International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(1): 105-110
www.biochemjournal.com
Received: 16-10-2025
Accepted: 18-11-2025

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Influence of seed rhizome treatment with metabolite elicitors on growth and yield parameters of turmeric

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DOI: https://www.doi.org/10.33545/26174693.2026.v10.i1Sb.6890

Abstract
The experiment was conducted at Horticultural Research Station, Mondouri, BCKV, West Bengal during 2019-2020 and 2020-2021to study the influence of seed rhizome treatment with metabolite elicitors on growth and yield of turmeric. The results were observed significant variations among different treatments in respect of most of the parameters. Plants raised from seed rhizome treated with salicylic acid-200 ppm recorded maximum number of leaves (21.15), tillers (3.37), clump weight (325.95 g), length of clump (18.55 cm), breadth of clump (16.46 cm), weight of primary finger (166.29 g), length of primary finger (9.99 cm), breadth of primary finger (2.31 cm), weight of secondary finger (140.51 g), length of secondary finger (5.06 cm), breadth of secondary finger (1.75 cm), yield plot^{-1} (12.39 kg 3m^{-2}), projected yield (30.96 t ha^{-1}.The maximum plant height (162.13 cm) and number of secondary fingers (14.09) were recorded in salicylic acid-300 ppm. The maximum number of primary fingers (9.61).

Keywords: Turmeric, elicitors, seed treatment, growth and yield parameters, Chitosan, Salicylic Acid, Proline, Methyl jasmonate

Introduction
Turmeric (*Curcuma longa* L.) is an herbaceous perennial plant, belongs to the family. Zingiberaceae. It is an ancient sacred spice of India known as 'Indian saffron". Turmeric originated in South-East Asia and one of the important spice crops of the tropics. India is the largest producer, consumer and exporter of turmeric in the world (Anandaraj *et al*., 2014) [1]. India being the world's largest producer of turmeric, gains importance for its oleoresin and curcumin, having medicinal value and ample export opportunity has been created in World Trade Centre. In India, turmeric makes up around 6% of the entire section dedicated to spices and condiments. The major states in India that cultivate turmeric include Telangana, Andhra Pradesh, Tamil Nadu, Orissa, Karnataka, West Bengal, Gujarat, Meghalaya, Maharashtra, and Assam. Turmeric was grown in an area of 3, 33,024 hectares with a total production of 12, 21,717 tonnes during 2021-22 (Spice Board, 2022) in India. In West Bengal during the year 2021-22, area covered under turmeric was 18772 hectares and production was 50938 tonnes (Spice Board, 2022). Elicitors are the chemical compounds derived from various sources that can trigger physiological and morphological responses and also trigger the phytoalexin accumulation in the target living organisms. Elicitor molecules attach to the special receptor proteins located on plant cell membranes. The receptors are able to recognize the molecular pattern of elicitors, which trigger the intracellular defense signaling and results in the increased synthesis of secondary metabolites.

A recent report indicates that, the export and demand of Indian turmeric have increased due to increased food as well as non-food uses (Ray *et. al*., 2016) [19]. It is used in several industries as a colouring agent for cheese, cereals, soups, ice-creams, yoghourt and more (Singh *et al*., 2014). The use of turmeric and its value added products is recognized globally and hence the production has to be increased to meet the requirements (Anasuya and Sathiyabama, 2016) [2]. The export demand of turmeric is increasing in the last few years due to its non-food as well as flavouring use. There-fore, the production of turmeric has to be increased to meet global requirements. Curcumin concentration in turmeric varies between genotypes and environmental conditions and for improved commercialization there is a need to increase and standardize its bio-production (Anandaraj *et al*., 2014) [1]. Recent studies indicated that both yield and quality affected to a great extent with the application of metabolic elicitors. Elicitors like chitosan, salicylic acid and methyl jasmonate, proline were found to show positive effect on growth, yield and quality in various crops. In view of the above background, the present research works were undertaken to evaluate the effect of seed rhizome treatment with the promising metabolite elicitors *viz*., chitosan, salicylic acid, methyl jasmonate and proline on growth and yield aspects in turmeric. In this experiment, four elicitors with three concentrations were included. The elicitors are chitosan (250, 500 and 750 ppm), methyl jasmonate (50,100 and 200 ppm), proline (50, 100, 200 ppm) and salicylic acid (100, 200 and 300 ppm) altogether 13 treatments included control and the variety was Suguna.

