

Original Research Article

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## Enhancing Productivity and Quality of Cabbage through Precision Farming Practices in Indian Cold Arids

M. S. Kanwar<sup>1\*</sup>, M. S. Mir<sup>2</sup> and P. Ishfaq Akbar<sup>3</sup>

<sup>1</sup>KVK (SKUAST-K), Nyoma, Ladakh, India

<sup>2</sup>Director Research, SKUAST-K, Srinagar, India

<sup>3</sup>Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir  
High Mountain Arid Agriculture Research Institute, India

\*Corresponding author

### ABSTRACT

The precision farming including plasticulture applications has proven its worth in realizing more output per unit of inputs and resources bestowed on to land. As an alternative to raise production and productivity especially to compete global trade and meet out own requirements. Cabbage is grown extensively in summers in Ladakh region and is stored for winters. Due to lack of scientific know how, improved varieties and modern precision farming techniques, crop yield and quality is comparatively low. Therefore, cabbage cultivation tried with precision farming practices including crop geometry, mulching and micro-irrigation methods to get early and higher yield with good quality heads at Precision Farming Development Centre, Leh. Black plastic mulching along with drip irrigation showed considerable improvement in yield as well good quality heads. Drip irrigation was found to be best method of irrigation during summer cabbage production. Mulching also reduced the labour cost in water application and weeding.

#### Keywords

Cabbage, mulch,  
drip, sprinkler, B:C  
ratio

#### Article Info

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### Introduction

Vegetable crops are care intensive and require proper upkeep and management so as to harvest their really vested potential. Any lacunae on this part pose heavy toll on profitability and in turn keeping the interest of growers intact in the venture. Dwindling land :

man ratio, harvesting more return from a unit area of land, disguised unemployment, improper availability of fruits and vegetables, malnutrition, generating employment and satiating needs of dominion population are major concern awaiting for strategic initiation and integration having bearing on hastening production and quality. The precision farming

including plasticulture applications has proven its worth in realizing more output per unit of inputs and resources bestowed on to land as an alternative to raise production and productivity especially to compete global trade and meet out own requirements. Seeing the efficacy, there is need of harnessing and leveraging the potential of precision farming on commercial scale. However, the challenges lying behind warrant proper retrospection.

Cabbage (*Brassica oleracea* var. *botrytis* L.) is third most important crop in India and in world (in terms of % share in vegetable production). Cabbage is basically a cool season crop and grown extensively during summers in Ladakh region. It has wide applicability as vegetable, salad, and pickle in Ladakh. During May-June, cabbage is not available locally and people have to depend on supply from other parts of country. Average productivity in Jammu and Kashmir is 21.35 t/ha which is at par with the average national productivity. It is third most important crop of Leh district but its productivity and quality is comparatively low due to cultivation of unknown/untested varieties, lack of scientific know how and modern precision farming techniques including plastic application in form of mulch and micro-irrigation. So, there is need to standardize cabbage cultivation with precision farming practices including crop geometry, mulching and micro-irrigation methods with the objectives of getting early produce of cabbage with high productivity and quality.

### **Materials and Methods**

The experiment was conducted during summer months in open field conditions at PFDC Farm, Stakna (Leh) of High Mountain Arid Agriculture Research Institute under Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir which is situated at 3319 m amsl with latitude

33<sup>o</sup>58.551' NS and longitude 77<sup>o</sup>41.995' EW. Climate of the area is typically dry temperate with extreme fluctuations in the temperature. Soil of the experimental field is sandy to sandy loam and used first time for crop cultivation. Effect of mulching (M0: un-mulched and M1: mulched with black polythene) was studied in cabbage var. Pride of India at two planting distances i.e. S1 (50 x40 cm) and S2 (50 x 30cm) along with three methods of irrigation i.e. I1 (flooding), I2 (drip irrigation) and I3 (sprinkler irrigation). Standard package of practices were followed to raise healthy crop. Design of the experiment was split-split plot and material was replicated 3 times. Data were recorded on 10 characters and subjected to statistical analysis as per Snedcor and Cochran (1967). Comparison was done among mulch & un-mulched, spacing and different methods of irrigation along with their interactions.

### **Results and Discussion**

Analysis of variance (Table 1) indicated that mulching showed significant effect on days to marketable maturity and polar diameter of head only. Crop geometry significantly influenced days to marketable maturity, gross & net head weight, equatorial & polar diameter of head. However, significant differences were observed among irrigation methods for all the characters for all the traits except stalk length and number of non wrapper leaves. Interaction effects were significant for days to marketable maturity only. However, Spacing x Irrigation as well as Mulch x Spacing x Irrigation interaction were significant for equatorial diameter of head. For all the other characters, interaction effects were non-significant.

