

Study on physio chemical properties and incidence of shot berry of grape cv.Sahebi as influenced by fertilizer and micronutrients levels.

ABSTRACT

The response of fertilizer levels and micronutrients on growth, yield and quality of grape cv. 'Sahebi' was carried out in model grapevine orchard of department of Horticulture at Kralbagh, Tehsil Lar, district Ganderbal (J&K) for two consecutive years. The treatment consisted of 3 levels of fertilizer doses, F₁ (FYM 50 kg/vine + recommended dose of NPK: 555, 227, 470g/vine), F₂ (FYM 50 kg/vine+ 2 times recommended dose of NPK: 1110, 454, 940g/vine), F₃ (FYM 50 kg/vine+ 3 times recommended dose of NPK: 1665, 681, 1410g/vine), 3 micronutrients viz. M₁ (Solubor 0.1%), M₂ (ZnSO₄ 0.4%) and M₃ (Solubor 0.1% + ZnSO₄ 0.4%) applied two weeks before bloom and their combinations replicated thrice with a double plot size in a completely randomized block design. Fertilizer level F₂ recorded maximum percentage of fruitful shoots per vine (44.10 and 44.99 %), number of bunches per vine (50.90 and 55.01), fruit yield (20.08 and 23.10 kg/vine), berry TSS (16.78 and 17.95 °Brix), berry total sugars (13.33 and 13.84 %), berry anthocyanin contents (61.23 and 63.15 mg/100 g) and lowest berry titrable acidity (0.480 and 0.498 %) and shot berries (13.20 and 12.46 %) during both the years. Among micronutrients, M₁ resulted in highest percentage of fruitful shoots per vine (43.57 and 44.40 %), number of bunches per vine (49.39 and 53.60), fruit yield (19.78 and 22.81 kg/vine), bunch weight (402.81 and 427.54 g), bunch diameter (13.55 and 13.31 cm), berry weight (8.66 and 9.03 g), berry length (2.92 and 3.08 cm), berry diameter (1.72 and 1.76 cm), berry juice (67.36 and 68.89%), berry TSS (16.48 and 17.48 °Brix), berry total sugars (12.92 and 13.30 %), berry anthocyanin content (59.36 and 61.20 mg/100 g) and lowest berry titrable acidity (0.488 and 0.505 %) and shot berries (14.14 and 13.33 %) during both the years of study. Combination of fertilizer level F₂ and micronutrient M₁ resulted in highest percentage of fruitful shoots per vine (44.36 and 45.26 %), number of bunches per vine (51.31 and 55.84), fruit yield (20.42 and 23.80 kg/vine), berry TSS (16.97 and 18.12 °Brix), berry total sugars (13.55 and 14.03 %), berry anthocyanin content (62.32 and 64.56 mg/100 g) and lowest berry titrable acidity (0.470 and 0.490 %) and shot berries (12.97 and 12.10 %) during both the years under study. Other parameters recorded were highest under other fertilizer levels, micronutrients and their combinations. From the present study, it could be concluded that fertilizer dose F₂ (FYM-50

kg/vine + 2 times recommended dose-NPK: 1110, 454, 940 g/vine), micronutrient M₁ (Solubor 0.1%) and their combination is helpful for improving growth, yield, quality and lowering shot berry incidence of grape cv. Sahebi.