Material and methods

The experiment was laid out in Randomized Block Design with three replications. Raised beds of 3.0 x 1.0 m^2 and 15 cm height were prepared. The planting and harvesting were done during middle of May and end of January respectively during both the years. Healthy seed rhizomes weighing 20-25 g size were soaked for two hours with different level of metabolite elicitors *viz.,* chitosan (250, 500 and 750 ppm), salicylic acid (100, 200 and 300 ppm), proline (50, 100 and 200 ppm) and methyl jasmonate (50, 100 and 200 ppm). After treatment the seed rhizomes were dried under shade. In the next day, the rhizome bits were treated with a solution mixture of Metalaxyl (3 g l^{-1}) and Dithane M-45 (2 g l^{-1}) for thirty minutes as seed treatment and dried under shade. The treated rhizome bits were planted in the raised beds to a depth of 3-4 cm and at a spacing 30×25 cm.

The recommended dose of fertilizer was NPK @ 150:60:150 kg ha^{-1}. The doses of fertilizers were adjusted with the application of urea, single super phosphate and muriate of potash. Nitrogen was applied in 3 split doses, one third nitrogen and full phosphorus were applied as basal, whereas 1/3rd N and 1/2nd K where applied at 45 and 90 days after planting.

First irrigation was given immediately after planting; the subsequent irrigations were given depending upon the soil moisture and weather condition. Rhizomes of turmeric were planted to a depth of 3-4 cm. Crops were mulched immediately after planting with paddy straw at the rate of 10 t ha^{-1} and 5 t ha^{-1} at 45 and 90 days after planting. Earthing up was done before second and third mulching.

Results

In this experiment, observations on growth parameters *viz.*, plant height, number of leaves $plant^{-1}$, number of tillers $plant^{-1}$ in five randomly selected turmeric plants were recorded at 150 and 180 days after planting. Rhizome characters and yield parameters were recorded during harvesting.

Plant height (cm) in pooled analysis, at 150 DAP the maximum plant height was recorded in salicylic acid-300 ppm (141.91 cm) followed by chitosan-750 ppm (139.21 cm) and salicylic acid-200 ppm (138.82 cm) as compared to lowest plant height in proline-200 ppm (114.56 cm). And at 180 DAP the maximum plant height was observed in salicylic acid-300 ppm (162.13 cm) followed by salicylic acid-200 ppm (160.56 cm) and chitosan-750 ppm (159.58 cm) as compared to lowest plant height in control (132.56 cm). At both 150 and 180 DAP the increasing trend in height was noticed with increasing concentration in chitosan and salicylic acid but up to medium concentration in other two elicitors.

Number of leaves $plant^{-1}$ in pooled analysis, at 150 DAP the maximum number of leaves (17.61) was recorded in salicylic acid-300 ppm followed by salicylic acid-200 ppm (16.92) and methyl jasmonate-200 ppm (16.76) as compared to minimum number of leaves under control (13.93). And at 180 DAP, the maximum number of leaves (21.15) was recorded in salicylic acid- 200 ppm followed by salicylic acid-300 ppm (20.90) and chitosan-500 ppm (20.10) as compared to minimum number of leaves under control (16.94). As per pooled analysis, At 150 DAP the increasing trend in leaf production with increasing concentration of upto highest level was noticed in all elicitors except in proline. And at 180 DAP the increasing trend in leaf production was noticed with increasing concentration upto medium level in all four elicitors.

Number of tillers $plant^{-1}$ in pooled analysis, at 150 DAP the maximum number of tillers (2.22) was recorded in salicylic acid-300 ppm followed by salicylic acid-200 ppm (2.17) and chitosan-750 ppm (2.08) as compared to minimum number of tillers under proline-100 ppm (1.29). And at 180 DAP, the maximum number of tillers (3.37) was recorded in salicylic acid-200 ppm followed by salicylic acid-300 ppm (3.17) and chitosan-750 ppm (2.99) as compared to minimum number of tillers under proline-50 ppm (1.71). At 150 DAP the tiller production increased with increasing the concentration was observed in chitosan and salicylic acid and at 180 DAP the tiller production increased with increasing the concentration was observed in chitosan and proline but up to medium concentration in methyl jasmonate and salicylic acid.

