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Quality assessment of bottle gourd as influenced by bioregulators and pinching operations

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Abstract
The trial was conducted during the summer season of 2021 and 2022 at Vegetable Research Centre, Department of Horticulture, JNKVV (M.P.) to determine the influence of bioregulators and pinching on quality of bottle gourd var Pusa Naveen. A field experiment was laid out with 21 treatment combinations encompassing three levels of pinching and seven levels of plant growth regulators (NAA, Salicylic acid and Biofertisol) laid out in a Randomized Block Design (Factorial) with three replicates. The interaction effect of pinching operation and bioregulators had a marked influence on quality of bottle gourd. The treatment combination comprising of pinching operation done on 3rd node with exogenous application of Salicylic acid @ 0.5 mM (P1G3) recorded higher moisture of 91.10% in the course of first year. No pinching with foliar application of NAA @ 200 ppm (P0G2) recorded higher moisture content of 91.20% during second year whereas, the pooled average exhibited 90.80%. No pinching along with the foliar spray of Biofertisol @ 5 ml recorded higher ascorbic acid content of 10.20 mg/ 100 g during the first year however, pinching operation carried on 6th node with spray of NAA @ 100 ppm noted maximum magnitude of 10.09 mg/ 100 g for this trait during second year. The pooled average revealed a maximum value of 9.80 mg/ 100 gm of ascorbic acid content. In regards to the TSS content, treatment combination of no pinching with spray of Biofertisol @ 5 ml recorded higher value of 4.20˚Brix during the first year. Treatment combination of no pinching with spray of Biofertisol @ 5 ml and pinching carried out on 3rd node with SA @ 0.7 mM recorded higher value of 4.20˚Brix during the second year. The pooled data revealed higher value of 4.15˚Brix. Maximum magnitude of 0.41%, 0.37% and 0.39% for crude protein content was exhibited in the treatment combination comprising of no pinching with foliar spray of NAA @ 200 ppm. Thus it can be concluded that among the bioregulators, foliar application of NAA @ 200 ppm recorded better moisture content, crude protein and TSS content in Bottle Gourd.

Keywords: Bottle gourd, quality, NAA, salicylic acid, biofertisol

Introduction

Bottle gourd is an important cucurbitaceous vegetable crop and commonly known as ghia, dudhi or lauki in India. It originated from Africa and thrives best in loamy soil with a pH range of 6-7. Fruit is of many forms, shape, and varieties. Each variety produces different shaped, sized fruit from round to large some elongated with narrow neck (Anonymous, 2016) [2]. Tender fruits are used as a vegetable and also for the preparation of sweets and pickle especially in the hills (Sharma and Sengupta, 2012) [23]. Pusa Naveen having earliness, ability and maximum fruit yield in adverse environmental conditions especially in high-temperature stress under hot arid environment. Considerable variability was displayed in the qualitative traits particularly blossom, shape and ridges of bottle gourd whereas significant differences were also recorded for quantitative characters like fruit length, fruit width and fruit circumference (Sivaraj and Pandravada, 2005 and Vaniya *et al.*, 2008) [28, 32].

The immature fruit is a good source of glucose and fructose. The edible fruits consist of vitamin B, ascorbic acid and minerals like potassium, calcium, phosphorus, magnesium, sodium, zinc, iron, manganese, copper and (USDA 2016) [31]. It is used to for the treatment of jaundice, diabetes, ulcer, insanity and hypertension (Duhan *et al.*, 2022) [6]. Growth regulators increase the number of female flowers and fruits, resulting in improved seed yield and quality (Priyadarshi *et al*., 2022) [33]. The young and tender fruit of bottle gourd are mostly used in rayata, halwa, petha etc. dry shells of the mature fruits are used to make containers and musical instruments. The plant has also been suggested to possess antioxidant activity, laxative, cardioprotective, diuretic, hepatoprotective, hypolipidemic, central nervous system stimulant, anthelmintic, antihypertensive, immunosuppressive analgesic, adaptogenic and free radical scavenging activity. It has the highest content of choline among all the vegetables known to man till date, which serves as the precursor of neurotransmitter acetylcholine, which in turn is crucial for retaining and enhancing memory (Minocha *et al*., 2015) [27]. The bottle gourd contains moisture, protein, fat, carbohydrate, fibre, ash, and energy (94.5±0.06, 1.2±0.06, 0.2±0.02, 3.75±0.03, 0.7±0.01, 0.5±0.01, and 15±0.12 dry wt%), respectively (Ahmad *et al*., 2021) [1]. The bottle gourds' edible part has niacin, ascorbic acid, potassium, calcium, and phosphorus of 0.3, 12, 87, 12, and 37 mg, respectively, per 100 g of fruit (Sawate *et al*., 2009) [34]. The bottle gourd peels are proficient in various minerals and antioxidants. Bottle gourd's skin has the highest (84.86%) scavenging activity compared to whole and pulp (20.73%) (Ahmad *et al.*, 2021) [1]. The seed kernel generally contains the percentage of moisture, protein, fat, carbohydrate, ash, and fibre of 2.47, 30.72, 52.54, 8.3, 4.43, and 1.58%, respectively (Hemeda & Khattab, 2010) [8]. Keeping this in view, the study was undertaken to study the effect of plant growth regulators on the quality of bottle gourd.

