fruiting habit classes for fruit yield and its contributing traits in both F2 and backcross populations and one pair of NILs indicated the lack of influence of fruiting habits on fruit yield and its contributing traits. However, there was a significant difference between NIL pairs with different fruiting habits developed from another pair of parents differing for both fruit orientation and fruits node^{-1}. These results indicate the possibility of developing high yielding cultivars that produce pendant fruits.

Supplementary material

The supplementary material for this article can be found at https://doi.org/10.1017/S1479262121000058.

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Author's contribution

Conceptualization of research (AMR, SR); designing experiments (CA, AMR, SR, TLP); the contribution of experimental material (AMR); execution of field/lab experiments and data collection (CA); analysis of data and interpretation (CA, AMR, SR); preparation of the manuscript (CA, SR, AMR).

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