Mulching produced longer stalks while S1 generated higher stalk length (Table 2). Drip irrigation resulted in maximum stalk length. Un-mulched cabbage produced higher number

of non-wrapper leaves. Inference can be drawn that early head formation and maturity in mulched cabbage reduced the number of non-wrapper leaves.

Mulched cabbage crop took 72.83 days to marketable maturity (Table 2) which was statistically earlier than un-mulched one. Marketable heads were obtained 10 days earlier through mulching with black-polythene due to increase in soil temperature favourable for early growth. S1 produced statistically early crop than S2. It may be due to the better chances of crop growth and less competition for light and nutrients. Drip irrigation took minimum days to produce cabbage heads and was at par with sprinkler irrigation. M1 x S1 produced statistically earliest crop in 64 days irrespective of any irrigation method. M1 x I2 could produce early crop which was at par with M1 x I3 and M1 x I1. S1 x I2 took statistically lesser number of days to maturity over other S x I interactions except S1 x I3. Best treatment combination in three way interaction was M1 x S1 x I2 which was at par with M1 x S1 x I3 and M1 x S1 x I1.

Similar trends were observed for gross and net head weight. Gross and net head weights (Table 3) were maximum in mulched cabbage. S1 produced statistically higher gross and net head weight than S2. Gross and net head weights were maximum in drip irrigated crop and the performance was at par with sprinkler irrigated crop. I2 and I3 out yielded I1 statistically w.r.t gross and net head weight.

Although all the interaction effects were non-significant; M1 x S1, M1 x I2, S1 x I2 and M1 x S1 x I2 were the best performing combinations. S1 exhibited maximum equatorial as well as polar diameter of head and was statistically superior over S2. Drip irrigation could produce maximum equatorial and polar diameter but found to be at par with sprinkler irrigation.

Yield is the ultimate goal of any breeder as well as producer beside good crop quality. Black plastic mulch as well as S1 produced better yield per ha. Díaz-Pérez (2009) reported that broccoli plant growth and yield responded more favorably to dark-colored mulches than to light-colored mulches. Yield per ha was maximum to the tune of 302.6 qt/ha in drip irrigated crop and found to be at par with sprinkler irrigation. All the interactions were non-significant. However, M1 x S1, M1 x I2, S1 x I2 and M1 x S1 x I2 were the best combinations to produce highest yield of cabbage var. Pride of India. Higher yields (4.72 per cent) were obtained for drip irrigation with plastic mulch as compared to drip irrigation alone by Tiwari *et al.*, (2003) in agreement with present findings. The highest benefit–cost ratio of 8.17 was obtained for furrow irrigation followed by 6.99 for drip. However, the highest yield of cabbage var. Golden Acre was obtained in the micro sprinkler irrigation treatment (40.23 t/ha) followed by drip irrigation (38.97 t/ha) and surface irrigation (33.76 t/ha) by Srivastava and Chauhan (1999). Present study reveals that drip irrigation has a definite role in increasing the productivity of cabbage. Quality in terms of compactness revealed that 100 per cent compact head were obtained in treatment combinations of M0xS1xI2, M1xS1xI2 and M1xS1xI3. Economics of production is very important for adoption of technology in a particular area. Highest B:C ratio of 4.00 was obtained in M1xS1xI2 followed by M0xS1xI3 (3.84) and M0xS1xI2 (3.31). These ratios showed that micro-irrigation technologies along with mulching are economically feasible for adoption in cold arid region.

In contrast, highest benefit–cost ratio of 8.17 was obtained for furrow irrigation followed by 6.99 for drip irrigation by Tiwari *et al.*, (2003).