Materials and Methods

The present field trial was undertaken during the summer season of 2021 and 2022 at Vegetable Research Centres, Department of horticulture, JNKVV (M.P.) to ascertain the response of bioregulators and pinching on bottle gourd var Pusa Naveen. The experiment was arranged over 21 treatment combinations comprising of three levels of pinching (P0: No pinching, P1: Pinching at 3rd node and P2: Pinching at 6th node) and seven levels of plant growth regulators (G0: water spray, G1:NAA (100 ppm), G2: NAA (200 ppm), G3: Salicylic acid (0.5 mM), G4: Salicylic acid (0.7 Mm), G5: Biofertisol (5 ml) and G6: Biofertisol (7.5 ml)) laid out in a Randomized Block Design (Factorial) with three replicates. The required quantity of PGR's (NAA, Salicylic acid and Biofertisol) after weighing was dissolved in water. Two successive sprays of growth regulators was done at 2 and 4 true leaf stage in all treatments during morning hours of the day. The control plot was sprayed with distilled water. The observations were recorded for crude protein content (%), total soluble solids, Moisture content and ascorbic acid content of bottle gourd fruit. Crude protein was estimated from nitrogen of the fruit which was determined as per the method prescribed by Snell and Snell (1939) [29] and multiplied with factor 6.25. Ascorbic acid content was estimated by diluting the known volume of bottle gourd juice with 3% metaphosphoric acid and titrated with 2, 6-Dichlorophenol-indophenol solutions (AOAC, 1980). Total soluble solids (%) (TSS) was determined with the help of hand refrectometer. Moisture content was estimated by AOAC, 1984. The critical difference was calculated to test the significance of difference among the treatments, wherever the results were significant.

Results and Discussion

Ascorbic acid

The data for vitamin C contents in fruits under different pinching operations exhibited significant differences. Among factor A, Pinching operations, Table 1 (a) it was found that during the first year, maximum magnitude of 9.28 mg/ 100 g ascorbic acid content was measured under no pinching operation. Higher ascorbic acid content of 9.09 mg/ 100 g and was noted under pinching done at 6th node. The corresponding value obtained during the pooled average of the two years recorded more ascorbic acid content of 9.16 mg/ 100 g which was superior over the rest.

The foliar application of bioregulators showed a significant effect. The data presented in Table 1 (a) showed that during first year, higher ascorbic acid of 9.67 mg/100 g was obtained under the exogenous application of Biofertisol (5 ml) (G5). Foliar application of Salicylic acid (0.5 mM) recorded better ascorbic acid content (8.61 mg/100 g) over the rest of the treatments during second year whereas, the pool of the two year data expressed maximum value of 9.06 mg/ 100 g. Lowest values were noted under water spray (G0). It was observed that all the bio-regulators at lower concentration was found to have shown a positive effect on ascorbic acid of bottle gourd fruit. The improvement in the ascorbic acid content of guava fruits might be due to increased synthesis of metabolites which can stimulate the synthesis of the ascorbic acid precursor (Orzorek and Angell, 1974 and Singh *et al*., 2017) [18, 26]. The finding was in agreement with the results reported by Kalpana *et al.*, (2008), Li *et al*., (2009), Iqbal *et al*., (2014) and Gajera (2017) [13, 15, 11, 7].