Key words : Fertilizer doses, micronutrients, grapes, growth, yield, quality

1. INTRODUCTION

Grape (*Vitis vinifera* L.) is one of the most important fruit crops of temperate zone, which has acclimatized to sub tropical and tropical agro climatic conditions prevailing in the Indian sub-continent. It is a refreshing fruit, rich in sugars, acids, minerals, vitamins and tannins. It can be eaten raw or can be used for making jam, juice, jelly, vinegar, wine, grape seed extracts, raisins, molasses and grape seed oil. In India, the major grape growing states are Maharashtra, Karnataka, Andhra Pradesh, Punjab and Tamil Nadu and the bulk of the production is used for table purpose followed by raisin. In Jammu and Kashmir, grapes are grown in an area of 321 hectares with a production of 648 MT [6] but the productivity of grape vines had been declining and has come down to a very low level. Further quality of grape is also poor when compared to other grape growing states of India. The possible reason is non-adoption of proper management practices particularly pruning and fertilizer application. The productivity and quality of grapes is dependent mainly on perfect pruning and proper fertilization. Proper pruning plays an important role in sustaining the productivity for longer period of time. The purpose of pruning is to regulate or encourage good yield and to improve size and quality of fruit. Grape is a heavy feeder of nutrients. Three of the major elements i.e. N, P, K are removed from the soil in large amounts. Micro-nutrients e.g. B and Zn are those essential nutrient elements which are required in very small quantity but they have specific structural physiological and metabolic roles in the plant system. Boron is an important micro-nutrient governing many physiological and biochemical plant processes. It plays a significant role in flowering, fruit set, nitrogen metabolism, hormone movement and its action, sugar transport, cell wall synthesis and lignifications. Besides regulating K/Ca ratio in plants, it is associated with Ca uptake and also increases permeability of the membrane. Foliar application of boron act as a signal capable of interacting with cellular transcription factors to regulate various physiological processes affected by boron deficiency. Zinc is an important nutrient element for growth, flowering and quality of fruits. It is involved in the biosynthesis of the plant hormone, indole acetic acid and it is a component of variety of enzymes such as carbonic anhydrase, alcohol dehydrogenase. Zinc also plays a role in nucleic acid and protein synthesis and helps in the utilization of phosphorus and nitrogen. If major

macro and micro-nutrients are not replenished regularly, they start depleting in the soil and reach a threshold where they become deficient and result in reduced plant growth, yield and fruit quality. For a successful commercial cultivation of fruits, it is essential to ensure vigorous vegetative growth and development during the entire productive life of the tree. Therefore, it is necessary to apply the nutrients through manures and fertilizers to meet the growth and reproductive needs of the grapevine. Further the optimum combination of the pruning severity and the fertilizer rate play an important role in regulating the tree performance. The main grape growing belt of Kashmir valley is district Ganderbal and Sahebi is the predominating variety of the area but grape vines in the area are not being maintained on the scientific lines with respect to pruning, application of nutrients and other cultural techniques thus resulting in low yields of poor quality berries. During the last 10-11 years, the cultivar Sahebi is suffering from a physiological disorder, shot berry. This disorder is characterized by a number of small seeded berries (chicken) among large fully developed seeded berries (hen) and is caused due to the boron deficiency and inadequate or excess use of fertilizers.. Hence the present investigations were carried out to standardize the fertilizer dose and micronutrients for optimum growth, yield and quality of grape cv. Sahebi.

2. MATERIALS AND METHODS

These investigations were carried out to assess the influence of bud load, fertilizer levels and their combinations on growth, yield and quality of grape cv. 'Sahebi' in model grapevine orchard of department of Horticulture at Kralbagh, Tehsil Lar district Ganderbal (J&K) for two consecutive years.

2.1 Treatments

The treatment consisted of 3 levels of fertilizer doses, F_1 =FYM (50 kg/vine) + Recommended dose (NPK: 555, 227, 470g/vine), F_2 =FYM (50 kg/vine)+ 2 times recommended dose (NPK: 1110, 454, 940g/vine), F_3 =FYM (50 kg/vine)+ 3 times recommended dose (NPK: 1665, 681, 1410g/vine) 3 levels of micronutrients viz. M_1 (Solubor 0.1%), M_2 (ZnSO₄ 0.4%) and M_3 (Solubor 0.1% + ZnSO₄ 0.4%) and their combinations replicated thrice with a double plot size in a completely randomized block design. Micronutrients were applied two weeks before bloom.

2.2 Vegetative characteristics

Data on percentage of fruitful shoots/vine was calculated by dividing the number of fruitful shoots with total number of shoots emerged and multiplying by 100. Percentage of vegetative

shoots per vine was calculated by dividing the number of vegetative shoots with total number of shoots emerged and multiplying by 100. Leaf area was calculated with the help of leaf area meter (Licor model 3100) and expressed in centimeter square (cm²). Number of leaves in the randomly selected four canes in different directions were counted and then mean number of leaves per shoot was worked out

2.3 Fruit yield and physical characteristics

Fruit yield per vine was calculated based on the number of bunches and the mean weight of bunches at harvest [14]. The weight of five bunches from each replication was observed on laboratory balance and the mean weight per bunch was recorded in grams. Five bunches were randomly selected replication wise and the mean bunch length was recorded in centimeters. Each bunch length was measured from the apex to the base. Five bunches from each replication were randomly selected and their mean diameter was recorded in centimeters. Each bunch diameter was recorded at the place of maximum spread. Fifty berries were separated from five randomly selected bunches per replication (10 berries per bunch) and weighed on laboratory balance. The mean weight per berry was calculated in grams. Ten berries were taken randomly from each bunch and the berry length was noted in centimeters with a vernier caliper and from this the average berry length was calculated. Ten berries were randomly taken from each bunch and the berry diameter was recorded in centimeters with a vernier caliper and from this the average berry diameter was noted. Fruit juice percentage was measured as per the method described by Mazumdar and Majumder [17].

