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Effect of integrated bioformulations and canopy management practices on reproductive and quality of Pomegranate

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ABSTRACT

A field experiment entitled Effect of integrated bioformulations and canopy management practices on growth, yield and quality of pomegranate (*Punica granatum* L.) cv. Bhagwa was conducted at the Instructional Farm (Horticulture), Career Point University, Kota during 2024-2025. Among the different training systems studied, three stem training system (S_2) recorded maximum number of flowers per plant, minimum days to flowers initiation, earliest maturity, number of fruits per plant, fruit length, fruit diameter, fruit volume, rind weight, rind thickness, rag weight, number of arils/ fruit, number of arils/ 100, 100 arils weight, total aril weight (g) and 100 seeds weight. Regarding the bioformulation treatments, B_8 [Amrithpani (4%) + Panchagavya (5%) + Jeevamruth (6%) + *P. fluorescens* (25 g/ plant)] exhibited maximum number of flowers per plant, minimum days to flowers initiation, earliest maturity, number of fruits per plant, fruit length, fruit diameter, fruit volume, rind weight, rind thickness, rag weight, number of arils/ fruit, number of arils/ 100, 100 arils weight, total aril weight (g) and 100 seeds weight.

KEYWORDS

Integrated Bioformulations, Canopy Management, Pomegranate, Yield, Growth, Quality

HOW TO CITE THIS ARTICLE

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Pomegranate (*Punica granatum* L.) belongs to family Punicaceae, regarded as “fruit of paradise”, an ancient favorite fruit of tropical and sub-tropical regions of the world. The fruit is symbolic of plenty and also referred as seed apple. It is an ancient fruit originated in Persia, Afghanistan and Baluchistan (Candolle, 1967) and is also thought to be indigenous to the region of Iran, but later spread to Mediterranean countries. Further, it is extensively cultivated in Spain, Morocco, India, Afghanistan, Pakistan, Egypt, Russia, Europe and Iran. In India it is commercially grown in semi-arid and arid tracts of Maharashtra, Karnataka, Gujarat, Rajasthan, Uttar Pradesh, Andhra Pradesh, Tamil Nadu and Maharashtra state is the leading producer of pomegranate in India. It can be grown from plains to an elevation of up to 2000 meter. Under temperate environment, it behaves as a deciduous plant while in subtropical and tropical climate it behaves as evergreen or partially deciduous plant. The pomegranate plant tends to produce profuse suckers, if left untrained will leads to wild bush like undesirable canopy formation. Hence, like several other fruit plants, pomegranate also requires a proper training system to develop a strong framework which gives an annual production of high sustainable yields of good quality fruits.

The process must be started soon after planting otherwise too many suckers will develop which would be difficult to manage (Gill *et al.,* 2011). Since, biofertilizers are able to fix atmospheric nitrogen in the range of 20-200 kg/ha/year, solubilize phosphorus in the range of 30-50 kg P_2O_5/ha/year; mobilize P, Zn, Fe, Mo to varying extent, they also helps the host plants to resist against diseases and withstand stress conditions by adopting different mechanism depending upon the type of biofertilizers agent involved. Nitrogen fixing organism (*Azospirillum),* phosphate solubilizing bacteria (PSB) and potassium solubilizing bacteria (KSB) are the main biofertilizers being used for horticultural crops and these microorganisms are either free living in soil or symbiotic with plants and contribute directly or indirectly towards nitrogen, phosphorus and potassium nutrition of the plants respectively. Maximization of fruit production with improvement in the fruit quality has been and will continue to be the primary aim of the fruit growers and to achieve this goal farmer needs to adopt the latest developed orchard practices. Use of different training system and bio formulations in horticultural crops for increasing production and improvement in the quality of the fruit is recognized as one of the essential production practices.