The interaction effect between the pinching operation and bioregulators was found to be significant Table 1 (b) and depicted graphically in Fig.1. The perusal of the data revealed that during the first year, no pinching with Biofertisol @ 5 ml (P0G5) recorded higher ascorbic acid content of 10.20 mg/ 100 g. During the second year, pinching on 6th node with NAA @ 100 ppm (P2G1) expressed a higher magnitude of 10.09 mg/ 100 g. The results collaborate with the findings of Jain and Dashora (2011) [12] who reported that maximum ascorbic acid (205.18 mg/100 g pulp) due to application of 200 ppm NAA treatment. Combination consisting of Pinching done on 6th node with foliar spray of Biofertisol (5 ml) (P2G5) recorded ascorbic acid content of 9.80 mg/ 100 g and showed significant superiority. P2G0, P1G0 and P2G2 recorded lowest values during First year, second year and pooled data respectively.

Moisture Content

The Bottle gourd fruit moisture content (%) observed during the pinching operation showed a non-significant effect. The result so encompassed in Table 1 (a) exhibited a significant influence on moisture content of bottle gourd under the foliar application of bioregulators. The scrutiny of the set of observations revealed that during first and the pooled data, higher moisture content (90.13% and 89.67%) was obtained under the foliar spray of NAA @ 200 ppm (G2) respectively whereas during the second year, higher moisture content of 90.27% was noted under the application of NAA 100 ppm.

Concerning the interaction effect, the combination of pinching operation along with foliar spray of bioregulators as depicted in Table 1 (b) and graphically presented in Fig.2 was significant. The data expressed that the treatment combination comprising of pinching operation done on 3rd node with exogenous application of Salicylic acid @ 0.5 mM (P1G3) recorded higher moisture of 91.10% in the course of first year. No pinching with foliar application of NAA @ 200 ppm (P0G2) recorded higher moisture content of 91.20% during second year whereas, the pooled average exhibited 90.80%. Similar trend was reported by Marbhal *et al*. (2006) [17] in bitter gourd and Kumar *et al*. (2014) [14] in bitter gourd.

Table 1(a): Response of bottle gourd (*Lagenaria siceraria* (Mol.) Standl) to Bioregulators and pinching on Ascorbic acid and Moisture Content of Bottle gourd

Treatments	Ascorbic acid content			Moisture Content (%)		
	2021	2022	Pooled	2021	2022	Pooled
Factor A						
No pinching (P0)	9.28	7.04	8.16	89.19	89.46	89.32
Pinching at 3rd node (P1)	8.61	7.99	8.30	89.37	88.94	89.16
Pinching at 6th node (P2)	9.23	9.09	9.16	88.87	88.96	88.92
S.Em±	0.078	0.123	0.079	0.218	0.151	1.44
C.D. (at 5%)	0.22	0.35	0.23	NS	NS	NS
Factor B						
Water spray (G0)	7.73	6.20	6.97	88.54	89.37	88.96
NAA 100 ppm (G1)	8.97	8.39	8.68	88.29	90.27	89.28
NAA 200 ppm (G2)	9.17	8.47	8.82	90.13	89.20	89.67
Salicylic Acid 0.5 (G3)	9.22	8.61	8.91	89.74	89.37	89.56
Salicylic Acid 0.7 (G4)	9.30	8.03	8.67	89.39	87.37	88.38
Biofertisol 5 ml (G5)	9.67	8.44	9.06	89.07	88.83	88.95
Biofertisol 7.5 ml (G6)	9.22	8.12	8.67	88.83	89.44	89.14
S.Em±	0.120	0.124	0.120	0.333	0.231	0.220
C.D. (at 5%)	0.34	0.35	0.34	0.95	0.66	0.63

Table 1(b): Interactive effect of Bioregulators and Pinching application on Quality Content of Bottle gourd