Fruit chemical characterstics and incidence of shot berries

Freshly extracted juice of fifty randomly selected berries was strained through muslin cloth. It was thoroughly stirred and a drop of it was placed on the hand refractometer and the TSS reading was recorded in °Brix. The readings were corrected at 20°C with the help of temperature correction chart [1]. Titrable acidity was estimated by titrating a known quantity of homogenised juice against 0.1N NaOH solution using phenolphthalein as indicator [1] and was expressed in terms of tartaric acid. Total sugars were estimated by Lane and Eynon method [21]. Anthocyanin content was extracted with ethanolic hydrochloride and the intensity of the colour appeared was measured colorimetrically [12]. The count of normal and shot berries per bunch was taken separately. The berries of the size of black pepper or small were considered as shot berries. The sum of the normal berries and shot berries gave the total

number of berries per bunch. The percentage of shot berries was calculated as under, according to the procedure suggested by Nangia and Bakhshi [19] and Dhillon *et al.*, [9].

The data generated were subjected to statistical analysis as per the procedures described by Gomez and Gomez [11].

3. RESULTS AND DISCUSSION

3.1 Vegetative characteristics

Fertilizer doses, micronutrients and their interactions significantly influenced percentage of fruitful shoots per vine, vegetative shoots per vine and leaf area, however interaction effect of fertilizer levels and micronutrients on number of leaves per shoot was non-significant during both the years of study (Table 1). Significantly highest percentage of fruitful shoots per vine was recorded with F₂ (44.10 and 44.99 %) and M₁ (43.57 and 44.40 %) in comparison to other fertilizer levels and micronutrients. Among the fertilizer level and micronutrient combination, highest percentage of fruitful shoots per vine was recorded with F₂M₁ (44.36 and 45.26 %). This is because the medium dose of nitrogen, phosphorus and potassium produced more fertile buds. Optimum nitrogen is required for the proper fruitset in vines which results in maximum fruitful shoots/vine. Phosphorus helps to promote fruitfulness through synthesis of higher rates of ribonucleic acids in the buds. Potassium promotes fruitfulness through activation of enzymes involved in the conversion of carbohydrates to ribose sugar which is a component of RNA. This is in accordance with the findings of Maatouk *et al.* [15] and Girgis *et al.* (1998). Further boron helps in the metabolism of nitrogen biosynthesis, translocation of carbohydrates and fruiting process. These results are in conformity with the findings of Ali [4], Ahmad and Abd El-Hameed [3] and Mostafa *et al.* [18].

Significantly higher percentage of vegetative shoots per vine (57.49 and 56.76 %) was reported when vines were pruned to F₃ level during both the years. Micronutrient M₂ resulted in maximum percentage of vegetative shoots per vine (56.91 and 56.04 %) during both the years, respectively. Significantly maximum percentage of vegetative shoots per vine was recorded in F₃M₂ (57.81 and 57.03 %) during both the years, respectively. Maximum percentage of vegetative shoots/vine was registered in B₃ (160 buds/vine), F₃ (FYM-50 kg/vine + 3 times recommended dose NPK-1665, 681, 1410 g/vine) and M₂ (ZnSO₄-0.4%) because of less percentage of fruitful shoots/vine recorded in these treatments. This is in line with the findings of Tewfik [23], Salem *et al.* [22], Mostafa *et al.* [18] and Abd El-Razek *et*

al. [2].

