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# Impact of Molybdenum Application on Yield, Quality and Profitability of Cauliflower (*Brassica oleracea* var. *botrytis* L.) in an Acid Alfisol Soil

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***Abstract***: A field experiment was laid out to evaluate the impact of molybdenum application on the yield, quality, and profitability of cauliflower. The experiment comprised of eleven treatments i.e., $T_1$=NPK (control), $T_2$=NPK + FYM (RDF), $T_3$=NPK + Lime, $T_4$=NPK + Lime + FYM, $T_5$=RDF + Mo at recommended rate @ 1 kg $ha^{-1}$ (soil), $T_6$=RDF + Mo at 1.5 times the recommended rate @ 1.5 kg $ha^{-1}$ (soil), $T_7$=RDF + Mo at recommended rate @ 0.1% (foliar sprays), $T_8$=RDF + Mo at 1.5 times the recommended rate @ 0.15% (foliar sprays), $T_9$=RDF along with Mo @ 1 kg $ha^{-1}$ (soil) and @ 0.1% as foliar sprays, $T_{10}$=RDF along with Mo @ 1 kg $ha^{-1}$ (soil) and @ 0.15% as foliar sprays, and $T_{11}$=Subhash Palekar's Natural Farming (SPNF). The highest curd yield (20.7 t $ha^{-1}$) was recorded in $T_{10}$, where NPK was applied along with FYM and Mo @ 1 kg $ha^{-1}$(soil) + @ 0.15% (foliar) with a 29.1 per cent increase over treatment $T_2$. The same treatment enhanced the ascorbic acid (77.8 mg $100g^{-1}$), curd solidity (46.25 g $cm^{-1}$), and total soluble solids (8.4° Brix) and also resulted in higher net-returns (₹ 3,10,260 $ha^{-1}$) and benefit-cost ratio (3.99). Mo application positively influenced the cauliflower production in an acid Alfisols. However, the conjoint application of Mo (basal and foliar) proved its superiority in enhancing the productivity and profitability of cauliflower compared to their respective sole application.

***Keywords***: Cauliflower, Molybdenum, SPNF, Acid soils

Cauliflower (*Brassica oleracea* var. *botrytis* L.) belongs to the Cruciferae family, is one of the major cole crop grown throughout the world (Wani et al 2016). In India, it is being cultivated in an area of 0.45 mha with a production of 8.7 million MT (Anonymous 2018). In Himachal Pradesh, it occupies an area of 5.56 thousand ha with a production of 131.01 thousand MT (Anonymous 2018). As cauliflower is a heavy feeder of nutrients, it requires a high amount of NPK and micronutrient fertilization besides other recommended package of practices for successful cultivation. Among many constraints for the low productivity of cauliflower, imbalanced nutrition is one of the major limiting factor responsible for multi nutrient deficiency, particularly of molybdenum, resulting in yield and quality deterioration.

Molybdenum (Mo) is one of the essential micronutrient affecting crop quality and productivity. Common Mo deficiency in cauliflower is generally whiptail in which leaf-blades are not fully developed and only the midrib is present which appear as a whip (Sharma 2002). It helps in biological N fixation as it is a component of the enzymes nitrogenase and the nitrate reductase and plays an important role in phosphorus utilization and protein synthesis. In India, 49 mha area is occupied by acid soils, of which 24.4 mha are considered moderately acidic (pH 4.5-5.5) and in the Himachal Pradesh, about 1.57 lakh ha area is under moderately acid soils (Maji et al 2012). Molybdenum in acid soils tends to be unavailable to plants. The Mo availability for growth of the plant is strongly dependent on the soil reaction, soil N levels, concentration of adsorbing oxides (e.g., Fe oxides), the organic matter, and the extent of water drainage (Elkhatib 2009, Rutkowska et al 2017). Molybdenum occurs in the soil as an oxy complex molybdate ($MoO_4^{2-}$) (Mengel et al 2001) and its soil chemistry resembles as that of phosphate or sulphate. Mo is likely to become critical in the future for sustaining high productivity in certain areas, particularly in acid soils. Keeping in view the future scenario, the present study was carried out with an objective to find out the effective method of Mo application to renumerate the Mo deficiency in the plant which greatly effects the productivity, quality, and the productivity of cauliflower in an acid Alfisol.