Treatments		Quality Parameters											
		Ascorbic acid content			Moisture content			Crude Protein Content			TSS (%)		
		2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
T1	P0G0	8.10	6.06	7.08	88.30	89.40	88.85	0.23	0.22	0.22	2.80	2.73	2.77
T2	P1G0	7.80	6.25	7.03	89.00	89.70	89.35	0.25	0.24	0.25	3.33	3.20	3.27
T3	P2G0	7.30	6.30	6.80	88.33	89.00	88.67	0.28	0.27	0.27	4.13	3.00	3.57
T4	P0G1	9.40	7.80	8.60	87.70	90.50	89.10	0.34	0.30	0.32	3.47	3.40	3.43
T5	P0G2	9.20	7.20	8.20	90.40	91.20	90.80	0.41	0.37	0.39	3.70	3.50	3.60
T6	P0G3	9.30	6.55	7.93	90.10	90.20	90.15	0.37	0.29	0.33	4.07	3.60	3.83
T7	P0G4	9.50	7.60	8.55	90.10	85.60	87.85	0.31	0.28	0.29	4.03	3.70	3.87
T8	P0G5	10.20	7.35	8.78	90.00	87.20	88.60	0.25	0.36	0.31	4.20	3.40	3.80
T9	P0G6	9.25	6.70	7.98	89.00	88.50	88.75	0.21	0.27	0.24	3.90	4.20	3.70
T10	P1G1	8.20	7.28	7.74	88.00	89.20	88.60	0.26	0.42	0.34	4.10	3.60	3.85
T11	P1G2	8.90	8.20	8.55	91.00	89.20	90.10	0.23	0.33	0.28	4.10	3.50	3.15
T12	P1G3	8.75	9.28	9.02	91.10	89.60	90.35	0.22	0.32	0.27	2.70	3.60	4.15
T13	P1G4	8.70	7.30	8.00	89.20	88.10	88.65	0.21	0.26	0.23	2.80	4.20	3.50
T14	P1G5	8.70	8.70	8.70	87.63	90.20	88.92	0.31	0.26	0.28	4.10	4.10	4.10
T15	P1G6	9.20	8.90	9.05	88.37	90.20	89.28	0.25	0.27	0.26	2.80	3.40	3.10
T16	P2G1	9.30	10.09	9.70	89.17	91.10	90.13	0.28	0.27	0.28	2.60	3.60	3.10
T17	P2G2	9.40	10.00	9.70	89.00	87.20	88.10	0.36	0.36	0.36	2.90	3.73	3.32
T18	P2G3	9.60	10.00	9.80	88.03	88.30	88.17	0.33	0.36	0.34	2.60	3.40	3.00
T19	P2G4	9.70	9.20	9.45	88.87	88.40	88.63	0.24	0.28	0.26	3.47	3.60	3.53
T20	P2G5	10.10	9.28	9.69	89.57	89.10	89.33	0.26	0.24	0.25	3.20	3.53	3.37
T21	P2G6	9.20	8.75	8.98	89.13	89.63	89.38	0.27	0.23	0.25	3.50	3.47	3.48
S.Em±		0.207	0.214	0.209	0.577	0.400	0.381	0.026	0.016	0.013	0.140	0.173	0.122
C.D. (at 5%)		0.59	0.61	0.60	1.65	1.44	1.09	0.08	0.05	0.04	0.40	0.49	0.35

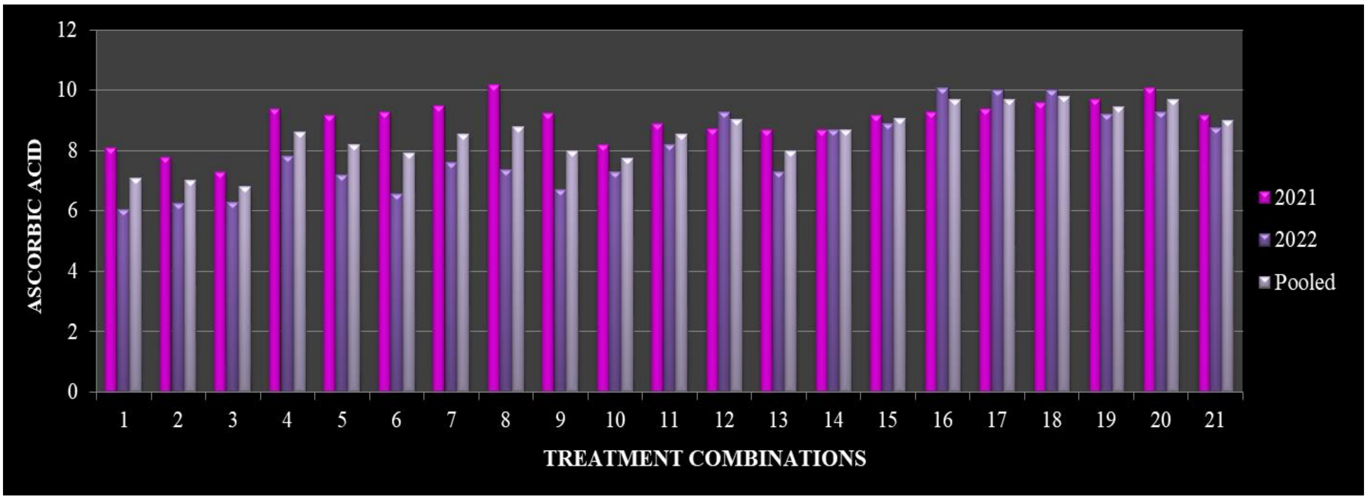

Fig 1: Interaction effect of pinching operation and bioregulators on Ascorbic acid content of bottle gourd