Maximum leaf area (188.74 and 195.54 cm²) was recorded with fertilizer level F₃ and micronutrients M₃ (184.48 and 190.08 cm²). Combination of F₃M₃ registered maximum leaf area (191.08 and 198.10 cm²) in comparison to other fertilizer levels and micronutrients during both the years, respectively. Highest number of leaves per shoot was recorded with fertilizer level F₁ (54.42 and 61.65) and micronutrient M₁ (52.45 and 60.21). The combined influence of fertilizer level and micronutrient had shown non-significant influence on number of leaves per shoot. These results indicate that there was a direct effect on leaf expansion of each nutrient. The role of nitrogen as a constituent of amino acids and protein, as well as important role of phosphorus and potassium in encouraging cell division and development of meristematic tissues (Tisdale *et al.*, [24] provides an explanation for their effect on leaf area. These findings are in agreement with Keller *et al.*, [13] Delgado *et al.* [8] and Salem *et al.*, [22] Boron has a direct effect on plant tissue growth via cell wall development (toughness and firmness) and protein synthesis. Zinc also increases the source of energy used in producing chlorophyll and preparing the joined enzymes in the active operation especially in generating chlorophyll and increasing surface area of leaves. The results are in agreement with the reports of Mostafa *et al.*, [21] and Al Iman and Al Saidi [5].

Highest number of leaves/shoot was obtained in fertilizer dose F₁ (FYM-50 kg/vine + Recommended dose, NPK-555, 227, 470 g/vine) which was statistically at par with F₂ (FYM-50 Kg/vine + 2 times recommended dose, NPK-1110, 454, 940 g/vine). This is because of the fact that shoots under the low and medium fertilizer dose grow less rapidly with shorter internodes which in turn affected the number of leaves per shoot. Similar results were found by Keller *et al.* [13] and Salem *et al.* [22]. Maximum number of leaves/shoot was obtained in micronutrient M₁ (Solubor-0.1%). This is due to the favourable effect of boron on metabolism of nitrogen which in turn increased the number of leaves/shoot. This is in agreement with the findings of Zhang [25] and Ahmad and Abd El-Hameed [3].

3.2 Fruit Yield and physical characteristics

Effect of fertilizer level, micronutrients and their interaction on fruit yield, bunch weight, length and diameter and berry weight, length and diameter is given in Table 2. Highest fruit yield per vine (20.08 and 23.10 kg/vine) was recorded with fertilizer level F₂ and micronutrient M₁ (19.78 and 22.81 kg/vine). Combination of F₂M₁ registered maximum fruit yield (20.42 and 23.80 kg/vine) in comparison to other fertilizer level and micronutrient

doses during both the years, respectively. This may be due to increase in both number of clusters per vine and cluster weight and better flower set, improved pollen viability, germination and fertilization, reduced fruit drop and increase in the berry size. These results are in agreement with the findings of Dhillon *et al.*[9], Salem *et al.* [22]and Prabu and Singaram [20].

Among fertilizer levels, highest bunch weight (412.61 and 436.98 g), bunch length (23.06 and 23.47 cm) and bunch diameter (13.87 and 13.68 cm) was recorded with fertilizer level F₃. Among micronutrients, highest bunch weight (402.81 and 427.54 g) and diameter (13.55 and 13.31cm) was recorded with M₁ however bunch length was highest (22.65 and 23.85 cm) with M₂. Combination of F₃M₁ resulted in highest bunch weight (419.22 and 442.44 g) and bunch diameter (14.05 and 13.90 cm) however bunch length was highest (23.29 and 24.67 cm) with F₃M₂ during both the years under study. This is probably because of the role of N, P and K in photosynthetic activity of the vine that results in more accumulation of assimilates for higher bunch weight. Similar findings were reported by Abd El-Razek *et al.* [2]. The highest bunch weight observed with micronutrient M₁ (Solubor-0.1%) was because of more fruitset due to boron. These results are in agreement with the findings of Mostafa *et al.* [18].

Highest berry weight (8.98 and 9.41 g), berry length (2.99 and 3.15 cm) and berry diameter (1.76 and 1.81 cm) was recorded with fertilizer level F₃. Among micronutrients, highest berry weight (8.66 and 9.03 g), berry length (2.92 and 3.08 cm) and berry diameter (1.72 and 1.76 cm) was recorded with M₁. Combination of F₃M₁ resulted in highest berry weight (9.12 and 9.54 g), berry length (3.02 and 3.18 cm) and berry diameter (1.79 and 1.86 cm) during both the years of study. This is due to the role of nitrogen, phosphorus, and potassium in increasing the cell division and cell elongation that might have contributed in increasing the berry weight,length and diameter. Also the highest berry weight,length and diameter may be due to enhanced supply of food material by way of increased leaf area due to boron. These results are in agreement with the findings of Delgado *et al.* [8], Mostafa *et al.*[18] and Abd El-Razek *et al.* [2].