**Table.1:** Analysis of variance for different character under study

Source of variation	df	MSS							
		Stalk length (cm)	No. of non-wrapper leaves	Days to marketable maturity	Gross head weight (g)	Net head weight (g)	Equatorial dia of head (mm)	Polar dia of head (mm)	Yield per ha (Q)
<b>Mulch</b>	1	0.72	6.38	850.69*	109120	82728	693.01	413.04*	25755
<b>Replication</b>	2	0.04	11.39	104.36	214970	86977	900.92	167.78	27888
<b>Ea</b>	<b>2</b>	<b>0.18</b>	<b>0.61</b>	<b>17.69</b>	<b>37678</b>	<b>25297</b>	<b>190.29</b>	<b>3.64</b>	<b>9227.8</b>
<b>Spacing</b>	1	0.58	5.72	1667.4*	820840*	40497*	3272.8*	2460.5*	18196
<b>Mulch x Spacing</b>	1	0.96	6.13	148.03*	38809	7678.1	413.51	2.27	736.49
<b>Eb</b>	<b>4</b>	<b>0.23</b>	<b>0.08</b>	<b>5.69</b>	<b>61804</b>	<b>14406</b>	<b>148.00</b>	<b>273.85</b>	<b>4646.9</b>
<b>Irrigation method</b>	2	0.21	12.00	114.53*	154360*	75502*	876.46*	466.82*	22167*
<b>Mulch x Irrigation method</b>	2	0.01	13.09	21.36*	34164	8887.9	118.45	48.53	3000.5
<b>Spacing x Irrigation method</b>	2	0.22	2.09	31.86*	116380	19049	530.80*	195.30	3352.8
<b>Mulch x Spacing x Irrigation method</b>	2	0.39	4.68	82.03*	53203	15237	556.87*	32.24	5116.1
<b>Ec</b>	<b>16</b>	<b>0.11</b>	<b>5.85</b>	<b>4.07</b>	<b>32168</b>	<b>15753</b>	<b>114.31</b>	<b>76.02</b>	<b>5270.2</b>

**Table.2** Effect of mulch, crop, geometry and MI methods on performance of cabbage

Spacing	MI method	Characters											
		Stalk length (cm)			Number of non-wrapper leaves			Days to marketable maturity			Gross head weight (g)		
		M0	M1	Mean (SI)	M0	M1	Mean (SI)	M0	M1	Mean (SI)	M0	M1	Mean (SI)
<b>S1</b>	I1	1.233	1.860	1.547	17.67	17.20	17.43	87.33	65.00	76.17	690.0	1028	859.0
	I2	1.417	1.697	1.557	17.80	19.27	18.53	73.00	63.00	68.00	1177	1333	1255
	I3	1.100	2.020	1.560	17.00	15.95	16.47	73.00	64.00	68.50	1168	1202	1185
<b>Mean(MS)i.e. MS1</b>		1.250	1.859	<b>1.554</b>	17.49	17.47	<b>17.48</b>	77.78	64.00	<b>70.89</b>	1012	1188	<b>1100</b>
<b>S2</b>	I1	1.367	1.300	1.333	21.67	16.67	19.67	87.33	85.00	86.17	825.0	741.7	783.0
	I2	1.367	1.733	1.550	18.00	19.33	18.67	87.33	77.67	82.50	691.7	950.0	820.8
	I3	1.233	0.800	1.017	17.67	16.33	17.00	87.33	82.33	84.83	810.0	768.3	789.2
<b>Mean(MS)i.e. MS2</b>		2.322	1.278	<b>1.300</b>	19.11	17.44	<b>18.28</b>	87.33	81.67	<b>84.50</b>	775.6	820.0	<b>797.8</b>
<b>Mean (MI)</b>	<b>MI1</b>	1.300	1.580	<b>1.440</b>	19.67	16.93	<b>18.30</b>	87.33	75.00	<b>81.17</b>	757.5	884.8	<b>821.2</b>
	<b>MI2</b>	1.392	1.715	<b>1.553</b>	17.90	19.30	<b>18.60</b>	80.17	70.33	<b>75.25</b>	934.5	1142	<b>1038</b>
	<b>MI3</b>	1.167	1.410	<b>1.288</b>	17.33	16.14	<b>16.74</b>	80.17	73.17	<b>76.67</b>	989.2	985.0	<b>987.1</b>
<b>Mean of M</b>		<b>1.286</b>	<b>1.568</b>		<b>18.30</b>	<b>17.46</b>		<b>82.56</b>	<b>72.83</b>		<b>893.7</b>	<b>1004</b>	
<b>CD<sub>0.05</sub> (M)</b>		<b>NS</b>			<b>NS</b>			<b>6.03</b>			<b>NS</b>		
<b>CD<sub>0.05</sub> (S)</b>		<b>NS</b>			<b>NS</b>			<b>2.21</b>			<b>230.08</b>		
<b>CD<sub>0.05</sub> (I)</b>		<b>NS</b>			<b>NS</b>			<b>1.75</b>			<b>155.22</b>		
<b>CD<sub>0.05</sub>(MS)</b>		NS			NS			6.34/3.12			NS		
<b>CD<sub>0.05</sub>(MI)</b>		NS			NS			6.12/2.47			NS		
<b>CD<sub>0.05</sub>(SI)</b>		NS			NS			2.96/2.47			NS		
<b>CD<sub>0.05</sub>(MSI)</b>		NS			NS			3.49			NS		

