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Effect of mulching on economics studies of vegetables as intercrop in the kinnow orchard under agro-climatic condition of Bastar plateau of Chhattisgarh

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Abstract
A field experiment entitled "Effect of mulching on economics studies of vegetables as intercrop in the Kinnow orchard under agro-climatic condition of Bastar plateau of Chhattisgarh" was conducted during the *Rabi* season of 2016-17 at the Instructional farm, College of Horticulture and Research Station, Jagdalpur (C.G.). The experiment was laid out in T-test with three replications. The treatment consisted of mulched and non-mulched plots in four different crops *viz.*, tomato, chilli, brinjal and bitter gourd. The mulched plots of tomato recorded the maximum yield ha^{-1} (130.33q) and benefit cost: ratio of (2.66). However, the non-mulched plots recorded the maximum yield ha^{-1} (100.00q) and benefit cost: ratio of (2.56).

Keywords: maximum, yield and economics

Introduction
Kinnow is a high yield mandarin hybrid cultivated extensively in the wider Punjab region of Pakistan and India. It is a hybrid of two citrus cultivars King (*Citrus nobilis*) × Willow Leaf (*Citrus × deliciosa*) first developed by Howard, B. Frost at the University of California Citrus Experiment Station. After evaluation, the kinnow was released as a new citrus hybrid for commercial cultivation in 1935. In a hot climate, plants can grow up to 35 feet high Kinnow trees are highly productive. It is not uncommon to find 1000 fruits per tree in usual (Rattanpal *et al.*, 2008) [7]. In India, Kinnow is being grown in Punjab, Rajasthan, Haryana, Himachal Pradesh, Jammu & Kashmir and Uttar Pradesh. Mulching is the process or practice of covering the soil surface to make it more favourable for plant growth, development and efficient crop production. Natural mulches such as leaf, straw, dead leaves and compost have been used for centuries, during the last 60 years the advent of synthetic materials has altered the methods and benefits of mulching. Tomato (*Solanum lycopersicon* L.) is one of the most popular and versatile cash earning vegetable crop and plays a vital role in culinary purposes for its nutrients, delicious taste and various modes of consumption i.e. fresh as salads, cooked vegetables and its utilization in preparation of range of processed products such as puree, paste, powder, ketchup, sauce, soup and canned whole fruits. In India, tomato is cultivated in about 791 thousand hectares area with the production of 173.98 t ha^{-1} (Horticulture Statistics Division, 2015) [5]. In Chhattisgarh also, tomato is one of the top ranking vegetable and is estimated to be grown on about 414.440 hectares area comprising three leading districts of the state *viz.* Bilaspur 74.05 ha, Jashpur 51.43 ha and Durg 44.10 ha (Directorate of Horticulture, 2015). Brinjal (*Solanum melongena* L.) is a common vegetable crop grown in the sub-tropics and tropics. It is called eggplant in USA and aubergine in Europe. It is being produced in 14.76 million tonnes from an area of 23.63 million hectare (Horticulture Statistics Division, 2015) [5]. Chhattisgarh produces nearly 606.711 metric tonnes of brinjal from an area of 334.21 hectares whereas; Jagdalpur region of Bastar produces 124.00 metric tonnes from an area of 77.5 hectares (Directorate of Horticulture, 2015) [5]. Chilli (*Capsicum annuum* L.) is an important spice crop belonging to the family Solanaceae. Chilli is widely cultivated throughout the warm temperature of tropical and sub-tropical countries and is a native to Mexico. Its fruits are rich source of vitamin C, A and E. Nearly 19.83 million tonnes of it is being produced from an area of 17.0 million hectare (Horticulture Statistics Division, 2015) [5]. Chhattisgarh produces 640.027 metric tonnes of chilli from an area of 911.15 hectares. The region in Bastar produced 119.07 metric tonnes of chilli from an area of 10.85 hectares (Directorate of Horticulture, 2015) [4]. Bitter gourd (*Momordica charantia* L.) is grown for its bitter tender fruits. It is a rich source iron. It can be canned and pickled.

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India produces 12.40 million tonnes of bitter gourd from an area of 12.2 million hectares (Horticulture Statistics Division, 2015) [5]. Chhattisgarh produces 130.772 metric tonnes from an area of 103.85 hectare whereas Jagdalpur region of Bastar produces 31.00 metric tonnes from an area of 31.0 hectares (Directorate of Horticulture, 2015) [4].

