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Genotypic differences in growth, yield and quality attributes of capsicum (*Capsicum annuum*) under black polyethylene mulch

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ABSTRACT

A field experiment was conducted during rainy (*kharif*) seasons of 2006–08 to study the response of different genotypes of capsicum (*Capsicum annuum* L.) grown under mulch and without mulch for growth, yield and quality attributes at high hills of Garhwal region. Varietal differences were prominent at both situations. Plant growth and fruit yield of genotypes significantly improved with mulching. Plant height varied from 32.27 cm ('Miety') to 38.15 cm ('Orobelle') under mulch and 26.20 cm ('Miety') to 33.15 cm ('Bomby') under non- mulch conditions. Mulch induced earliness by advancing the crop by 26 days ('California Wonder', 'Miety', 'Orobelle' and 'Green Beauty') to 38 days ('Tanvi'). Harvest duration was extended by 29 days ('California Wonder' and 'Green Beauty') to 50 days ('McKong') under mulch. Differences in the incidence of collar rot (*Phytophthora capsici* Leonian) were observed among the genotypes as well as between the treatments. It ranged from 1.15 ('Orobelle') to 5.00% ('Bomby') and 4.75 ('Green Beauty') to 14.50% ('Bomby') under mulch and without mulch treatments, respectively. Increase in yield over unmulched varied from 3.06 ('Miety') to 19.07% ('Green Beauty').

Key words: Black polyethylene, Capsicum, *Capsicum annuum,* Collar rot, Genotypes, Growth parameters, Mulch, Yield

The production of vegetables in protected environments is suffering great transformation for improved yield which requires great effort in the direction of identifying and eliminating the technological shortcomings. Vegetable production may be optimised by applying management techniques and technologies that will not threaten the natural soil functions. Fertigation in combination with mulching can provide ecologically desirable conditions for maximum yields of vegetables and, from the aspect of sustainable agriculture, can contribute to a more economical use of water, decreased nutrient leaching from the soil and thereby reduced fertilizer requirements (Bowen and Frey 2002). Mulch films are used in horticultural practice to raise soil temperature, suppress weeds, and control soil borne pathogens and conserve soil water (Brault *et al*. 2002). Sweet pepper (*Capsicum annuum* L.) is an important high value vegetable crop grown for its immature fruits throughout the world. The high market price is attributed to the heavy demand from the urban consumers and has become money spinner for the hill farmers wherein ideal climatic conditions enable its off-season production during the period (June-October) when the crop does not grow well in the adjoining plains on account of unfavourable temperature. But at the same time it is essential to select genotypes which suit to the area and have resistance to diseases. Use of plastics in capsicum cultivation can play a pivotal role in minimizing plant mortality, increasing productivity and can fetch good price by enhancing earliness and by extending harvest duration. In the present communication an attempt has been made to study the genotypic differences of capsicum in respect to growth, yield and other attributes grown with black polyethylene mulch under rainfed conditions of high hills.

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MATERIALS AND METHODS

A field trial was conducted during 2006–2008 at Veer Chander Singh Garhwali College of Horticulture, G B Pant University of Agriculture and Technology, Bharsar (Pauri Garhwal) located at latitude of 30°03′35″N, longitude of 78°59′42″and at an altitude of 2200 m above mean sea level.

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The area falls under central Himalayan region and the climate of the area is wet temperate. Seven genotypes, namely 'California Wonder', 'Miety', 'Orobelle', 'Green Beauty', 'McKong', 'Bomby' and 'Tanvi' were included in the present experiments. Six weeks old seedlings were planted in the raised beds at a spacing of 45 cm × 45 cm in the second week of May in a plot size of 3 m × 2 m (6 m^2) under black polythene mulch as well as without mulch. The experiment was laid out in randomized block design with 4 replications. The recommended packages of practices were followed to raise the healthy crop. Observations were recorded on different parameters, viz plant height (cm), average fruit weight (g), days to first picking, harvest duration (days) and fruit yield (tonnes/ha) and disease incidence (%). The data were subjected to statistical analysis and the least significant difference was used to compare the values (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Plant growth and fruit yield of capsicum was significantly improved with mulching over control (Table 1). The varietal differences were prominent for all the parameters in both the situations. Significantly higher plant height was recorded under mulch in comparison to unmulched treatment. Irrespective of the mulch, highest plant height (35.29 cm) was recorded in 'Bomby' while least in 'Miety' (26.20 cm). 'Bomby' fruits were the heaviest (77.54 g) while lightest fruits were of 'California Wonder' (57.07 g) irrespective of the treatment. Genotype × mulch interaction revealed that fruit weight of 'Bomby' (unmulched) and 'McKong' (mulch) did not differ significantly while in all other combinations it differed significantly. Marked differences in the treatments for days to first picking as mulching induced earliness in all the genotypes. Irrespective of the genotypes, it took 35.29 days under mulch for picking to start in comparison to 66.86 days under without mulch. The crop was advanced by 26 days ('California Wonder', 'Miety', 'Orobelle' and 'Green Beauty'), 36 days ('McKong' and 'Bomby') and 38 days in 'Tanvi'. Most of the genotypes took 32 days for first picking after transplanting under mulch while it was 58 days in without mulch treatment. Duration varied from 32 to 41 days under mulch and 58 to 79 days under without mulch treatment. 'California Wonder', 'Miety' and 'Green Beauty' took minimum days (45) for picking while maximum (60) was recorded in 'Tanvi'. On the other hand, extended crop duration was observed under mulch treatment. Harvest duration (after first picking) varied from 59 to 76 days and 23 to 47 days under mulch and without mulch treatments, respectively. Shortest harvest duration was observed in 'Tanvi' (23 days) while longest harvest duration (47 days) was recorded in 'California Wonder' and 'Green Beauty' under traditional method of crop raising. Under mulch treatment, 'Bomby' and 'Tanvi' genotypes were earliest to terminate while in rest of the genotypes it took 76 days (after