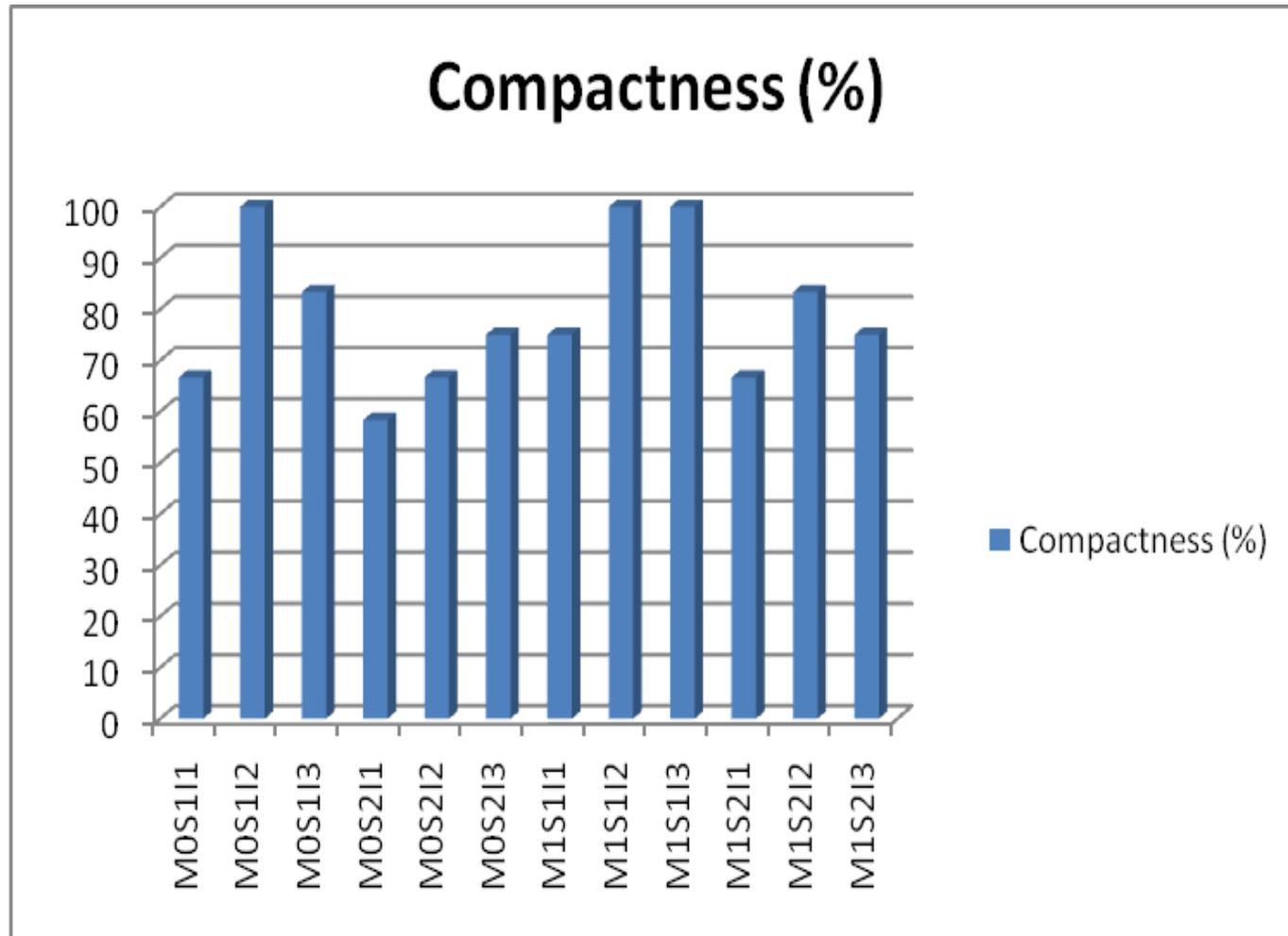
**Table.3** Effect of mulch, crop, geometry and MI methods on performance of cabbage

