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Short communication

Effect of *in-situ* conservation practices on soil properties and yield of broccoli under rainfed conditions of mid hill zone of Himachal Pradesh

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ABSTRACT

An *in-situ* moisture conservation study on broccoli grown under rain-fed conditions was undertaken for three years. Of the five treatments, minimum run-off (56.67 mm) was recorded with treatment comprising conservation tillage + black polythene mulek (T_3). This treatment gave the highest yield (216.4 q/ha) compared to control (187.12 q/ha). The treatment T_3 had good soil moisture retention with lowest weed count (18.41/m^2). Grass mulch (10 t/ha) was also effective.

Key words: Broccoli, moisture conservation, mulch, rainfed conditions.

The growth and yield of broccoli is very much affected by availability of water which is a limiting factor during the growing season. Proper management of available water and conservation for longer duration in the root zone plays an important role in enhancing the yield and quality. In mid-hills of Himachal Pradesh, low productivity in the rainfed areas is the main problem due to inadequate soil moisture content in the root zone during different growth stages of the plant. Moreover, uneven distribution of rains, occurrence of run-off and soil loss during rains further add to the factors leading to low productivity. The ill effects of water deficit can be overcome by irrigation or adopting *in-situ* moisture conservation techniques such as use of mulches (Shinde *et al*., 6; Walter, 9; Gupta and Bhan, 3). Mulching has also been identified by many workers as a method to provide a favourable soil environment by minimizing the crusting at the soil surface and keep it stable. Soil surface crusting which generally occurs after every little shower due to loose and dispersed soil mass is another problem. Moreover, the soil underneath mulch remained protected from splash erosion during high intensity rains. Keeping all these points in view, the present studies were undertaken on response of different conservation practices on run-off, soil loss, moisture carry over, weed reduction and yield of broccoli under rainfed conditions.

The experiment was conducted at the Experimental Farm of Department of Soil Science and Water Management, University of Horticulture and Forestry, Solan, during three seasons, *i.e.* 2003-04, 2004-05 and 2005-06. The soil was gravely loam having bulk density 1.20 g/cm^3, pH 7.20, organic carbon 2.01 g/kg, maximum water holding capacity 33.82%, available N 307.32 kg/ha, available P 358.40 kg/ha and available K 198.40 kg/ha status. The experiment was started in October 2003 to April 2006 with broccoli cv. Green Head. Two tillage treatments, *i.e.* conservation tillage and conventional tillage (CT) and three types of mulches, *viz*., black polyethylene mulch, bi-coloured polyethylene mulch (grey/black) and grass mulch were used. In conservation tillage, narrow slit was prepared to transplant the seedlings, whereas, in conventional tillage (CT), whole plot was cultivated up to plough depth. Thick black and bi-coloured polyethylene (25 micron) mulchs were used. The locally available grass mulch @ 10 t/ha was used. In total, five treatments with four replications under randomized block design were used. The treatments were T_1= Conservation tillage, T_2= Conventional tillage (CT), T_3= CT + black polyethylene mulch, T_4= CT + bi-coloured polyethylene mulch and T_5= CT + grass mulch. To study the run-off and soil loss, the bunds of the experimental plots were raised to 15 cm height during preparation of plots for transplanting to prevent the entry of water from neighbouring plots. Ramser samplers were installed in each plot and iron drums of 220 l capacity as run-off collectors were installed just below the plot surface in 1.10 m buffer zone. The run-off from each plot was drained to the respective collectors through the outlet of samplers. Every container was marked in terms of depth in centimetres. The depth of run-off was recorded after each rainfall and converted to volume as:

Volume of run-off water (L) = r^2h

Where, r = radius of collector drum (cm); h = depth of water in collector (cm).

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Table 1. Effect of different conservation practices on run-off, soil loss and yield of broccoli.

Treatment	Run-off (mm)	Soil loss (t/ha)	Yield (q/ha)
T_1	158.3	7.32	187.12
T_2	193.7	8.19	180.75
T_3	56.63	0.54	216.48
T_4	56.67	0.54	213.23
T_5	59.4	0.57	209.25
$CD_{0.05}$	3.82	0.32	3.93

After every rainstorm, the data on run-off were recorded. Run-off samples were collected after thorough stirring. To estimate soil loss, a known volume of the run-off sample was centrifuged and filtered through Whatman No.1 filter paper and sediment on the filter paper was dried and weighed. The soil loss was expressed in t/ha. Moisture carry over was studied by determining soil moisture content at harvesting of broccoli and at the transplanting of next crop by standard gravimetric method. The per cent loss in moisture content was estimated by subtracting moisture content at transplanting time from that present at the time of harvesting of broccoli. Moisture content carried over to new crop at the time of transplanting under different conservation treatments over unmulched conventional treatment (T_2) was estimated by:

$$\frac{\text{Moisture content under conservation - Moisture content under unmulched } (T_2)}{\text{Moisture content under unmulched treatment } (T_2)} \times 100$$

Different conservation practices were found to exert significant impact on run-off volume (Table 1). Maximum run-off (193.7 mm) was recorded under unmulched conventional tillage treatment (T_2). Minimum run-off (56.63 mm) was recorded under black polyethylene mulch but was statistically at par with the bi-coloured polyethylene mulch (56.67 mm) and grass mulch (59.4 mm). The application of black (T_3) and bi-coloured polyethylene mulch (T_4) under CT on an average reduced the run-off by 70.8 and 70.74 per cent, respectively over unmulched conventional tillage treatment (T_2). Grass mulch under CT (T_5) also reduced the run-off up to 69.33 per cent over unmulched conventional tillage treatment. The conventional tillage also reduced the run-off to the tune of 18.23 per cent. Different mulch materials were found to be statistically at par in respect of run-off reduction under broccoli.