## MATERIAL AND METHODS

A field trial was conducted during winter season of 2019-20 on cauliflower cv. Pusa Snowball K-1 at the experimental farm of Department of Soil Science, CSK HPKV, Palampur situated at 32°09' N latitude and 76°55' E longitude and at an altitude of about 1291 m above mean sea level. The study area lies in the Palam valley representing mid hills sub-humid agro-climatic conditions of Himachal Pradesh with an average rainfall of 2500 mm of which 20% is received during October to April. Taxonomically, the soils of the experimental site fall under order Alfisol (Typic Hapludalfs). The soils of the experimental site were silty clay loam in texture, strongly acidic with pH 5.29, organic carbon content of 7.11 g $kg^{-1}$ and the content of available nitrogen, phosphorus, potassium and molybdenum were 251 kg $ha^{-1}$, 21.2 kg $ha^{-1}$, 170 kg $ha^{-1}$ and 0.13 mg $kg^{-1}$, respectively.

The experiment was laid out in Randomized complete Block Design with eleven treatments, each allocated randomly and replicated thrice. The treatments comprised of $T_1$=NPK (control), $T_2$=NPK + FYM (RDF), $T_3$=NPK + Lime, $T_4$=NPK + Lime + FYM, $T_5$=RDF + Mo at recommended rate @ 1 kg $ha^{-1}$ (soil), $T_6$=RDF + Mo at 1.5 times the recommended rate @ 1.5 kg $ha^{-1}$ (soil), $T_7$=RDF + Mo at recommended rate @ 0.1% (foliar sprays), $T_8$=RDF + Mo at 1.5 times the recommended rate @ 0.15% (foliar sprays), $T_9$=RDF along with Mo @ 1 kg $ha^{-1}$ (soil) and @ 0.1% as foliar sprays, $T_{10}$=RDF along with Mo @ 1 kg $ha^{-1}$ (soil) and @ 0.15% as foliar sprays, and $T_{11}$=Subhash Palekar's Natural Farming (SPNF).

Basal application of molybdenum was done before transplanting and its foliar sprays were applied at 45 and 60 DAT. The cauliflower seedlings were transplanted in October, 2019 at a spacing of 60 × 45 cm. The recommended doses of N, $P_2O_5$, and $K_2O$ were applied @ 115: 60: 75 kg $ha^{-1}$ through urea, single super phosphate (SSP), and muriate of potash (MOP), respectively, except in treatment $T_{11}$. Half dose of urea (N), muriate of potash ($K_2O$) and full dose of single super phosphate ($P_2O_5$) were applied at the time of transplanting. The remaining half dose of urea (N) was applied further in two equal splits at 30 days after transplanting and at curd initiation whereas the remaining half dose of muriate of potash ($K_2O$) was applied at curd initiation. The experiment field was ploughed twice and the recommended FYM @ 20 t $ha^{-1}$ was added to all treatments except in treatment $T_1$, $T_3$, and $T_{11}$. Lime application was done at the rate of 10 t $ha^{-1}$ in the treatment $T_3$ and $T_4$. In treatment $T_{11}$, the cauliflower seedlings were raised by the seeds soaked overnight with beejamrit solution @ 1 l $kg^{-1}$ before sowing. The ghanjeevamrit @ 250 kg $ha^{-1}$ along with the FYM @ 250 kg $ha^{-1}$ was incorporated in the treated plots before transplanting. The jeevamrit was applied at 21 days interval through foliar sprays @ 50 l $ha^{-1}$ per spray (Mahankuda and Tiwari 2020). Irrigation and other intercultural operations were followed as per the recommended package of practices

**Plant sampling and analysis:** Five plants were randomly selected to record observations for various growth, yield contributing characters, yields, and quality parameters of cauliflower which consisted of curd initiation, marketable curd maturity, stalk length, number of leaves, plant height, curd depth, equatorial length, curd size index, curd diameter, curd solidity, marketable yield $plant^{-1}$, curd yield, gross weight $plant^{-1}$, gross yield, total soluble solids (TSS) and ascorbic acid. The determination of TSS and ascorbic acid were done on fresh curds by employing the refractometric (AOAC 1990) and titration method (Ranganna 1979).