Spacing	MI method	Characters											
		Net head weight (g)			Equatorial dia of head (mm)			Polar dia of head (mm)			Yield per ha (Q)		
		M0	M1	Mean (SI)	M0	M1	Mean (SI)	M0	M1	Mean (SI)	M0	M1	Mean (SI)
<b>S1</b>	I1	341.7	556.3	449.0	92.45	114.3	103.4	95.68	109.0	102.3	170.8	278.2	224.5
	I2	615.4	749.7	682.5	132.3	127.0	129.6	117.9	121.5	119.7	307.7	374.8	341.3
	I3	591.7	618.0	604.8	114.8	144.8	129.8	116.4	118.4	117.4	295.8	309.0	302.4
<b>Mean(SV)i.e. MS1</b>		516.2	641.3	<b>578.8</b>	113.2	128.7	<b>120.9</b>	110.0	116.3	<b>113.2</b>	258.1	320.7	<b>289.4</b>
<b>S2</b>	I1	325.0	316.7	320.8	103.7	95.63	99.68	90.59	98.28	94.43	216.7	211.1	213.9
	I2	316.7	475.0	395.8	96.79	109.4	103.1	96.43	107.4	101.9	211.1	316.7	263.9
	I3	358.3	408.3	383.3	102.1	103.6	102.8	91.93	95.06	93.49	238.9	272.2	255.5
<b>Mean(SV)i.e. MS2</b>		333.3	400.0	<b>366.7</b>	100.9	102.9	<b>101.9</b>	92.98	100.3	<b>96.62</b>	222.2	266.7	<b>244.4</b>
<b>Mean (MI)</b>	<b>MI1</b>	333.3	436.5	<b>384.9</b>	98.09	105.0	<b>101.5</b>	93.13	103.6	<b>98.39</b>	193.7	244.6	<b>219.2</b>
	<b>MI2</b>	466.0	612.3	<b>539.2</b>	114.5	118.2	<b>116.4</b>	107.2	114.5	<b>110.8</b>	259.4	345.7	<b>302.6</b>
	<b>MI3</b>	475.0	513.2	<b>494.1</b>	108.4	124.2	<b>116.3</b>	104.2	106.7	<b>105.4</b>	267.3	290.6	<b>279.0</b>
<b>Mean of M</b>		<b>424.8</b>	<b>520.7</b>		<b>107.0</b>	<b>115.8</b>		<b>101.5</b>	<b>108.3</b>		<b>240.2</b>	<b>293.7</b>	
<b>CD<sub>0.05</sub> (M)</b>		NS			NS			2.74			NS		
<b>CD<sub>0.05</sub> (S)</b>		<b>111.08</b>			<b>11.26</b>			<b>15.32</b>			NS		
<b>CD<sub>0.05</sub> (I)</b>		<b>108.62</b>			<b>9.25</b>			<b>7.55</b>			<b>62.83</b>		
<b>CD<sub>0.05</sub>(MS)</b>		NS			NS			NS			NS		
<b>CD<sub>0.05</sub>(MI)</b>		NS			NS			NS			NS		
<b>CD<sub>0.05</sub>(SI)</b>		NS			15.38/13.09			NS			NS		
<b>CD<sub>0.05</sub>(MSI)</b>		NS			18.51			NS			NS		