Materials and Methods

Location

Kota district is located at 25.18° N to 75.83° E Latitude in South Eastern Rajasthan. It covers an area of 221.36 km^2. Agro-climatically, the district falls in Zone V, known as Humid South Eastern Plain. The average rainfall in the region is 660.6. mm. Maximum temperature range in the summer is 40 to 48°C and minimum 1.0- 2.6°C during winter.

Experimental Details

Orchard Details

Experiment was carried out in an established pomegranate orchard of 3 years old plants with spacing of 5 m × 2.5 m

Training Systems

Number of stem retention as two, three and four stems as per the treatments was carried out (August-September) for three replications.

Preparation of Bioformulations

Preparation of Amritpani

Ten kilograms of cow dung and 250 g of cow ghee were mixed properly. To this mixture, 500 g of honey was added and mixed thoroughly. This mixture was kept for incubation for 24 hours before use (Pathak and Ram, 2004).

Preparation of Panchagavya

Seven kilograms of cow dung and one kilogram of cow ghee were mixed thoroughly and incubated for two days. On the third day, three liters of cow urine and10 liters of water were added to the above mixture and kept for incubation. After 15 days of incubation, three liters of sugar cane juice, two liters of cow milk, two liters of cow curd, three liters of tender coconut water and 12 ripe bananas were added and mixed thoroughly. This mixture was again kept for 15 days for incubation and then used (Pathak and Ram, 2004).

Preparation of Jeevamruth

Ten Kilograms of cow dung, ten liters of cow urine, two kilograms local jaggery, two kilograms pulse flour and hand full garden soil were mixed properly. This mixture was again kept for 7 days for incubation and then used (Pathak and Ram, 2004).

Pseudomonas fluorescens Application

P. fluorescens was mixed with FYM and applied at 25 g/ plant as per the treatments in single and combinations (Gaikwad *et al*., 2010).

Design and Layout of the Experiment

The design adopted for the experiment was Factorial RBD with training systems as one factor and bioformulations and their combinations as second factor in each replication allotted randomly.

Treatment Details

Factor I – Training (stem retention)
S_1 -Two stem
S_2- Three stem
S_3- Four stem
Factor II–Bio-formulations

B_1- Amrithpani (4%)
B_2- Panchagavya (5%)
B_3- Jeevamruth (6%)
B_4- *Pseudomonas fluorescens* (25 g/plant)
B_5 -Amrithpani (4%) + Panchagavya (5%)
B_6- Amrithpani (4%) + Jeevamruth (6%)
B_7- Panchagavya (5%) + Jeevamruth (6%)
B_8- Amrithpani (4%) + Panchagavya (5%) + Jeevamruth (6%) + *Pseudomonas fluorescens* (25 g/ plant)
B_9- RDF + FYM (Control)

Determination of the Parameters

The total numbers of flowers were counted on the five randomly selected shoots and average number of flowers / shoot was calculated. It was recorded by counting the number of fruits per tree at the time of harvesting. Number of days taken to first harvesting was counted from the fruit set to first picking in each treatment. Diameter of the randomly selected five fruits in each treatment was recorded with the help of digital vernier caliper in centimeter and averaged. Randomly selected five fruits in each treatment during harvesting were weighed with the help of single pan balance and mean weight of fruit was calculated.

The volume of five randomly selected fruits in each treatment was measured by water displacement method. For this purpose, the fruits were dipped in a full filled jar of water and the water displaced by the fruits was collected and measured by graduated glass jar and the recorded reading was averaged. After removing the arils with the help of hand and knife from fruits, the arils were counted. After removing the arils from fruits, arils were weighed by electronic weighing balance (Sartorius). After removing the arils from fruits, the 100 arils were weighed by electronic weighing balance (Sartorius). After removing the arils from fruits, rind was weighed by electronic weighing balance (Sartorius). Rind thickness of the randomly selected five fruits in each treatment was recorded with the help of digital vernier caliper in millimeter and averaged.

Results and Discussion

The data regarding number of flowers per plant as influenced by different training and bioformulations are depicted in table 1.