Weight of clump (g) in pooled analysis, the maximum (325.95 g) clump weight was observed with salicylic acid-200 ppm followed by chitosan-750 ppm (316.45 g) and salicylic acid-300 ppm (301.46 g) as compared to minimum (213.00 g) clump weight with proline-50 ppm. As per pooled analysis, the increasing trend were noticed with increasing concentration of chitosan and methyl jasmonate but reduction in clump weight was noticed with medium concentration of other two elicitors.

Length of clump (cm) in pooled analysis, the maximum (18.55 cm) length of clump was observed with treatment salicylic acid-200 ppm followed by chitosan-750 ppm (18.34 cm) and methyl jasmonate-100 ppm (17.56 cm) as compared to minimum (13.99 cm) length of clump with control. As per pooled analysis the length of clump was increased up to medium concentration at methyl jasmonate, proline and salicylic acid but exception with proline, where the length of clump was increased up to highest concentration.

Breadth of clump (cm) in pooled analysis, the maximum (16.46 cm) breadth of clump was observed with treatment salicylic acid-200 ppm followed by chitosan-750 ppm (15.67 cm) and methyl jasmonate-100 ppm (15.40 cm) as compared to minimum (12.88 cm) breadth of clump with proline-50 ppm. Increasing trend in breadth was observed with increasing concentration in chitosan and methyl jasmonate but up to medium concentration with proline and salicylic acid.

Number of primary finger in pooled analysis, the maximum (9.61) number of primary fingers was observed with treatment chitosan-750 ppm followed by salicylic acid-300 ppm (9.35) and salicylic acid-200 ppm (9.23) as compared to minimum (7.37) number of primary fingers with proline-50 ppm. As per pooled analysis, the increasing trend in increasing the numbers was recorded with chitosan and salicylic acid up to highest concentration but reduction in number was noticed after medium concentration in case of both methyl jasmonate and proline.

Weight of primary finger (g) in pooled analysis, the maximum (166.29 g) weight of primary finger was observed with treatment salicylic acid-200 ppm followed by methyl jasmonate-100 ppm (162.08 g) and chitosan-750 ppm (161.78 g) as compared to minimum (100.80 g) weight of primary finger with proline-50 ppm. The response of chitosan and proline up to highest concentration were observed but in case of other two elicitors the response up to medium concentration were recorded.

Length of primary finger (cm) in pooled analysis, the maximum (9.99 cm) length of primary finger was observed with treatment salicylic acid- 200 ppm followed by chitosan-750 ppm (9.13 cm) and methyl jasmonate-100 ppm (8.99 cm) as compared to minimum (7.09 cm) length of primary finger with proline-50 ppm. As per pooled analysis, the increasing trend in increasing length was noticed in case of chitosan and proline but reduction in length was recorded at highest concentration in both the methyl jasmonate and salicylic acid.

Breadth of primary finger (cm) in pooled analysis, the maximum (2.31 cm) breadth of primary finger was observed with salicylic acid-200 ppm and methyl jasmonate-100 ppm followed by salicylic acid-100 ppm (2.30 cm) and chitosan-750 ppm (2.14 cm) as compared to minimum (1.55 cm) breadth of finger with proline-50 ppm. Like length of primary finger the similar trend of response was noticed in respect of increasing concentration of elicitors.

Number of secondary finger in pooled analysis, the maximum (14.09) number of secondary fingers was observed with treatment salicylic acid-300 ppm followed by salicylic acid-200 ppm (14.06) and chitosan-750 ppm (13.27) as compared to minimum (8.41) number of secondary fingers with control. Like number of primary finger the similar trend of responses with increasing concentration were observed.