Materials and Methods
The study was conducted during *Rabi* season 2016-17 at the Instructional farm, College of Horticulture and Research Station, Jagdalpur (C.G.). The experiment was laid out in T-test with three replications. The treatment consisted of mulched and non-mulched plots in four different crops *viz.*, tomato, chilli, brinjal and bitter gourd. **.**

Economics
Cost of production for all treatment was worked out on the basis of the inputs used and market price existing for the produce. The net return ha^{-1} was calculated by deducting the cost of production ha^{-1} from the gross return ha^{-1}. Ultimately, net return per rupees (Benefit: Cost ratio) was calculated treatment wise to assess the economic impact of the treatment by dividing the net return ha^{-1} by the cost of production.

$$\text{Benefit-Cost ratio} = \frac{\text{Gross returns (ha}^{-1})}{\text{Cost of cultivation (ha}^{-1})}$$

Results and Discussion
Yield ha^{-1} (q) **-** The data on the effect of fruit yield (q ha^{-1}) with and without mulches has been presented in Table 4.19 for tomato, chilli, brinjal and bitter gourd. The mean yields of the mulched plot were 130.33, 30.00, 200.00, and 101.66 while that of the non mulched plots were 100.00, 19.66, 100.00, 80.00q ha^{-1} for tomato, chilli, brinjal and bitter gourd respectively. The effect of the mulched plots on fruit yield was significant for all the crops under study. Similar kind of observations was also reported by Awasthi *et al.* (2006) [3], Ashrafuzzaman *et al.* (2011) [2] and Singh *et al.* (2017) [9].

Economics
The gross income (Rs ha^{-1}) with the mulched and non-mulched plots has been given in Table 4.31. In the mulched plots the gross income was observed to be 104264.00, 45000.00 and 100000.00 and 202000.00 whereas in the non-mulched plots it was recorded to be 80000.00, 28599.00, 50000.00 and 160000.00 respectively for tomato, chilli, brinjal and bitter gourd. The highest gross return in the mulched plots and non-mulched plots was recorded in bitter gourd followed by tomato. The mulched plots recorded an amount of Rs 202000.00 ha^{-1} in bitter gourd followed by Rs 104264.00 ha^{-1} tomato while that in the non-mulched plots it was observed to be bitter gourd Rs 160000.00 ha^{-1} followed by Rs 80000.00 ha^{-1} tomato. Similar results were reported by Singh (2017) [9].

Table 4.3: Yield ha^{-1} (q) in the mulched and non-mulched intercrops in the Kinnow orchard

S. No.	Crop	With mulch	Without mulch	t-value	P -value	Test of significance
1.	Tomato	130.33	100.00	20.87	0.001	Significant
2.	Chilli	30.00	19.66	7.11	0.001	Significant
3.	Brinjal	200.00	100.00	5.69	0.002	Significant
4.	Bitter gourd	101.66	80.00	9.28	0.003	Significant

Table 4.4: Economics of kinnow based intercropping with mulch

Treatments	Yield (q/ha)	Gross income (Rs)	Treatment Cost (Rs.)			Net return (Rs)	Benefit: Cost Ratio (BCR)
			Fixed Cost	Variable Cost	Total Cost		
Tomato	130.33	104264.00	35081.00	4100.00	39181.00	65083.00	2.66
Chilli	30.00	45000.00	31801.00	4100.00	35901.00	9099.00	1.25
Brinjal	200.00	100000.00	35081.00	4100.00	39181.00	60819.00	2.55
Bitter gourd	101.66	202000.00	37481.00	4100.00	41581.00	160419.00	4.85

Sale price of tomato @ Rs. 8/kg; chilli @ Rs 15/kg; brinjal @ Rs 5/kg; bitter gourd @ Rs 20/kg.

Table 4.5: Economics of kinnow based intercropping without mulch

Treatments	Yield (q/ha)	Gross income (Rs)	Treatment Cost (Rs.)			Net return (Rs)	Benefit :Cost Ratio (BCR)
			Fixed Cost	Variable Cost	Total Cost		
Tomato	100.00	80000.00	27081.00	4100.00	31181.00	48819.00	2.56
Chilli	19.66	28599.00	23801.00	4100.00	27901.00	698.00	1.02
Brinjal	100.00	50000.00	27081.00	4100.00	31181.00	18819.00	1.60
Bitter gourd	80.00	160000.00	29481.00	4100.00	33581.00	126419.00	4.76

Sale price of tomato @ Rs. 8/kg; chilli @ Rs 15/kg; brinjal @ Rs 5/kg; bitter gourd @ Rs 20/kg.

Net returns (Rs ha^{-1})
The net returns (Rs ha^{-1}) were the highest in the treatments having mulch. Bitter gourd (160419.00) followed by tomato (65083.00) recorded the maximum net returns in the mulched plots while in the non-mulched plots bitter gourd and tomato recorded a net return of Rs 126419.00 and Rs 48819.00 ha^{-1} respectively. The lowest net return was obtained in chilli in the mulched (9099.00) and non-mulched plots chilli Rs 698.00 ha^{-1} respectively. The highest net returns with the drip and plastic mulch treatment may be attributed to the higher yield of fruits. Similar results were reported by Singh (2017) [9] and Suresha *et al.* (2007) [10].

Benefit-cost ratio
The benefit-cost ratio was higher in bitter gourd and tomato both in the mulched (4.85 and 2.66) and non mulched plots (4.76 and 2.56 respectively). Similar results were reported by Prajapati *et al.* (2016) [6] and Singh (2017) [9].

Conclusions
The present investigation revealed that among the mulched and non-mulched treatments, plastic mulch recorded comparatively higher yield attributes of tomato, chilli, brinjal and bitter gourd as intercrops in the kinnow orchard. Higher

economic returns were obtained with mulch under tomato, chilli, brinjal and bitter gourd intercropping system.

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