**Economic evaluation:** Net returns and benefit-cost ratio were calculated as suggested by Zivenge et al (2013) i.e., Net returns = Gross returns – Total production cost.

$$\text{Benefit it: Cost (B:C)} = \frac{\text{Gross returns}}{\text{Total production cost}}$$

## RESULTS AND DISCUSSION

**Curd initiation:** It was not significantly affected by different treatments (Table 1). However, a noticeable difference in days to initiation of curd among treatments was observed. The variation among the desired growth trait might be because of the temperature fluctuations recorded during the crop growing period. The same observations were also reported by Thakur (2014) in cauliflower and Thapa et al (2016) in broccoli.

**Marketable curd maturity:** The highest number of days to curd marketable maturity (122.3 days) were in $T_{11}$ and lowest (101.7 days) in $T_{10}$ as shown in Table 1. The number of days were significantly lower in $T_{10}$ and the per cent reduction was to a tune of 11.3, 8.13, 8.4, and 6.4 per cent when compared to the treatment $T_1$, $T_2$, $T_3$, and $T_4$, respectively. Treatment $T_{10}$ was statistically at par with the $T_9$ and the treatments receiving the foliar application ($T_7$ and $T_8$). The role of Mo in converting inorganic phosphorus to organic phosphorus compounds i.e., phospholipids, amino acids, ATPs, etc. within the plant (Kaiser et al 2005) might have played a significant role for causing early maturity (Sahito et al 2018). A similar effect on the number of days to marketable curd maturity resulting from the Mo application was also reported in broccoli by Thapa et al (2016).

**Plant height:** The plant height was significantly more in $T_{10}$ (51.6 cm) with an increase of 33.3, 21.1, 24.3, and 19.7 per cent over the treatment $T_1$, $T_2$, $T_3$, and $T_4$, respectively, and the lowest plant height (33.3 cm) was in $T_{11}$ as depicted in table 1. The beneficial role of FYM and lime in improving the soil health (Chander and Verma 2009) and increasing the availability of nutrient by affecting the soil pH (Santos et al 2018), might have resulted in taller plants. The treatment $T_{10}$ was statistically at par with the treatment $T_9$ and $T_8$. Among the treatments comprising of Mo application (soil or foliar), plant height in foliar treated treatments ($T_7$ and $T_8$) were superior to the basal application ($T_5$ and $T_6$). Mo is a component of enzyme nitrogenese and nitrate reductase which are required for the nitrogen fixation and assimilation. As nitrogen is responsible for an increase in the vegetative growth of the plant (Sahito et al 2018) and Mo application might have played a significant role in enhancing the plant height. A similar increase in the plant height due to the Mo application was also reported by Kumar et al (2010b), Ningawale et al (2016) and Sani et al (2018).

**Stalk length:** The stalk length was superior in $T_{10}$ (4.6 cm) over rest of the treatments. The treatments comprising of Mo application either through soil, foliar or both, behaved statistically alike as depicted in Table 1. The Mo role in nitrogen metabolism might have influenced the stalk length. Stimulative effect of Mo on stalk length has also been reported by Kumar et al (2010a,b). In treatment $T_{11}$, because of the sole application of organic inputs (ghanjeevamrit, beejamrit, and jeevamrit) having low nutrient contents did not prove good enough to meet the nutrient requirement of the crop. Hence, leading to shorter stalk length (3.7 cm) when compared to the control and other treatment combinations.

**Number of leaves:** The number of leaves plant$^{-1}$ were significantly more in $T_{10}$ (21.2) with an increase of 26.2, 19.8, 23.2, and 14.6 per cent higher when compared to the treatment $T_1$, $T_2$, $T_3$, and $T_4$, respectively as depicted in Table 1. However, it was statistically at par with the $T_9$ and the treatments receiving the foliar application of Mo ($T_7$ and $T_8$). The treatments of Mo application either through soil or foliar, behaved statistically similar to each other. Mo is responsible for the synthesis of indole-3 acetic acid (IAA) (Kaiser et al 2005) which enhances the bud formation and hence resulted in a greater number of leaves plant$^{-1}$. Similar stimulative effect of Mo application on the number of leaves plant$^{-1}$ were also reported by Kumar et al (2010a,b) and Ningawale et al (2016).