Weight of secondary finger (g) in pooled analysis, the maximum (140.51 g) weight of secondary finger was observed with salicylic acid-200 ppm followed by chitosan-750ppm (140.36 g) and salicylic acid-300 ppm (137.03 g) as compared to minimum (75.02 g) weight of secondary finger with proline-50 ppm. As per pooled analysis, the increasing trend in increasing weight of secondary finger was noticed in respect of chitosan (99.13 g to 140.36 g) and methyl jasmonate (103.13 g to 123.58 g) but reduction of weight was observed after medium concentration in case of both proline and salicylic acid.

Length of secondary finger (cm) in pooled analysis, the maximum (5.06 cm) length of secondary finger was observed with salicylic acid-200 ppm followed bychitosan-750 ppm (4.73 cm) and salicylic acid-100 ppm (4.60 cm) as compared to minimum (3.21 cm) length of secondary finger with proline-50 ppm. The decreasing trend in length was noticed after medium concentration in case of methyl jasmonate, proline and salicylic acid. The increasing trend with increasing concentration was observed only in chitosan.

Breadth of secondary finger (cm) in pooled analysis, the maximum (1.75 cm) breadth of secondary finger was observed with treatment salicylic acid-200 ppm followed by chitosan-750 ppm (1.70 cm) and methyl jasmonate-100 ppm (1.66 cm) as compared to minimum (1.30 cm) breadth secondary of finger with proline-200 ppm. The similar trend in respect of response of concentration in length of secondary fingers was observed here also.

Yield per plot (kg $3m^{-2}$) in pooled analysis, the maximum (12.39 kg $3m^{-2}$) yield plot-1 observed with treatment salicylic acid-200 ppm followed by chitosan-750 ppm (12.02 kg $3m^{-2}$) and salicylic acid- 300 ppm (11.52 kg $3m^{-2}$) as compared to minimum (8.10 kg $3m^{-2}$) yield $plot^{-1}$ with proline-50 ppm. As per pooled analysis, the increasing trends in increasing yield plot-1 was recorded with increasing concentration of chitosan (10.51 to 12.02 kg $3m^{-2}$) and methyl jasmonate (10.61-11.30 kg $3m^{-2}$) but yield decreased after medium concentration of other two elicitors.

Projected yield (t ha^{-1}) In pooled analysis, the maximum (30.96 t ha^{-1}) projected yield observed with treatment salicylic acid-200 ppm followed by chitosan-750 ppm (30.06 t ha^{-1}) and salicylic acid-300 ppm (28.64 t ha^{-1}) as compared to minimum (20.24 t ha^{-1}) projected yield with proline-50 ppm. The similar trend of response in respect of concentration was observed here also like yield $plot^{-1}$.

Discussion

The observations on plant height, number of leaves and tillers indicated that among the different elicitors evaluated, salicylic acid (200 and 300 ppm) and chitosan (500 and 750 ppm) treatments improved the vegetative parameters of plant. The results were conformity with the findings of Martin-Mex *et al.* (2005) [16]. They observed that plant height increased due to application of salicylic acid through increasing photosynthetic activity. Plant growth increased with increasing cell division in both stem and roots, under both greenhouse and field conditions. It plays a vital role in plant growth, ion uptake and transport, reduced transpiration and leaf abscission (Ashraf *et al.*, 2010) [3]. The improvement in plant height by the application of salicylic acid might be due to increase of the length of internodes Kim (2009) [13] also observed that application of carboxy methyl chitosan, increased key enzyme of nitrate, nitrate reduction glutamine synthase and protease which enhanced the plant growth in sweet basil.

Chitosan treatment on turmeric plants resulted in high yield and curcumin content when applied at a regular interval of 30 days up to 210 days (Anasuya and Sathiyabama, 2016) [2]. Chitosan have been recognized as a product to enhance crop production due to its stimulation and seed germination, increasing nutrient uptake, reducing oxidative stress, increasing chlorophyll content, photosynthetic and chloroplast enlargement in the leaves, antifungal, antiviral and antibacterial properties (Hadrami *et al.*, 2010 and Hadwiger, 2013) [9, 10].