Analyzed data showed significant difference among different training systems with respect to number of flowers per plant. Maximum number of flowers (129.19, 103.81 and 94.44) per plant was recorded in four stem (S_2) training at 30, 45 and 60 DAT respectively, which was on par with S_3. Significant difference with respect to number of flowers per plant was also observed at different levels of bioformulations application. The maximum number of flowers per plant was recorded in B_8 (129.17, 105.17 and 94.50) at 30, 45 and 60 DAT respectively, which was on par with B_5 whereas, lowest number of flowers per plant were noticed in B_9 (105.89, 83.56 and 75.39) consisting of only RDF + FYM (Control). The interaction effect had shown non-significant difference with respect to number of flowers per plant. However, highest number of flowers per plant was recorded in S_2B_8 and the least in S_1B_9 treatments combination at 60 DAT.

The data regarding initiation of flowering, days to maturity after fruit and number of fruits per plant as influenced by training and bioformulations are depicted in table 2. The analyzed data on initiation of flowering showed significant difference among different training systems. Significantly minimum days (18.34) taken for initiation of flowering was recorded in four stem (S_2) training, which was followed by (19.58) S_3 and the maximum days (21.11) was recorded in S_1 training system. Significant difference with respect to initiation of flowering was observed at different levels of bioformulations application. Significantly minimum days was observed in B_8 (16.68), followed by B_5 (18.13), B7 (18.68) and B_6 (19.21) whereas, the maximum days was noticed in B_9 (22.11) consisting of only RDF + FYM (Control).

The interaction effect had shown non-significant difference with respect to initiation of flowering. However, the minimum days was recorded in S_2B_8 and the maximum in S_1B_9 treatments combination. The analyzed data on days to maturity after fruit set showed significant difference among training systems. Significantly lowest days (137.00) for maturity was recorded in four stem (S_2) followed by (S_3) and maximum days (141.19) recorded in (S_1) training system. Significant results were also obtained by bioformulations.

The minimum days taken for maturity after fruit set was recorded in B_8 (135.05), followed by B_5 (136.44) whereas, the maximum days was noticed in B_9 (143.14) consisting of only RDF + FYM (Control). The interaction effect had shown non-significant difference with respect to days to maturity after fruit set. However, minimum days was recorded in S_2B_8 and maximum days in S_1B_9 in which three stem training with RDF + FYM (Control) was followed. Analyzed data on total number of fruits per plant showed significant difference among different training systems. Maximum number of fruits (44.41) per plant was recorded in (S_2) training, which was on par with (42.06) in S_3 and the least (32.02) was recorded in three stem (S_1) training system.

Significant difference with respect to number of fruits per plant was also observed at different levels of bioformulations application. Significantly maximum number of fruits per plant was recorded in B_8 (49.91), followed by B_5 (42.91) whereas, the lowest number of fruits per plant was noticed in B_9 (28.80) consisting of only RDF + FYM (Control). The interaction effect had shown non-significant difference with respect to number of fruits per plant. However, maximum number of fruits per plant in S_2B_8 where four stem training with Amrithpani (3%) + Panchagavya (3%) + Jeevamruth (3%) + *P. fluorescens* (50 g/plant) was applied and the minimum were recorded in S_1B_9 treatments combination.

The data pertaining to fruit length, fruit diameter and fruit volume as influenced by training and bioformulations are depicted in table 3. The results regarding the fruit length was significantly different among the different training system. Significantly highest fruit length (7.38 cm) was recorded in three stem (S_2) training, followed by S_3 (7.12 cm) and the lowest fruit length (6.56cm) was recorded in two stem (S_1) training system. Highest fruit length was recorded in B_8 (7.57 cm) consisting of Amrithpani (4%) + Panchagavya (5%) + Jeevamruth (6%) + *P. fluorescens* (25g/ plant), which was on par with B_5 (7.32 cm) whereas, the lowest fruit length was noticed in B_9 (6.44 cm) consisting of RDF + FYM (Control) only. The interaction effect had shown non-significant results for fruit length among all the treatments combination.