All the growth parameters were significantly influenced by Mo application (Table 1). Similar enhancements in the growth parameters due to Mo application were also reported by Pandher et al (1976), Kumar et al (2010a,b, 2012), Ningawale et al (2016), and Singh et al (2017). The incremental effect of Mo on cauliflower's growth parameters may be due to the regulatory effect of Mo on enzyme systems involved in N assimilation and nitrate reduction. The enhancement in the growth parameters resulted from the foliar application of Mo when compared to the soil application was probably due to the direct application of fertilizer to the plant in the former treatment, which might have resulted in the timely availability of Mo at critical growth stages which might have enhanced the overall plant growth attributes. Also, the better plant growth observed with combined (soil and foliar) application of the molybdenum when compared to their respective sole application might be attributed to the availability of Mo throughout the crop growth and development stages i.e., in early growth stages as basal while as foliar fertilization in the latter stages.

### Yield Contributing Characters

**Equatorial length:** The equatorial length was significantly more in $T_{10}$ (16.7 cm) over rest of the treatments and lowest in $T_{11}$ (11.2 cm) as depicted in Table 1. Among treatments comprising of Mo application (soil or foliar), equatorial length in foliar sprayed treatments ($T_7$ and $T_8$) were superior to the basal application ($T_5$ and $T_6$). The significant effect of Mo

**Table 1.** Effect of different treatments on growth and yield contributing parameters of cauliflower

| Treatments | Days to curd initiation from DAT | Days to marketable curd maturity from DAT | Plant height (cm) | Stalk length (cm) | Number of leaves plant$^{-1}$ | Equatorial length (cm) | Curd depth (cm) | Curd size index (cm$^2$) |
|---|---|---|---|---|---|---|---|---|
| $T_1$ | 91 ± 1.55 | 114.7 ± 1.33$^{b*}$ | 38.7 ± 0.91$^{g}$ | 4.1 ± 0.10$^{c}$ | 16.8 ± 0.15$^{ef}$ | 12.5 ± 0.44$^{g}$ | 10.1 ± 0.64$^{f}$ | 126.2 ± 11.37$^{g}$ |
| $T_2$ | 90 ± 0.58 | 110.7 ± 2.60$^{bc}$ | 42.6 ± 1.49$^{ef}$ | 4.2 ± 0.06$^{bc}$ | 17.7 ± 1.24$^{cdef}$ | 13.9 ± 0.32$^{ef}$ | 10.5 ± 0.77$^{def}$ | 145.4 ± 13.04$^{ef}$ |
| $T_3$ | 90 ± 2.33 | 111.0 ± 2.00$^{bc}$ | 41.5 ± 1.13$^{fg}$ | 4.1 ± 0.25$^{c}$ | 17.2 ± 0.71$^{def}$ | 13.6 ± 0.52$^{f}$ | 10.3 ± 1.04$^{ef}$ | 140.2 ± 18.21$^{f}$ |
| $T_4$ | 89 ± 1.15 | 108.7 ± 1.45$^{cd}$ | 43.1 ± 1.18$^{ef}$ | 4.2 ± 0.15$^{abc}$ | 18.5 ± 0.45$^{bcde}$ | 14.3 ± 0.21$^{def}$ | 10.7 ± 0.58$^{def}$ | 153.0 ± 9.02$^{def}$ |
| $T_5$ | 89 ± 1.20 | 108.3 ± 2.03$^{cd}$ | 43.5 ± 0.68$^{def}$ | 4.3 ± 0.13$^{abc}$ | 18.8 ± 0.91$^{bcde}$ | 14.6 ± 0.17$^{de}$ | 10.9 ± 0.94$^{cde}$ | 159.1 ± 14.49$^{de}$ |
| $T_6$ | 88 ± 0.88 | 106.3 ± 0.88$^{de}$ | 45.4 ± 1.56$^{cde}$ | 4.4 ± 0.12$^{abc}$ | 18.8 ± 0.97$^{bcde}$ | 14.9 ± 0.23$^{cd}$ | 11.0 ± 0.58$^{cd}$ | 164.2 ± 11.18$^{d}$ |
| $T_7$ | 87 ± 1.15 | 105.7 ± 1.20$^{def}$ | 46.8 ± 0.83$^{bcd}$ | 4.5 ± 0.07$^{abc}$ | 19.4 ± 0.59$^{abc}$ | 15.0 ± 0.83$^{cd}$ | 11.1 ± 0.67$^{cd}$ | 166.4 ± 9.47$^{cd}$ |
| $T_8$ | 87 ± 1.45 | 105.0 ± 0.58$^{def}$ | 48.0 ± 1.48$^{abc}$ | 4.5 ± 0.19$^{ab}$ | 19.2 ± 0.67$^{abcd}$ | 15.6 ± 0.64$^{bc}$ | 11.4 ± 0.77$^{bc}$ | 178.5 ± 17.93$^{bc}$ |
| $T_9$ | 87 ± 0.88 | 102.3 ± 1.45$^{ef}$ | 49.1 ± 0.66$^{ab}$ | 4.5 ± 0.08$^{a}$ | 20.6 ± 0.99$^{ab}$ | 16.0 ± 0.28$^{ab}$ | 11.9 ± 0.81$^{ab}$ | 191.1 ± 14.63$^{ab}$ |
| $T_{10}$ | 85 ± 2.03 | 101.7 ± 2.60$^{f}$ | 51.6 ± 1.13$^{a}$ | 4.6 ± 0.12$^{a}$ | 21.2 ± 1.16$^{a}$ | 16.7 ± 0.33$^{a}$ | 12.2 ± 0.83$^{a}$ | 204.1 ± 17.38$^{a}$ |
| $T_{11}$ | 93 ± 0.58 | 122.3 ± 1.20$^{a}$ | 33.3 ± 1.28$^{h}$ | 3.7 ± 0.10$^{d}$ | 15.8 ± 0.64$^{f}$ | 11.2 ± 0.13$^{h}$ | 8.5 ± 0.70$^{g}$ | 94.3 ± 8.29$^{h}$ |
| LSD (P=0.05) | NS | 4.1 | 3.6 | 0.4 | 2.2 | 0.9 | 0.7 | 13.8 |