The stimulating effect of chitosan on plant growth may be attributed to an increase in the availability and uptake of water and essential nutrients through adjusting cell osmotic pressure, and reducing the accumulation of harmful free radicals by increasing antioxidants and enzyme activities (Guan *et al.*, 2009) [2] or may be attributed to an increase in the key enzyme activities of nitrogen metabolism (nitrate reductase, glutamine synthetase and protease) and improved the transportation of nitrogen in the functional leaves as well as increased photosynthesis which enhanced plant growth and development (Mondal *et al*., 2012) [17]. In the present experiment, similar phenomenon may be occurred and thereby increased plant height, number of leaves, clump weight and yield in chitosan applied turmeric plants than control plants. The findings are in good agreement with those of Anasuya and Sathiyabama (2016) [2], who found that as compared to a control, chitosan (0.1%, w/v) increased plant height, leaf number, and fresh weight per plant in turmeric. The rhizome yield was enhanced by up to 60% by fresh weight and 50% by dry weight when chitosan (0.1%) was applied topically above the control group.

The administration of chitosan through seed treatment greatly increased the number of tillers, demonstrating the ability of chitosan to promote higher differentiation of vegetative buds to produce tillers. These findings were in consistent with Thengumpally (2019) [28] in turmeric. The increment in fresh weight plant-1 after treatment with chitosan may be due to its impact on enhancing uptake and transport of minerals such as nitrogen, phosphorus and potassium

Chitosan significantly increased turmeric yield, which may be related to improved photosynthetic pigments and biochemical plant processes that increased the amount of photosynthates directed towards the rhizomes (El-Tantawy, 2009). Our findings are also in line with Ullah *et al*. (2020) who reported that chitosan increased yield in tomato.

These results are similar to Sofy *et al*. (2020) and Manjusha *et al.,* (2023) [25, 15] Chitosan may include amino groups that enhance plants' photosynthetic area, maximise photosynthesis and ultimately improve plant height because of the turmeric plants' favourable response to chitosan concentration. Ibraheim and Mohsen 2015 [12] also found that different chitosan concentration positively improved plant height and other growth parameters of cucumber plants. Increased uptake of nitrogen and potassium eventually increases plant growth.

The results of Waly *et al*. (2019) [31] clearly indicated similarly that the different applied treatments increased the measured growth characteristics i.e. plant height, number of branches/plant, fresh and dry weights as well parallel increase of photosynthetic pigments and Krishna *et al.,*

Salicylic acid application increases the plant height because of increased Rubisco chemical action and photosynthetic activity. It causes plant growth to increase with increasing cell division in both stem and roots, thus increasing plant height under greenhouse and field conditions. It has numerous functions, particularly the reduced transpiration and leaf abscission (Ashraf *et al*., 2010) [3].

Salicylic acid treatments reported to have increased the cell division by stimulating the mitotic system of the apical meristem of roots which caused better plant growth (Basra *et al*., 2006) [4]. Salicylic acid intensified the net photosynthetic rate, internal CO_2 concentration and water use efficiency which ultimately influence the final yield (Shakirova, 2007) [22]. This root growth promoting domain of salicylic acid has now made it one of the most important, effective and cost beneficial phytohormone that has the potential to enhance the root growth in economically important vegetables and salad crops.

The growth yield and essential oil yield and essential oil yield of cumin were increased with the application of salicylic acid and methyl jasmonate in cumin, Fruit yield of 776.7 kg ha-1 and 611.3kg ha-1 were observed with salicylic acid 0.1mM and methyl jamonate 1.0 mM as compared to 439.0 kg ha-1 under control, showing significant increase about 77% band 40% as compared with control. Important role in plant development- and physiological processes induces or increases the biosynthesis of many secondary secondary metabolites that play important roles, (Choi *et al*., 2005 and Kim *et al*., 2009) [5, 13]. Sivaranjani *et al*., (2022) [24] are suggested that foliar spray of chitosan and salicylic acid at rhizome development stage could be employed to elicit the physiological response and improve the quality of turmeric grown under rain fed condition

The promotive effect of salicylic acid on vegetative growth could be attributed to its bio regulator effects on physiological and biochemical processes in plants such as ion uptake cell elongation, cell division, sink/source regulation, enzymatic activities, protein synthesis and photosynthetic activity as well increase the antioxidant capacity of plants (El-Tayab, 2005) [7] and its role in enhancing rooting of plants (Sandoval - Yapiz, 2004) [21] which play a key role in enhancing the growth and productivity of plants. Our results are in harmony with those of Manoj (2017) [14] in turmeric, Hesami *et al*., (2013) [11] on coriander, Rahimi *et al*., (2013) [18] on cumin. Among four elicitors, salicylic acid and chitosan proved better as compared to others.