Different management practices recorded a significant effect on soil loss reduction under broccoli (Table 1). Maximum soil loss (8.19 t/ha) was recorded under unmulched conventional tillage (T_2), whereas,

Table 2. Effect of different conservation practices on *in-situ* moisture conservation on soil moisture, percent loss, carry over at transplanting time and weed count/m^2 in broccoli.

Treatment	Average soil moisture (%)		Per cent loss (-)	Per cent gain/carry over at transplanting time over CT	Weed count (per m^2)
	At harvest	At transplanting			
T_1	11.62 (3.41)*	9.93 (3.15)*	1.69	29.80	176.53
T_2	9.97 (3.16)	7.65 (2.77)	2.32	-	312.02
T_3	14.31 (3.78)	12.07 (3.47)	1.64	57.78	18.41
T_4	14.24 (3.77)	11.66 (3.41)	1.58	52.42	19.21
T_5	12.31 (3.51)	11.28 (3.36)	1.03	47.45	72.57
$CD_{0.05}$	0.20	0.18	-	-	51.80

*Transformed values

both black and bi-coloured polyethylene mulch recorded the minimum soil loss of 0.54 t/ha. Grass mulch under CT recorded 0.52 t/ha soil loss. The maximum average reduction in soil loss as to the tune of 93.40 per cent each recorded with the application of black and bi-colouerd polyethylene mulch, while grass mulch recorded soil loss reduction upto 93 per cent over unmulched conventional tillage treatment. The reduction in soil loss under plastic and grass mulched plots was found to be statistically at par with each other. The conventional tillage was found to reduce the soil loss to the tune of 10.62 per cent over unmulched CT. The reduction in run-off and soil loss under plastic mulched treatments might be due to reduction in raindrop impact on the soil surface. Whereas, increased infiltration and residence time for rain water as well as reduced over land flow velocity might have reduced run-of and soil loss under grass mulched treatments. Sharma *et al.* (5) also reported reduction in run-off and soil loss through CT + mulch.

Crop yield was statistically significant under black and bi-coloured polyethylene mulched treatments as compared to grass mulch under CT and CT and conservational tillage treatments (Table 1). Black polyethylene mulch (T_3) recorded the highest yield (216.48 q/ha) and was statistically at par with the bi-coloured polyethylene mulch (T_4) that recorded 213.23 q/ha and were 20 and 17.9 per cent higher in yield over unmulched (T_2). Grass mulch with CT recorded 209.25 q/ha yield and was 15.76 per cent higher over unmulched CT (T_2). This may be attributed to higher moisture status and consequently to better water balance in plant system under plastic and grass mulched plots. Bhardwaj *et al.* (2), and Kumar (4) reported similar results in vegetable crops. Conservation tillage treatment reported 4 per cent higher yield over unmulched conventional tillage treatment.

Weeds not only affect the available soil moisture by losses through transpiration but are also responsible for depletion of nutrients. Different management practices reduced the weed population significantly as compared to the unmulched conventional tillage treatment. Almost negligible weed growth was observed under black polyethylene mulch and bi-coloured polyethylene mulch which recorded 18.41 and 19.21 weeds/m^2, respectively, and weeds were significantly lower as compared to T_1, T_2 and T_5 (Table 2). The weeds were negligible under plastic mulched treatments because the light was not available to the weeds to grow, whereas little amount of light might have penetrated through grass mulch which have resulted in 76.7 per cent lesser than unmulched treatment. Black polyethylene and bi-coloured polyethylene mulch treatments recorded 94.1 and 93.8 per cent lesser weed incidence than unmulched CT. Shirgure *et al.* (7, 8) also reported reduced weed growth under black polyethylene mulch and grass mulch.

Soil moisture content and its carry over to the next crop was found to be influenced by the different conservation practices. Highest moisture content (14.31%) was observed under T_3, which was found to be statistically at par with T_4 and T_5, whereas lowest (9.97%) was noted under T_2. It was also noticed that conservation tillage (T_1) conserved statistically higher moisture as compared to conventional tillage (T_2). At the time of transplanting of next crop, moisture content ranged from 7.65 to 12.07 per cent and highest was observed under T_2 being statistically at par with T_4 and T_5, whereas lowest was under T_2. Unmulched CT (T_2) recorded the maximum moisture loss (2.32%) from the time of harvest to the transplanting of next crop. The application of black and bi-coloured polyethylene mulch and grass mulch relatively reduced the moisture loss to the range of 1.58 to 1.03 per cent. Conservation tillage resulted in soil moisture loss of 1.69 per cent. Different conservation treatments were found to increase moisture carry over to next crop over unmulched CT. Under conservation treatments, moisture carry over ranged from 29.80 to 57.78 per cent. This increased carry-over over unmulched CT is apparently related to reduced evaporation and more downwards movement of water into deeper parts of the profile where it remained conserved for larger period (Bhardwaj *et al.*, 2). Conservation tillage (T_1) by retaining previous season's crop residue on the surface was found to increase moisture carry over by 29.80 per cent. It is inferred from the present studies that black polyethylene mulch/bi-coloured polyethylene mulch (25 micron thickness) and grass mulch @ 10 t/ha proved effective in controlling soil loss, run-off, increasing moisture carry-over to the next crop, reduced weed incidence and increasing yield of broccoli as compared to the unmulched treatments. Hence, black polyethylene mulch can be used for producing maximum yield benefits of broccoli under rainfed conditions.

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