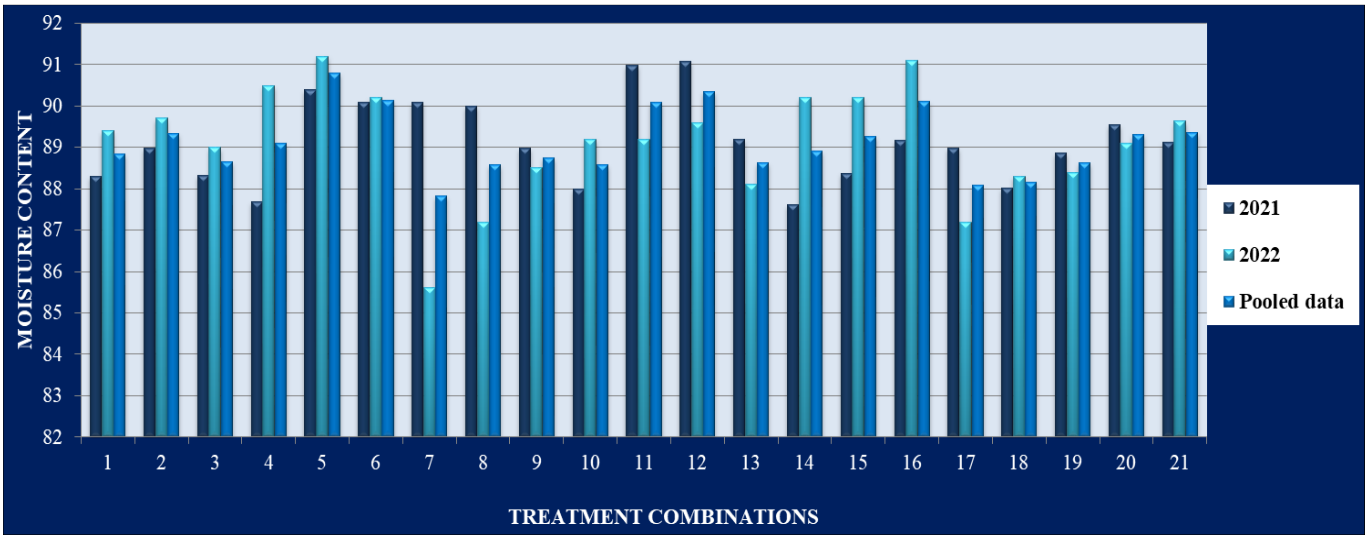

Fig 2: Interaction effect of pinching operation and bioregulators on Moisture content (%) of bottle gourd

Total Soluble Solids (TSS) (˚Brix)

Data clearly indicated that the pinching operation could not exhibit a significant variation on total soluble solid content in individual years as well as pooled average.

The result so depicted in Table 2 (a) and graphically presented in Figure (b) showed a significant effect on TSS of bottle gourd under the foliar application of bioregulators. The data revealed that during first year, higher TSS content of 3.59˚Brix was obtained under the foliar spray of NAA @ 200 ppm (G2) whereas, in the course of second year, TSS content of 3.83˚Brix was measured under the application of Salicylic acid @ 0.7 mM. The increase in TSS may be because of the synthesis of auxin which enhanced the synthesis of metabolites and promoted their rapid translocation from other parts of plants to the developing fruits. Thus, the fruits treated with NAA constituted as a strong sink for drawing metabolites from the leaves (Singh *et al*., 2017) [26]. The pooled data revealed a higher TSS content of 3.69˚Brix under the application of Salicylic acid (0.5 mM). These findings were in accord with Ouzounidou *et al.* (2008) [19] in muskmelon, Sinojiya *et al.* (2015) [27] in watermelon, Chaurasiya *et al.* (2016) [5] in muskmelon and Shafeek *et al.* (2016) [22] in summer squash, Chaudhary *et al.*, (2019) [4], Imnatemsu *et al.*, (2020) [10] and Pravallika *et al* 2020 [20].