However, highest fruit length was noticed in S_2B_8 and lowest in treatments combination. The results regarding the fruit diameter was significantly different among the different training system. Significantly highest fruit diameter (8.41 cm) was recorded in three stem (S_2) training, which was followed by S_3 (7.47 cm) and the lowest fruit diameter (7.06 cm) was recorded in two stem (S_1) training system. Highest fruit diameter was recorded in B_8 (8.16 cm) which was on par with B_5 (7.87 cm) whereas, the lowest fruit diameter was noticed in B_9 (6.95 cm) consisting of only RDF + FYM (Control). The interaction effect had shown non-significant results for fruit diameter. The highest fruit diameter was noticed in S_2B_8 and lowest in S_1B_9 treatments combination. The data on fruit volume showed significant difference among different training systems. Significantly highest fruit volume (224.83 ml) was recorded in three stem (S_2) training, which was followed by S_3 (213.86 ml) and the lowest fruit volume (208.46 ml) was recorded in three stem (S_1) training system. Significant results were also obtained by bioformulations. The highest fruit volume was recorded in B_8 (226.99 ml), which was on par with B_5 (224.15 ml) and the lowest fruit volume was recorded in B_9 (195.82 ml). The interaction effect had shown non-significant results for fruit volume. The highest fruit volume was noticed in S_2B_8 and lowest in S_1B_9 treatments combination.

The data pertaining to rind weight, rind thickness and rag weight as influenced by training and bioformulations are depicted in table 4. The analyzed data on rind weight showed significant difference among different training systems. Significantly highest rind weight (56.51g) was recorded in three stem (S_2) training, followed by S_3 (53.55 g). The lowest rind weight (49.42 g) was recorded in two stem (S_1) training system. Rind weight was found significantly different among the different bioformulations level. Significantly highest rind weight was recorded in B_8 (65.28 g), followed by B_5 (59.71 g), B_7 (56.19 g) and the lowest rind weight was recorded in B_9 (43.24 g). The interaction effect had shown non-significant results for rind weight. The highest rind weight was noticed in S_2B_8 and lowest in S_1B_9 treatments combination. The highest rind thickness (1.24 mm) was recorded in three stem (S_2) training, which was on par with S_3 (1.22 mm).

Table 1. Influence of training and bioformulations on number of flowers per plant of pomegranate cv. Bhagwa at different stages of growth

Treatments	Number of Flowers/ Plant											
	30 DAT				45 DAT				60 DAT			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
B_1	105.50	127.33	117.33	116.72	81.67	102.00	92.17	91.94	71.50	92.67	82.67	82.28
B_2	107.17	127.67	117.00	117.28	82.33	103.17	93.33	92.94	72.20	93.67	83.00	82.96
B_3	106.83	128.17	116.50	117.17	80.67	101.83	92.50	91.67	70.79	91.50	81.33	81.21
B_4	106.50	126.17	116.83	116.50	81.50	102.00	91.67	91.72	72.55	93.67	82.50	82.91
B_5	110.50	134.33	124.33	123.06	85.33	108.00	97.33	96.89	75.50	98.00	88.17	87.22
B_6	108.33	132.33	120.33	120.33	83.50	105.17	95.50	94.72	73.50	94.33	85.33	84.39
B_7	109.50	133.17	122.50	121.72	84.11	106.17	96.17	95.48	74.13	95.83	86.83	85.60
B_8	112.83	141.17	133.50	129.17	93.33	115.00	107.17	105.17	81.33	105.33	96.83	94.50
B_9	97.00	112.33	108.33	105.89	74.83	91.00	84.83	83.56	66.67	85.00	74.50	75.39
Mean	107.13	129.19	119.63	118.65	83.03	103.81	94.52	93.78	73.13	94.44	84.57	84.05
	S.Em±		C.D. @5%		S.Em±		C.D.@ 5%		S.Em±		C.D. @ 5%	
Training (S)	2.06		5.84		1.68		4.78		1.60		4.54	
Bioformulations (B)	3.57		10.12		2.92		8.28		2.77		7.86	
Interactions (S×B)	6.18		NS		5.05		NS		4.80		NS	