Table 1 Performance of capsicum genotypes grown under mulch vis-à-vis without mulch (mean data of 3 years)

Genotype	Average plant height (cm)			Average fruit weight (g)			Days to first picking			Harvest duration (days)			Collar rot incidence (%)			Yield (tonne/ha)			Increase in yield over unmulched (%)	Additional income (₹)
	M	UM	Mean	M	UM	Mean	M	UM	Mean	M	UM	Mean	M	UM	Mean	M	UM	Mean		
'California Wonder'	35.13	30.43	32.78	60.52	57.07	58.79	32.00	58.00	45.00	76.00	47.00	61.50	3.50	8.25	5.87	27.5	22.6	25.0	18.00	74 250
'Miety'	32.27	26.20	29.23	66.67	64.31	65.49	32.00	58.00	45.00	76.00	45.00	60.50	2.75	7.75	5.25	41.3	40.0	40.7	3.06	18 945
'Orobelle'	38.15	28.69	33.42	72.85	71.25	72.05	32.00	63.00	47.50	76.00	39.00	57.50	1.15	5.00	3.07	36.1	31.3	33.7	13.21	71 520
'Green Beauty'	33.89	27.85	30.87	73.53	71.61	72.57	32.00	58.00	45.00	76.00	47.00	61.50	1.25	4.75	3.00	39.3	31.8	35.6	19.07	1 12 470
'McKong'	33.75	28.47	31.11	74.13	72.63	73.38	39.00	76.00	57.50	76.00	26.00	51.00	4.15	11.0	7.57	38.7	31.9	35.3	17.50	1 01 580
'Bomby'	37.44	33.15	35.29	79.09	76.00	77.54	39.00	76.00	57.50	59.00	28.00	43.50	5.00	14.5	9.75	30.9	29.7	30.3	3.91	18 075
'Tanvi'	35.80	31.30	33.55	64.75	62.00	63.37	41.00	79.00	60.00	61.00	23.00	42.00	4.50	12.8	8.67	26.7	25.5	26.1	4.25	16 980
Mean	35.20	29.44		70.22	67.84		35.29	66.86		71.43	36.43		3.18	9.15		34.3	30.4			
	$CD_{0.05}$	SE		$CD_{0.05}$	SE		$CD_{0.05}$	SE		$CD_{0.05}$	SE		$CD_{0.05}$	SE		$CD_{0.05}$	SE			
Genotype (G)	0.86	0.42		2.39	1.61		1.92	0.93		2.41	1.17		1.64	0.80		23.00	11.19			
Mulching (M)	0.46	0.22		1.28	0.62		1.03	0.49		1.29	0.63		3.07	1.50		12.29	5.98			
GX M	1.21	0.59		3.37	1.64		2.71	1.32		3.39	1.65		4.36	2.12		32.53	15.82			

M, Mulched; UM, unmulched; Sale price: ₹ 15,000/tonne

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first picking) for the termination of the crop. Genotype × mulch interaction revealed significantly superior results under mulch treatment.