3.3 Fruit chemical characteristics and incidence of shot berries

Data on response of fertilizer levels, micronutrients and their interaction on berry TSS, titrable acidity, total sugars, anthocyanin content and shot berry and is presented in Table 3.

Maximum TSS (16.78 and 17.95 °Brix), total sugars (13.33 and 13.84 %) and lowest titrable acidity (0.480 and 0.498%) was recorded with fertilizer level F₂. Among micronutrients,

highest TSS (16.48 and 17.48 °Brix), total sugars (12.92 and 13.30 %) and lowest titrable acidity (0.488 and 0.505%) was recorded with M₁. Combination of F₂M₁ interaction resulted in highest TSS (16.97 and 18.12 °Brix), total sugars (13.55 and 14.03 %) and lowest titrable acidity (0.470 and 0.490%) in comparison to other treatments during both the years of study. This might be due to the fact that nitrogen increases the availability of the assimilates and higher dose causes excess vegetative growth which requires most of the metabolites while little was left for storage in the berries. Increasing the applied phosphorus improves sugar accumulation in the berries which in turn induces high TSS. Potassium fertilization also helps in sugar transport into the berries. This increased TSS is also due to enhanced hydrolysis of polysaccharides into monosaccharides. These findings are in parallel with those of Martin *et al.* [16] and Abd-EL Razek *et al.* [2]. The highest improvement in TSS due to the application of micronutrient M₁ (Solubor-0.1%) is because of the impact of boron on the enzyme system of vines resulting in better nucleic acid synthesis, better nutrient uptake due to adequate root growth, increase in the sugar content and better translocation of sugars and nutrients from leaves to fruit. These results are in agreement with the findings of Prabu and Singaram [20]. The lowest acidity recorded in these treatments is because the increased sugar content might have decreased the acidity. This may also be due to conversion of acids into sugars. Similar results were investigated by Dhillon *et al.* [9] and Salem *et al.* [22],

Fertilizer level F₂ resulted in significantly higher anthocyanin content in berries (61.23 and 63.15 mg/100 g) and lowest percentage of shot berries (13.20 and 12.46 %) during both the years. Among micronutrients, M₁ resulted in more anthocyanin accumulation (59.36 and 61.20 mg/100 g) and lowest proportion of shot berries (14.14 and 13.33 %) in comparison to other micronutrients. Combination of F₂M₁ resulted in highest anthocyanin accumulation (62.32 and 64.56 mg/100 g) and lowest shot berry percentage (12.97 and 12.10 %) in comparison to other fertilizer levels and micronutrient interactions during both the years. The increase in anthocyanin content with these treatments may be due to the presence of more sugars in these treatments which act as a trigger for anthocyanin synthesis. Moderate application of nitrogen stimulates the activity of phenylalanine ammonia lyase enzyme which is involved in anthocyanin synthesis. Potassium fertilization increases carbohydrate accumulation which in turn improves colour. Also boron plays an important role in metabolism of phenolic compounds resulting into the promotion of red colour in the fruits. These results are in agreement with the findings of Martin *et al.*, [16] Abd-EL Razek *et al.*, [2] Bhat *et al.* [7] and Ganai [10]. Vine nutrition has an impact on bud fruitfulness developed

during the previous season as well as floral differentiation in the current season prior to bloom. Nitrogen status of vines has been implicated as a potential cause of poor fruitset and incidence of shot berry. Too high or too low nitrogen can lead to poor fruitset. Poor nutrient uptake can also lead to poor fruitset and high percentage of shot berry. This indicates that fertilizer dose F₂ maintains proper C/N ratio in vines thereby minimizing the incidence of shot berry. The decrease of shot berries due to boron may be due to better pollination, germination and fertilization of ovules.