Table 2. Influence of training and bioformulations on flower initiation, days to maturity after fruit set and number of fruits per plant of pomegranate cv. Bhagwa

Treatments	Flower Initiation (Days)				Days to Maturity after Fruit Set				Number of Fruits per Plant			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
B_1	22.56	19.07	20.29	20.64	141.19	138.15	138.36	139.23	29.19	43.02	40.85	37.69
B_2	21.77	18.70	19.97	20.15	140.56	137.38	138.47	138.80	30.85	44.52	41.69	39.02
B_3	22.58	19.76	21.02	21.12	142.49	138.51	137.22	139.41	28.69	42.19	40.52	37.13
B_4	22.03	18.91	20.09	20.34	140.95	137.00	136.14	138.03	30.02	43.35	41.52	38.30
B_5	19.20	16.98	18.27	18.15	138.85	134.99	135.49	136.44	35.52	47.52	45.69	42.91
B_6	20.18	18.24	19.21	19.21	140.29	136.40	137.21	137.97	33.85	44.19	42.52	40.19
B_7	19.76	17.64	18.64	18.68	139.05	135.96	135.13	136.71	34.52	45.85	44.19	41.52
B_8	17.68	15.47	16.90	16.68	137.55	132.72	134.89	135.05	41.19	57.52	51.02	49.91
B_9	24.23	20.28	21.83	22.11	145.52	141.85	142.05	143.14	24.35	31.52	30.52	28.80
Mean	21.11	18.34	19.58	19.68	140.72	137.00	137.22	138.31	32.02	44.41	42.06	39.50
	S.Em±		C.D. @ 5%		S.Em±		C.D. @ 5%		S.Em±		C.D. @ 5%	
Training (S)	0.40		1.21		0.50		1.52		2.20		3.19	
Bioformulations (B)	0.77		2.11		3.20		9.61		2.10		6.32	
Interactions (S×B)	3.15		NS		4.16		NS		4.50		NS	

The lowest rind thickness (1.17 mm) was recorded in two stem (S_1) training system. Rind thickness was found significantly different among the different bioformulations level. The highest rind thickness was recorded in B_8 (1.34 mm), which was on par with B_5 (1.29 mm) and the lowest rind thickness recorded in B_9 (1.06 mm) level. The interaction effect had shown non-significant results for rind thickness. The highest rind thickness was noticed in S_2B_8 and lowest in S_1B_9 treatments combination. The lowest rag weight (10.08 g) was recorded in three stem (S_2) which was on par with (11.06 g) four stem (S_3) and two stem (S_1) respectively. Rag weight was found significantly different among the different bioformulations level. The lowest rag weight was recorded in B_8 (9.12 g) which was on par with B_5 (9.83 g) and B_7 (10.35 g) and highest rag weight was recorded in B_9 (12.07 g) level. The interaction effect had shown non-significant results for rag weight. The highest rag weight was noticed in S_3B_9 and lowest in S_2B_8 treatments combination. The data pertaining to number of arils per fruit, number of arils per 100g and 100 arils weight as influenced by training and bioformulations are depicted in table 5.

Significantly highest number of arils per fruit (604.66) was recorded in three stem (S_2) training, which was followed by S_3 (579.99). The lowest number of arils per fruit (558.40) was recorded in (S_1) training system. Number of arils per fruit was found significantly different among the different bioformulations level. Significantly highest number of arils per fruit was recorded in B_8 (645.92), which was followed by B_5 (614.53), B_7 (603.97) and the lowest number of arils per fruit recorded in B_9 (525.64) level. The interaction effect had shown non-significant results for number of arils per fruit.