The interaction effect between the pinching operation and bioregulators was significant. The result encompassed in Table 1 (b) and depicted graphically in Fig.4. The perusal of the data revealed that during the first year, interaction of no pinching along with spray of Biofertisol @ 5 ml (P0G5) recorded higher magnitude of 4.20˚Brix for TSS content. Treatment combination of no pinching with spray of Biofertisol @ 5 ml and pinching carried out on 3rd node with SA @0.7 mM recorded higher value of 4.20˚Brix during the second year. The pool of the data showed that Pinching at 3rd node with Salicylic acid (0.5 mM) (P2G3) gave maximum magnitude of 4.15˚Brix which was significantly superior over the rest. P0G0 recorded lowest values during second year and pooled data.

Table 2(a): Response of bottle gourd (*Lagenaria siceraria* (Mol.) Standl) to Bioregulators and pinching on Crude protein and Total Soluble Solids of Bottle gourd

Treatments	Crude Protein (%)			Total Soluble Solids (%)		
	2021	2022	Pooled	2021	2022	Pooled
Factor A						
NO PINCHING (P0)	0.30	0.30	0.30	3.74	3.40	3.57
Pinching at 3rd node (P1)	0.25	0.30	0.27	3.42	3.76	3.59
Pinching at 6th node (P2)	0.29	0.29	0.29	3.20	3.48	3.34
S.Em±	0.010	0.006	0.005	0.053	0.065	0.046
C.D. (at 5%)	NS	NS	NS	NS	NS	NS
Factor B						
Water spray (G0)	0.26	0.24	0.25	3.42	2.98	3.20
NAA 100 ppm (G1)	0.29	0.33	0.31	3.39	3.53	3.46
NAA 200 ppm (G2)	0.33	0.35	0.34	3.59	3.70	3.64
Salicylic Acid 0.5 (G3)	0.30	0.32	0.31	3.57	3.81	3.69
Salicylic Acid 0.7 (G4)	0.25	0.27	0.26	3.43	3.83	3.63
Biofertisol 5 ml (G5)	0.27	0.29	0.28	3.37	3.51	3.44
Biofertisol 7.5 ml (G6)	0.24	0.25	0.25	3.40	3.46	3.43
S.Em±	0015	0.009	0.008	0.081	0.100	0.070
C.D. (at 5%)	0.04	0.03	0.02	0.23	0.28	0.20

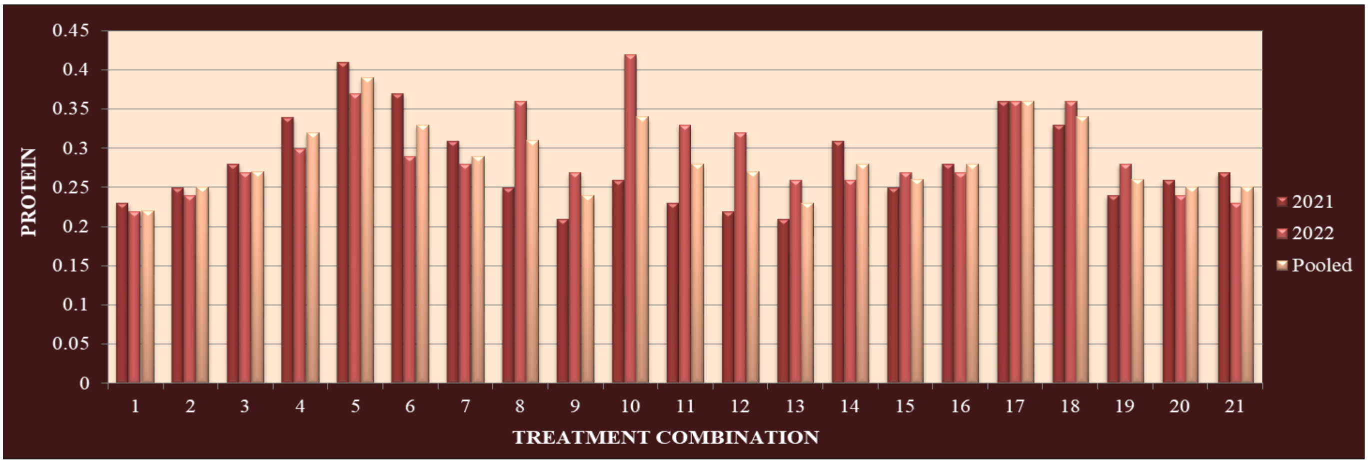

Fig 3: Interaction effect of pinching operation and bioregulators on Crude Protein content (%) of bottle gourd