Table 1: Influence of seed rhizome treatment with metabolite elicitors on growth parameters of turmeric

S. No.	Treatments (ppm)	Plant height (cm)		Number of leaves plant^{-1}		Number of tillers plant^{-1}	
		150 DAP (Pooled)	180 DAP (Pooled)	150 DAP (Pooled)	180 DAP (Pooled)	150 DAP (Pooled)	180 DAP (Pooled)
1	Chitosan-250	127.06	149.57	14.84	17.86	1.67	2.38
2	Chitosan-500	132.07	154.38	16.35	20.10	1.94	2.70
3	Chitosan-750	139.21	159.58	16.59	19.86	2.08	2.99
4	Methyl jasmonate-50	126.25	149.73	15.98	18.85	1.74	2.26
5	Methyl jasmonate-100	136.91	154.58	16.16	20.07	1.96	2.61
6	Methyl jasmonate-200	128.59	145.61	16.76	18.91	1.84	2.60
7	Proline-50	118.09	136.55	14.71	17.09	1.40	1.71
8	Proline-100	125.67	144.56	14.65	17.82	1.29	1.97
9	Proline-200	114.56	133.57	14.42	17.32	1.51	2.00
10	Salicylic acid -100	132.88	152.58	16.02	18.98	1.89	2.67
11	Salicylic acid -200	138.82	160.56	16.92	21.15	2.17	3.37
12	Salicylic acid -300	141.91	162.13	17.61	20.90	2.22	3.17
13	Control	115.29	132.56	13.93	16.94	1.30	1.82
14	S.Em. (±)	2.053	1.988	0.432	0.509	0.069	0.077
15	C. D. (P=0.05)	6.027	5.838	1.267	1.494	0.204	0.226

Table 2: Influence of seed rhizome treatment with metabolite elicitors on clump and Yield parameters of turmeric

S. No.	Treatments (ppm)	Weight of clump (g)	Length of clump (cm)	Breadth of clump (cm)	Yield per plot (kg 3m^{-2})	Projected yield (t ha^{-1})
		Pooled	Pooled	Pooled	Pooled	Pooled
1	Chitosan-250	276.49	16.09	14.49	10.51	26.28
2	Chitosan-500	298.77	16.49	14.34	11.36	28.39
3	Chitosan-750	316.45	18.34	15.67	12.02	30.06
4	Methyl jasmonate-50	279.19	16.06	14.67	10.61	26.53
5	Methyl jasmonate-100	294.02	17.56	15.40	11.24	27.94
6	Methyl jasmonate-200	297.27	16.16	14.74	11.30	28.24
7	Proline-50	213.00	14.77	12.88	8.10	20.24
8	Proline-100	249.07	15.64	13.73	9.46	23.65
9	Proline-200	235.38	15.57	13.85	8.95	22.36
10	Salicylic acid -100	294.68	17.27	15.29	11.20	28.00
11	Salicylic acid -200	325.95	18.55	16.46	12.39	30.96
12	Salicylic acid -300	301.46	17.41	14.93	11.52	28.64
13	Control	248.43	13.99	13.09	9.93	24.84
14	S.Em. (±)	5.673	0.226	0.273	0.220	0.718
15	C. D. (P=0.05)	16.657	0.664	0.801	0.647	2.107

Table 3: Influence of seed rhizome treatment with metabolite elicitors on primary finger and Secondary finger of turmeric