4.CONCLUSION

From the present study, it could be summarized that fertilizer dose F₂ (FYM-50 kg/vine + 2 times recommended dose-NPK: 1110, 454, 940 g/vine) micronutrient M₁ (Solubor 0.1%) and their combination proved to be the best for improving growth, yield quality as well as reducing the incidence of shot berry in grape cv. Sahebi

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351 **Table 1 Effect of fertilizer level, micronutrients and their combinations on vegetative**
352 **characteristics of grape**

Treatments	Fruitful shoots per vine (%)		Vegetative shoots per vine (%)		Leaf area (cm ²)		Number of leaves per shoot	
	1 st year	2 nd year	1 st year	2 nd year	1 st year	2 nd year	1 st year	2 nd year
F ₁	43.36	44.25	56.64	55.75	174.73	179.31	54.42	61.65

F ₂	44.10	44.99	55.90	55.01	182.33	187.35	51.23	59.11
F ₃	42.51	43.24	57.49	56.76	188.74	195.54	48.06	56.45
CD _(0.05)	0.13	0.12	0.17	0.19	2.76	2.84	2.20	2.55
M ₁	43.57	44.40	56.43	55.60	181.97	187.50	52.45	60.21
M ₂	43.09	43.96	56.91	56.04	179.35	184.61	50.96	59.02
M ₃	43.31	44.14	56.69	55.86	184.48	190.08	50.30	57.98
CD _(0.05)	0.13	0.11	0.10	0.12	1.43	1.57	0.20	0.23
F ₁ M ₁	43.50	44.43	56.50	55.57	175.32	179.79	55.77	63.19
F ₁ M ₂	43.27	44.16	56.73	55.84	171.11	175.79	54.03	61.48
F ₁ M ₃	43.30	44.17	56.70	55.83	177.76	182.35	53.46	60.28
F ₂ M ₁	44.36	45.26	55.64	54.74	182.13	187.26	52.43	60.00
F ₂ M ₂	43.82	44.75	56.18	55.25	180.26	184.98	50.96	59.04
F ₂ M ₃	44.11	44.98	55.89	55.02	184.59	189.80	50.31	58.29
F ₃ M ₁	42.84	43.50	57.16	56.50	188.47	195.46	49.14	57.43
F ₃ M ₂	42.19	42.47	57.81	57.03	186.68	193.06	47.90	56.54
F ₃ M ₃	42.51	43.27	57.49	56.73	191.08	198.10	47.13	55.37
CD _(0.05)	0.16	0.15	0.19	0.22	2.79	2.87	NS	NS

353

354 **Table 2 Effect of fertilizer level, micronutrients and their combinations on fruit yield**
355 **and physical characteristics of grape**

Treatments	Fruit yield (Kg/vine)		Bunch weight (g)		Bunch length (cm)		Bunch diameter (cm)		Berry weight (g)		Berry length (cm)		Berry diameter (cm)	
	1 st year	2 nd year	1 st year	2 nd year	1 st year	2 nd year	1 st year	2 nd year	1 st year	2 nd year	1 st year	2 nd year	1 st year	2 nd year
F ₁	18.64	21.50	385.01	407.92	21.70	22.75	12.91	12.57	8.01	8.36	2.76	2.96	1.61	1.66
F ₂	20.08	23.10	396.41	421.14	22.41	23.61	13.41	13.13	8.51	8.86	2.89	3.04	1.70	1.73
F ₃	19.02	22.00	412.61	436.98	23.06	24.37	13.87	13.68	8.98	9.41	2.99	3.15	1.76	1.81
CD _(0.05)	0.73	0.81	4.31	4.58	0.67	0.78	0.48	0.55	0.48	0.55	0.12	0.13	0.07	0.09
M ₁	19.78	22.81	402.81	427.54	22.37	23.59	13.55	13.31	8.66	9.03	2.92	3.08	1.72	1.76
M ₂	18.73	21.60	393.64	417.20	22.65	23.85	13.40	13.12	8.51	8.86	2.88	3.05	1.68	1.73