*Within a column number followed by different lower cases are different at P=0.05; mean ± SEM application in increasing the equatorial length might be due to the role of Mo in nitrogen assimilation and phosphorus utilization, which leads to enhancement in the yield attributes of the plant (equatorial length).

**Curd depth and curd size index:** The curd depth and curd size index varied from minimum value of 8.5 cm and 94.3 cm$^2$, respectively in $T_{11}$ and maximum value of 12.2 cm and 204.1 cm$^2$, respectively in $T_{10}$ as depicted in Table 1. The treatment $T_{10}$ recorded an increase of 20.8, 16.2, 18.4, and 14.0 per cent in curd depth and 61.7, 40.3, 63.9, and 33.4 per cent in curd size index when compared to treatment $T_1$, $T_2$, $T_3$, and $T_4$, respectively. However, it was statistically at par with the $T_9$. Also, the curd depth and curd size index in treatments comprising of Mo application either through basal or foliar, behaved statistically alike. The role of Mo in enhancing the growth parameters which might have resulted to the higher absorption and then utilization of the nutrients, might have played a significant role in enhancing the curd depth and as curd size index is a function of curd diameter and curd depth. The inferior curd depth and curd size index recorded in $T_{11}$, might be due to the sole application of organic inputs (ghanjeevamrit, beejamrit, and jeevamrit) with a low nutrient contents which proved to be insufficient to meet the nutrient requirement of the crop.