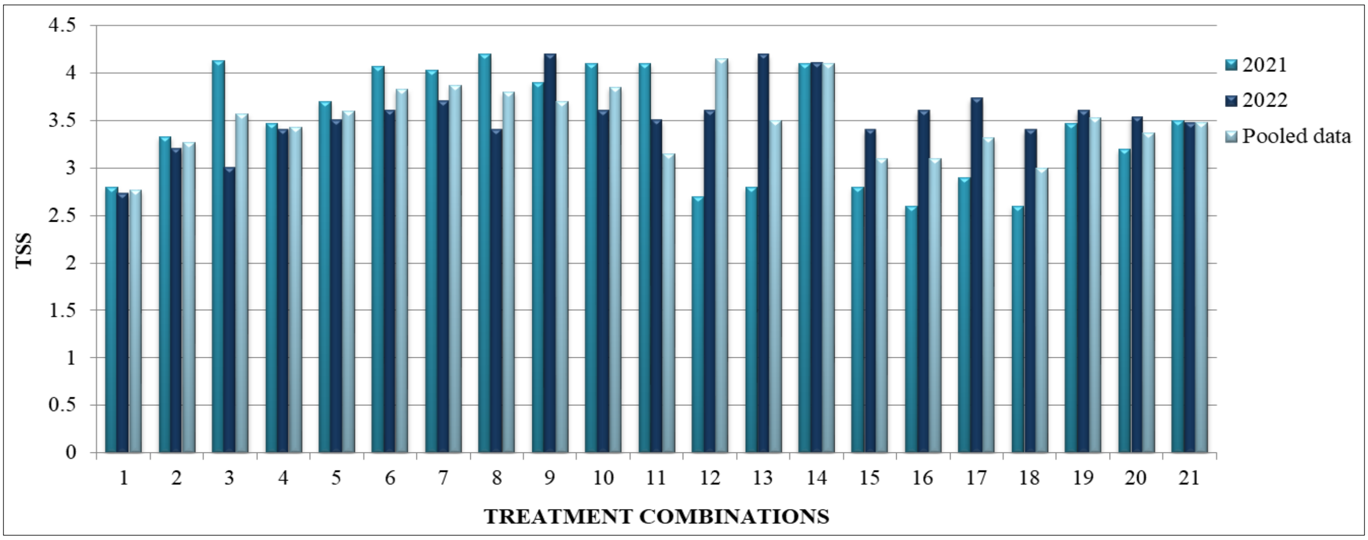

Fig 4: Interaction effect of pinching operation and bioregulators on Total Soluble Solid content (%) of bottle gourd

Crude Protein Content (%)

The crude protein content (%) depicted during the pinching operation was non-significant. The result encompassed in Table 2 (a) showed a significant effect on crude protein content (%) of bottle gourd under the foliar application of bioregulators. The set of observations revealed higher magnitude of 0.33, 0.35 and 0.34% protein content under the foliar application of NAA @ 200 ppm (G2). The lowest value of 0.24% was noted under water spray (G0) during the first year. In the course of second year, minimum value of 0.24% crude protein content was recorded. The corresponding values obtained during the pooled average of the data gave the lowest magnitude of 0.24% protein content in bottle gourd. These findings are in close consonance with those of Mahala *et al.*, (2016) [16].

The interaction effect between the pinching operation and bioregulators was found to be significant Table 1 (b) and depicted graphically in Fig.3. The perusal of the data revealed that no pinching with NAA @ 200 ppm recorded higher protein content of 0.41, 0.37 and 0.39% over the two years and pool of the data. P0G0 recorded lowest values during second year and pooled data.

Conclusion

Bottle gourd variety Pusa Naveen had shown significant variations in fruit quality traits. Among the bioregulators, foliar application of NAA @ 200 ppm recorded better moisture content, crude protein and TSS content. Among the interaction, no pinching along with foliar spray of NAA @ 200 ppm recorded better quality traits such as moisture content and crude protein.

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