Significant differences in the growth parameters and yield were observed among the genotypes which may be due to the genetic potential of these genotypes. The highest yield of 'Miety', followed by 'Green Beauty' and 'McKong' may be associated with the parameters, like fruit weight, plant height, early picking, and longest harvest duration and less disease incidence. In 'Bomby' despite of maximum plant height and fruit weight low yield was harvested which might be due to more days to first picking, short harvest duration and high incidence of collar rot. On the other hand, lowest yield in case of 'California Wonder' may be due to small fruit size while in case of 'Tanvi', it might be due to more days to first fruit harvest and shorter harvest duration. These results are in line with Chatterjee and Kohli (2001). Selection on the basis of horticultural traits, viz average fruit weight and number of fruits per plant are paying preposition in the genotypes (Sharma *et al*. 2010). In addition to these, crop duration, early flowering and disease index might lead to increase in yield (Leaya and Khader 2002). Plant growth and fruit yield of capsicum were significantly superior under mulch in comparison to the open field conditions. Plastic mulches directly affect the microclimate around the plant by modifying the radiation budget of the surface and decreasing the soil water loss and compaction of soil, which provides a better environment for root growth. Black polyethylene mulch greatly inhibits light penetration to the soil, thereby decreasing weed density and increase the soil temperature which promotes faster crop development and earlier yields. This variation in growth parameters and yield may be due to moderation in soil temperature, improved soil moisture, reduction in weed population, induction of higher root growth etc. which might have provided more congenial environment for the growth of these genotypes. Moreover, adequate presence of moisture to plants results in full cell turgidity and eventually higher meristematic activity leading to more foliage development, greater photosynthetic rate and consequently better plant growth. The results of present findings are in accordance to earlier workers who reported significantly higher yield under mulch because of effective weed control and conservation of soil moisture (Singh *et al.* 2005, Awodoyin *et al.* 2007, Mehta *et al*. 2010). Similarly Saren *et al*. (2008) reported higher yield and quality attributing parameters of niger (*Guizotia abyssinica*) under black polythene mulch. Lourduraj (2003) found significant increase in all yield parameters (plant height, fruits per plant, fresh fruit girth, fresh fruit length and fresh fruit yield) of chillies grown with mulch and net returns compared with the unmulched control.

Differences in the incidence of collar rot (*Phytophthora capsici* Leonian) were observed among the genotypes as well as between the treatments. The incidence varied from 1.15 to 5.00% and 4.75 to 14.50% under mulch and without mulch treatments, respectively. Genotype × mulch interaction revealed that incidence in 'Green Beauty' (without mulch) is at par with the incidence of all genotypes except 'Bomby' under mulch conditions. Low incidence of collar rot under mulch treatment might be due to non-stagnation of water in the field and as a physical barrier to dispersal of sources of soil borne inoculum to aerial portions of plants. The use of black plastic mulch and training methods significantly reduced the incidence of *Phytophthora nicotianae* var. *parasitica* (Mehta *et al*. 2010).

Significant differences were recorded among genotypes and between treatments for yield per unit area. Genotype × mulch interaction revealed that yield of 'Miety' (without mulch) is at par with the yield of 'Green Beauty' and 'McKong' under mulch conditions. Under mulch conditions 6–9 pickings were taken being minimum in 'Bomby' and 'Tanvi' and highest in' Orobelle' and 'Green Beauty', while only 4 pickings were taken under unmulched condition. Up to 6 pickings, 63–85% yield were harvested depending upon the genotypes under mulch. Increase in yield over unmulched varied from 3.06 to 19.07% being lowest in 'Miety' and highest in 'Green Beauty'. 'Miety', 'Bomby' and 'Tanvi' genotypes followed (yield wise) almost similar trend under both the situations. Highest returns/unit area was obtained with 'Green Beauty', followed by 'McKong' while lowest was obtained with 'Tanvi' followed by 'Bomby' and 'Miety'.

Mulching, apart from numerous other advantages, protects the bed from direct infiltration of excessive precipitation, which reduces the possibility of nutrients leaching from the root zone. Black polyethylene mulch is an enduring and impermeable material which also protects the bed from nitrate leaching in the rainy season, when the highest nitrate leaching occurs on unmulched soil (Romic *et al*. 2003). Present studies were conducted during rainy season and mulch might have protected the soil from leaching of nutrients and stagnation of water which provided congenial conditions for the growth of plants. Black polyethylene mulch increased pod yield of okra by 29.65% over no mulch (Patel *et al*. 2009). The use of mulch resulted in 33–46% increase in economic returns of bell pepper (Palada *et al*. 2000) and black plastic mulching resulted in highest net returns (₹ 74 600/ha) and ₹ 64 000/ha increase in the net seasonal income (Nagalakshmi *et al*. 2002).

It may be inferred that use of black polythene was much conducive for inducing earliness, extending harvest duration and for higher yields and suits to the vegetable growers of hills. Specific simple changes in cultural practices can have dramatic effects on the development of Phytophthora epidemics. Genotypes 'Green Beauty', 'McKong', 'Orobelle' and 'California Wonder' can be grown with black plastic mulch and 'Miety' is suitable for both the situations under high hill conditions.

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