**Yield and Quality Parameters**

**Curd yield:** The curd yield significantly varied from lowest (6.9 t ha$^{-1}$) in $T_{11}$ to highest (20.7 t ha$^{-1}$) in $T_{10}$ with an increase of 57.5, 29.1, 40.6, and 22.9 per cent compared to treatment $T_1$, $T_2$, $T_3$, and $T_4$, respectively as shown in Table 2. Similar results showing an increase in curd yield due to Mo application when compared to the individual plots treated with NPK, NPK + FYM, NPK + Lime, and NPK + Lime + FYM were also reported by Reddy et al (2007) and Chowdhury and Sikdar (2017). The higher yields in these treatments might be due to the constructive role of FYM and lime in improving the soil health (Chander and Verma 2009) and increasing the availability of nutrient by affecting the soil pH (Santos et al 2018). Among treatments comprising of Mo application (soil or foliar), curd yield in foliar sprayed treatments ($T_7$ and $T_8$) were superior to the basal application ($T_5$ and $T_6$). The significant effect of Mo application in increasing the yield attributes might be due to the role of Mo in phosphorus utilisation which might have played a significant role for causing early maturity of the plant (Sahito et al 2018), which prevented the curd deformation and better marketable curds compared to control. Similar results have also been reported by Kumar et al (2010b).

**Ascorbic acid and Total soluble solids (TSS):** The ascorbic acid and TSS content was lowest in $T_{11}$ (64.4 mg 100g$^{-1}$ and 7.7° Brix, respectively). The maximum content (77.8 mg 100g$^{-1}$ and 8.4° Brix, respectively) was in $T_{10}$ with an increase of 12.9, 10.0, 11.5, and 8.4 per cent in ascorbic acid and 8.9, 7.3, 8.2, and 5.8 per cent in TSS content when compared to the treatment $T_1$, $T_2$, $T_3$, and $T_4$, respectively as shown in table 2. However, $T_{10}$ was statistically at par with the treatment $T_8$ and $T_9$. Among treatments receiving the Mo application (soil or foliar), the higher ascorbic and TSS content were in foliar application ($T_8$ and $T_9$).

As ascorbic acid is greatly influenced by the better growth and development of the plant and the Mo role in enhancing the overall growth and development of the plant might have resulted to an increase in ascorbic acid content as depicted in treatments with better plant development. The significant effect of Mo application on TSS might be due to the Mo role in the nitrogen metabolism of the plant, which enhances the metabolic pools required for the synthesis of

**Table 2.** Effect of treatments on quality parameters and yield

| Treatments | Curd yield (t ha$^{-1}$) | Ascorbic acid (mg 100g$^{-1}$) | TSS\ (°Brix) | Curd solidity (g cm$^{-1}$) |
|---|---|---|---|---|
| $T_1$ | 13.1 ± 0.38$^{h*}$ | 68.9 ± 0.56$^{f}$ | 7.76 ± 0.03$^{g}$ | 35.6 ± 2.69$^{c}$ |
| $T_2$ | 16.0 ± 0.19$^{f}$ | 70.7 ± 0.79$^{ef}$ | 7.87 ± 0.01$^{f}$ | 41.8 ± 3.01$^{ab}$ |
| $T_3$ | 14.7 ± 0.22$^{g}$ | 69.8 ± 0.76$^{ef}$ | 7.80 ± 0.02$^{fg}$ | 39.5 ± 3.90$^{bc}$ |
| $T_4$ | 16.8 ± 0.30$^{ef}$ | 71.8 ± 0.16$^{de}$ | 7.98 ± 0.01$^{e}$ | 42.7 ± 2.35$^{ab}$ |
| $T_5$ | 17.2 ± 0.19$^{de}$ | 73.9 ± 0.97$^{cd}$ | 8.13 ± 0.03$^{d}$ | 43.1 ± 3.11$^{ab}$ |
| $T_6$ | 17.5 ± 0.14$^{de}$ | 74.8 ± 0.46$^{bc}$ | 8.23 ± 0.05$^{c}$ | 43.2 ± 2.05$^{ab}$ |
| $T_7$ | 18.1 ± 0.33$^{cd}$ | 75.0 ± 0.88$^{bc}$ | 8.32 ± 0.03$^{bc}$ | 44.3 ± 2.99$^{a}$ |
| $T_8$ | 19.0 ± 0.31$^{bc}$ | 75.7 ± 0.76$^{abc}$ | 8.37 ± 0.04$^{ab}$ | 45.4 ± 3.54$^{a}$ |
| $T_9$ | 19.5 ± 0.38$^{b}$ | 76.7 ± 0.76$^{ab}$ | 8.40 ± 0.06$^{ab}$ | 44.6 ± 3.59$^{a}$ |
| $T_{10}$ | 20.7 ± 0.66$^{a}$ | 77.8 ± 1.04$^{a}$ | 8.44 ± 0.02$^{a}$ | 46.3 ± 4.40$^{a}$ |
| $T_{11}$ | 6.9 ± 0.38$^{i}$ | 64.4 ± 0.71$^{g}$ | 7.67 ± 0.02$^{h}$ | 22.3 ± 2.06$^{d}$ |
| LSD (P=0.05) | 1.03 | 2.16 | 0.09 | 4.50 |