S. No.	Treatments (ppm)	Primary finger				Secondary finger			
		Number	Weight (g)	Length (cm)	Breadth (cm)	Number	Weight (g)	Length (cm)	Breadth (cm)
		Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
1	Chitosan-250	8.09	135.14	7.32	1.65	10.59	99.13	3.51	1.37
2	Chitosan-500	8.90	155.29	8.71	1.87	12.44	109.10	3.89	1.46
3	Chitosan-750	9.61	161.78	9.13	2.14	13.27	140.36	4.73	1.70
4	Methyl jasmonate-50	7.84	140.41	7.88	1.68	10.63	103.13	3.70	1.37
5	Methyl jasmonate-100	9.13	162.08	8.99	2.31	13.20	107.18	4.54	1.66
6	Methyl jasmonate-200	8.97	134.73	7.94	1.80	12.69	123.58	3.94	1.42
7	Proline-50	7.37	100.80	7.09	1.63	9.22	75.02	3.21	1.33
8	Proline-100	8.06	104.62	7.34	1.55	11.80	109.53	4.00	1.42
9	Proline-200	7.83	119.29	7.63	1.64	10.98	77.46	3.61	1.30
10	Salicylic acid -100	9.18	158.04	8.50	2.30	13.07	135.30	4.60	1.61
11	Salicylic acid -200	9.23	166.29	9.99	2.31	14.06	140.51	5.06	1.75
12	Salicylic acid -300	9.35	144.33	8.84	2.12	14.09	137.03	4.29	1.60
13	Control	7.69	125.47	7.14	1.86	8.41	79.67	3.78	1.39
14	S.Em. (±)	0.322	3.350	0.283	0.038	0.351	2.803	0.217	0.028
15	C. D. (P=0.05)	0.944	9.838	0.832	0.111	1.030	8.230	0.636	NS

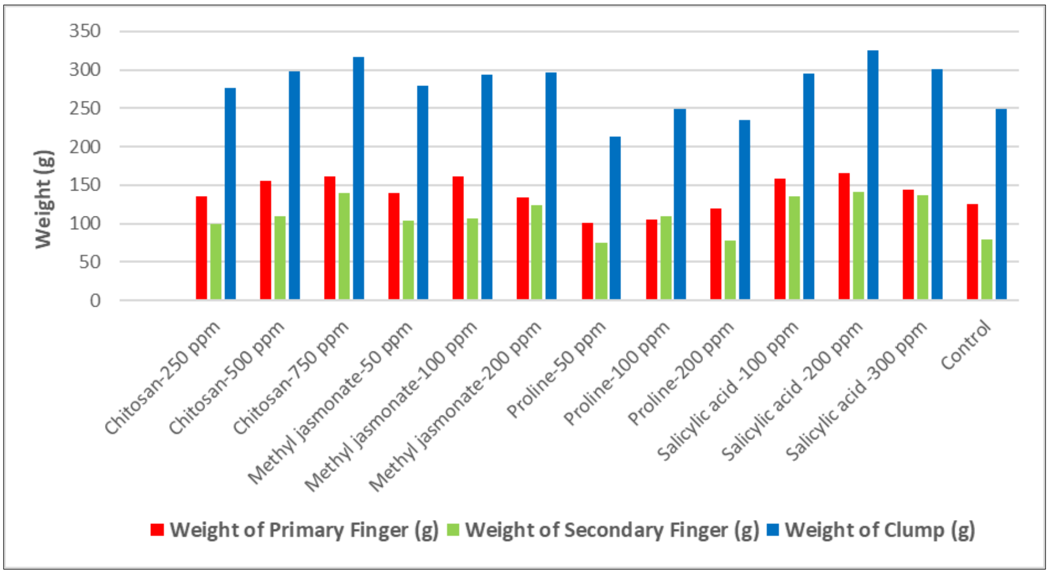

Fig 1: Influence of seed rhizome treatment with metabolite elicitors on primary-secondary finger weight and clump of turmeric

Conclusion

Considering the yield per plot and projected yield per ha the most effective treatment among different elicitors was salicylic acid 200 ppm followed by salicylic acid 300 ppm and chitosan 750 ppm towards improving the production of turmeric. These two elicitors are proved to be the best when compared to other elicitors on turmeric. at Horticultural Research Station, Mondouri, BCKV, West Bengal. Salicylic acid followed chitosan are affecting more impact on growth and yield parameters. These two elicitors can be suggested to the farmers for higher yields and increasing farmer's income.

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