M ₃	19.2 3	22.1 4	397. 59	421. 30	22.1 4	23.3 0	13.2 4	12.9 5	8.3 3	8.7 3	2.8 4	3.0 2	1.6 6	1.7 0
CD _(0.05)	0.15	0.17	3.22	4.12	0.14	0.13	0.06	0.08	0.0 1	0.0 2	0.0 1	0.0 1	0.0 1	0.0 2
F ₁ M ₁	19.2 9	21.9 6	389. 01	411. 97	21.6 6	22.7 5	13.0 6	12.7 3	8.2 1	8.4 7	2.8 1	2.9 9	1.6 4	1.6 8
F ₁ M ₂	18.0 5	21.1 2	381. 15	404. 34	22.0 5	23.0 1	12.9 3	12.5 7	7.9 7	8.3 6	2.7 6	2.9 6	1.6 1	1.6 6
F ₁ M ₃	18.5 7	21.4 8	384. 87	407. 46	21.3 9	22.5 0	12.7 4	12.7 3	7.8 6	8.2 4	2.7 2	2.9 3	1.5 8	1.6 3
F ₂ M ₁	20.4 2	23.8 0	400. 19	428. 22	22.3 9	23.6 3	13.5 4	13.3 0	8.6 4	9.0 8	2.9 3	3.0 7	1.7 2	1.7 5
F ₂ M ₂	19.7 0	22.4 7	392. 66	414. 95	22.6 2	23.8 6	13.4 2	13.1 4	8.5 5	8.8 4	2.8 9	3.0 5	1.6 9	1.7 3
F ₂ M ₃	20.1 1	22.9 3	396. 39	420. 27	22.2 1	23.3 4	13.2 6	12.9 4	8.3 3	8.6 7	2.8 5	3.0 1	1.6 7	1.7 0
F ₃ M ₁	19.6 2	22.6 6	419. 22	442. 44	23.0 6	24.3 9	14.0 5	13.9 0	9.1 2	9.5 4	3.0 2	3.1 8	1.7 9	1.8 6
F ₃ M ₂	18.4 4	21.2 1	407. 10	432. 32	23.2 9	24.6 7	13.8 6	13.6 5	9.0 1	9.3 9	2.9 9	3.1 5	1.7 5	1.8 1
F ₃ M ₃	19.0 1	22.0 0	411. 52	436. 17	22.8 2	24.0 5	13.7 1	13.4 9	8.8 1	9.2 9	2.9 6	3.1 2	1.7 2	1.7 7
CD _(0.05)	0.79	0.85	4.35	4.89	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

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360 **Table 3 Effect of fertilizer level, micronutrients and their combinations on fruit**
361 **chemical characteristics and incidence of shot berry.**

Treatments	TSS (°Brix)		Titrable acidity (%)		Total sugars (%)		Anthocyanin (mg/100 g)		Shot berry (%)	
	1 st year	2 nd year	1 st year	2 nd year	1 st year	2 nd year	1 st year	2 nd year	1 st year	2 nd year
F ₁	16.32	17.30	0.495	0.511	12.71	13.08	58.60	59.76	14.36	13.67
F ₂	16.78	17.95	0.480	0.498	13.33	13.84	61.23	63.15	13.20	12.46
F ₃	15.83	16.67	0.514	0.526	12.10	12.37	55.20	57.41	16.22	15.14
CD _(0.05)	0.13	0.13	0.01	0.01	0.58	0.73	1.18	1.20	1.14	1.20
M ₁	16.48	17.48	0.488	0.505	12.92	13.30	59.36	61.20	14.14	13.33
M ₂	16.13	17.12	0.503	0.524	12.51	12.87	57.36	59.24	15.05	14.18
M ₃	16.32	17.31	0.497	0.506	12.71	13.13	58.30	59.87	14.58	13.76

CD _(0.05)	0.10	0.12	NS	NS	0.31	0.28	1.04	1.26	0.19	0.13
F ₁ M ₁	16.48	17.50	0.490	0.506	12.94	13.29	59.62	60.91	13.73	13.29
F ₁ M ₂	16.16	17.10	0.496	0.520	12.51	12.88	57.58	58.95	14.87	14.05
F ₁ M ₃	16.32	17.29	0.500	0.506	12.68	13.08	58.61	59.40	14.49	13.67
F ₂ M ₁	16.97	18.12	0.470	0.490	13.55	14.03	62.32	64.56	12.97	12.10
F ₂ M ₂	16.62	17.76	0.493	0.513	13.10	13.59	60.05	61.78	13.48	12.85
F ₂ M ₃	16.77	17.95	0.476	0.493	13.33	13.91	61.32	63.13	13.14	12.43
F ₃ M ₁	15.98	16.83	0.506	0.523	12.28	12.57	56.16	58.14	15.73	14.61
F ₃ M ₂	15.62	16.50	0.520	0.540	11.92	12.15	54.46	57.00	16.81	15.64
F ₃ M ₃	15.87	16.69	0.516	0.516	12.10	12.40	54.98	57.08	16.11	15.19
CD _(0.05)	0.16	0.15	NS	NS	NS	NS	1.21	1.29	NS	NS