*Within a column number followed by different lower cases are different at P=0.05; mean ± SEM

**Table 3.** Effect of different treatments on economics of cauliflower

| Treatments | Cost of cultivation (₹ $ha^{-1}$) | Gross returns (₹ $ha^{-1}$) | Net returns (₹ $ha^{-1}$) | B:C |
|---|---|---|---|---|
| $T_1$ | 75984 | 262847 | 186863 | 3.46 |
| $T_2$ | 96484 | 320686 | 224202 | 3.32 |
| $T_3$ | 126484 | 294414 | 167930 | 2.33 |
| $T_4$ | 146734 | 336624 | 189891 | 2.29 |
| $T_5$ | 99145 | 343618 | 244473 | 3.47 |
| $T_6$ | 100475 | 351004 | 250529 | 3.49 |
| $T_7$ | 99645 | 361457 | 261812 | 3.63 |
| $T_8$ | 100975 | 379556 | 278581 | 3.76 |
| $T_9$ | 102306 | 389279 | 286974 | 3.81 |
| $T_{10}$ | 103636 | 413896 | 310260 | 3.99 |
| $T_{11}$ | 71855 | 138124 | 66269 | 1.92 |

Market price of (a) cauliflower: ₹20 $kg^{-1}$ and (b) ammonium molybdate: ₹1386 $kg^{-1}$

the saccharides with direct effect on this quality parameter (Kaiser et al 2005). Similar results showing an increase in the quality parameters i.e., ascorbic acid and TSS content have also been reported by Thapa et al (2016).

**Curd Solidity.** The curd solidity was minimum (22.3 g $cm^{-1}$) in $T_{11}$ and maximum (46.25 g $cm^{-1}$) in $T_{10}$ as shown in table 2. The curd solidity in treatments with the Mo application either through soil, foliar, or conjoint behaved statistically alike. In treatment $T_{11}$, due to the sole application of organic inputs (ghanjeevamrit, beejamrit, and jeevamrit) with a low nutrient contents, which proved insufficient to meet out the nutrient requirement of the crop. Hence, leading to poor curd solidity when compared to other treatments. There exists a proportional relationship between curd solidity and curd weight, thereby, the change in curd weight have a direct effect on curd solidity.

**Economics:** Higher net returns (₹ 3,10,260 $ha^{-1}$) and benefit-cost ratio (3.99) were recorded in $T_{10}$ (table 3) whereas, the lowest net returns (₹ 66,269 $ha^{-1}$) and benefit-cost ratio (1.92) were recorded in treatment $T_{11}$. The higher net returns and lower B:C recorded in treatment $T_3$ and $T_4$ when compared to the $T_1$, was because of the higher cost of inputs (lime and FYM). The treatment $T_4$ recorded the highest cost of cultivation over rest of the treatments. However, the higher B:C recorded in the treatments ($T_5$ to $T_{10}$), was because of the use of agricultural grade ammonium molybdate (₹ 1386 $kg^{-1}$) which resulted in lower cost of cultivation with perspective to higher gross returns. The treatment $T_{10}$ was more feasible with higher net returns and benefit-cost ratio, and should be recommended in the Mo deficient soils.

## CONCLUSIONS

Mo application played a significant role in enhancing the productivity, quality, and the profitability of cauliflower crop grown in Mo deficient soil. However, the conjoint application of Mo (soil plus foliar) @ 1.0 kg $ha^{-1}$ as basal and @ 0.15 % as foliar feeding, respectively, along with the RDF proved to be the best Mo application method to remediate the Mo deficiency in Typic Hapludalfs soil of Himachal Pradesh.

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