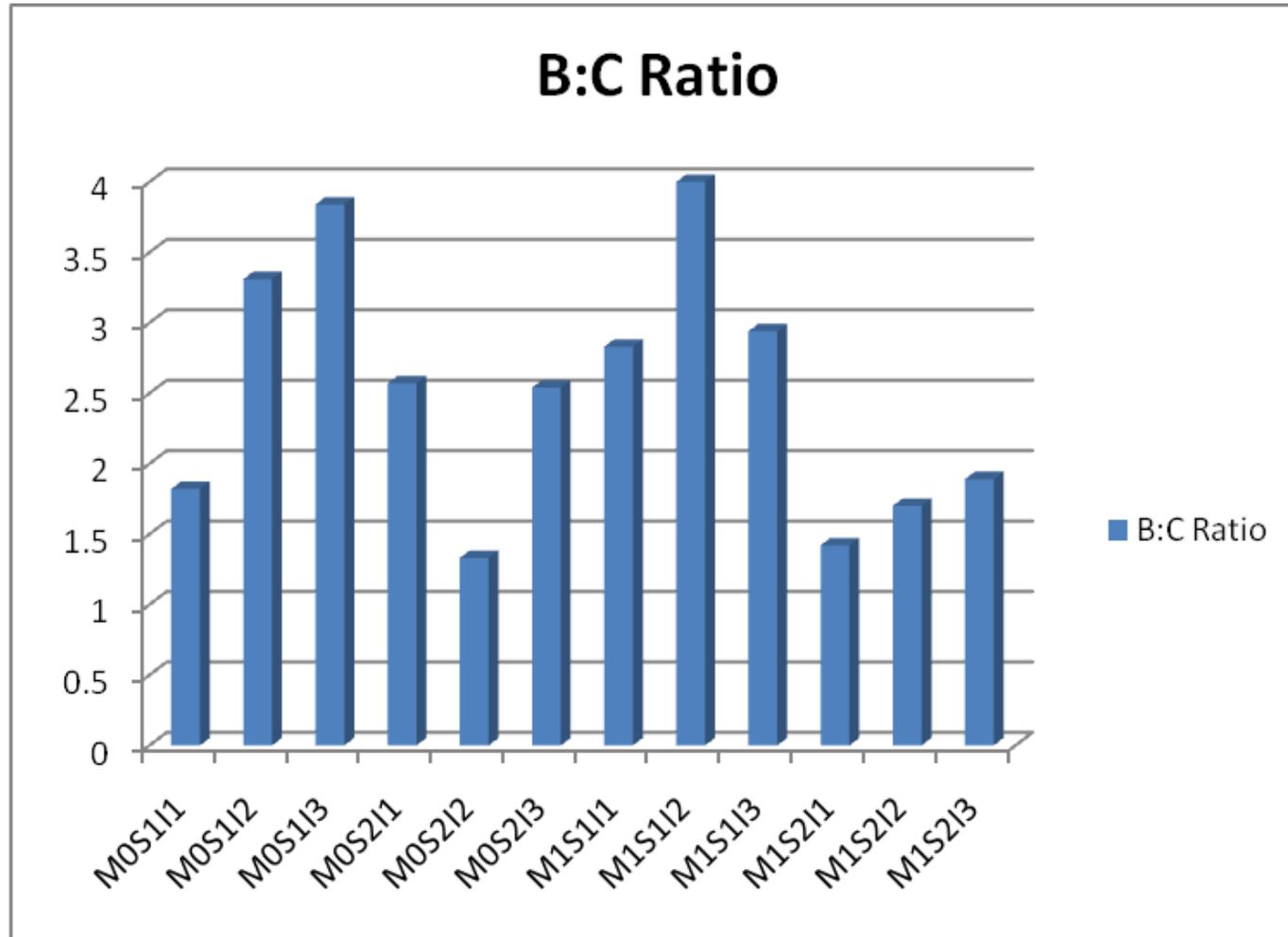
**Table.4** Water saving through micro-irrigation and mulching

<b>Sr. No.</b>	<b>Particulars</b>	<b>Water saving (%)</b>
<b>In Un-mulched</b>		
1.	Drip irrigation	72.22
2.	Sprinkler irrigation	48.53
<b>In Mulched cabbage</b>		
3.	Drip irrigation	58.33
4.	Sprinkler irrigation	22.80
5.	Mulched v/s Un-mulched	33.33

**Fig.1** Effect of treatment combination on head compactness of cabbage



**Fig 2** Effect of treatment combinations on economics of production



They got high B:C ratio due to higher yield per unit area in comparison to present investigations. In mulched cabbage, no weeding was needed, hence saved the labour for weeding. Black polyethylene film gives effective weed control by cutting down solar radiation by more than 90%, resulting in etiolated growth and the eventual death of weeds under the film (Hanada, 1991). Other aspect in mulching and micro-irrigation is water saving over the traditional practices. In mulched cabbage, drip and sprinkler irrigation saved 58.33 and 22.80 per cent water, respectively over flood irrigation. However, in un-mulched cabbage, water saving is much more i.e. 72.22 and 48.53 per cent, respectively in drip and sprinkler irrigation. Black polythene mulch also saved 33.33 per cent water as compared to un-mulched crop. Compared with surface irrigation, Srivastava and Chauhan (1999) reported water saving percentage to the tune of 59.28 and 36.82% for drip and micro sprinkler methods, respectively.

It may be concluded that black plastic mulch, spacing (50x40 cm) and drip irrigation individually and/or in combination were found best in yield and net curd weight. In mulched cabbage, no weeding was needed, hence saved the labour for weeding. Highest B:C ratio was obtained in the combination of black plastic mulch, spacing (50x40 cm) and drip irrigation. Drip irrigation could save water to the tune of 58.33-72.22 per cent.

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