The highest number of arils per fruit was noticed in S_3B_9 and lowest in S_2B_8 treatments combination. The highest number of arils per 100g (298.43) was recorded in (S_2) training, which was on par with S_3 (294.11). The lowest number of arils per 100g (282.810) was recorded in (S_1) training system. Number of arils per 100g was found significantly different among the different bioformulations level. The highest number of arils per 100g was recorded in B_8 (306.76), which was on par with B_5 (300.75), B_7 (297.31) and the lowest number of arils per 100g recorded in B_9 (269.90) level.

Table 3. Influence of training and bioformulations on physical parameters of pomegranate fruit cv. Bhagwa

Treatments	Fruit Parameters											
	Fruit Length (cm)				Fruit Diameter (cm)				Fruit Volume (mi)			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
B_1	6.38	7.20	7.04	6.87	7.03	8.26	7.28	7.52	209.44	220.44	213.27	214.38
B_2	6.54	7.17	7.06	6.92	7.04	8.31	7.49	7.61	209.45	222.62	214.28	215.45
B_3	6.37	7.17	7.01	6.85	7.03	8.20	7.23	7.49	207.37	215.20	211.53	211.37
B_4	6.44	7.20	7.09	6.91	7.07	8.36	7.53	7.65	208.72	220.72	213.06	214.17
B_5	6.81	7.78	7.37	7.32	7.19	8.73	7.70	7.87	212.37	238.37	221.71	224.15
B_6	6.61	7.47	7.22	7.10	7.13	8.52	7.58	7.74	210.35	229.35	215.18	218.29
B_7	6.66	7.62	7.28	7.19	7.17	8.67	7.67	7.84	211.66	233.16	217.66	220.83
B_8	6.99	8.12	7.59	7.57	7.30	9.09	8.08	8.16	214.60	244.10	222.27	226.99
B_9	6.20	6.67	6.46	6.44	6.60	7.55	6.70	6.95	192.15	199.48	195.82	195.82
Mean	6.56	7.38	7.12	7.02	7.06	8.41	7.47	7.65	208.46	224.83	213.86	215.72

	S.Em±	C.D. @ 5%	S.Em±	C.D. @ 5%	S.Em±	C.D. @ 5%
Training (S)	0.09	0.27	0.14	0.42	3.50	10.52
Bioformulations (B)	0.20	0.60	0.22	0.70	5.21	15.65
Interactions (S×B)	0.20	NS	0.35	NS	6.14	NS

Table 4. Influence of training and bioformulations on rind weight, thickness and rag weight of pomegranate cv. Bhagwa

Treatments	Rind Weight (g)				Rind Thickness (mm)				Rag Weight (g)			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
B_1	47.89	52.95	50.95	50.60	1.12	1.21	1.19	1.17	11.12	10.56	11.71	11.13
B_2	48.83	56.02	52.36	52.40	1.15	1.24	1.22	1.20	11.48	10.42	11.44	11.11
B_3	45.99	50.37	48.70	48.35	1.14	1.22	1.19	1.18	11.53	10.66	11.82	11.34
B_4	47.31	53.57	49.91	50.26	1.15	1.23	1.20	1.19	11.57	10.42	11.54	11.18
B_5	54.84	63.15	61.15	59.71	1.27	1.31	1.29	1.29	10.32	9.39	9.79	9.83
B_6	50.04	54.59	52.59	52.41	1.15	1.25	1.23	1.21	10.84	9.78	10.80	10.47
B_7	52.43	60.23	55.90	56.19	1.18	1.27	1.26	1.24	10.71	9.70	10.64	10.35
B_8	56.89	72.30	66.64	65.28	1.31	1.36	1.34	1.34	9.76	8.37	9.24	9.12
B_9	40.53	45.43	43.76	43.24	1.04	1.10	1.04	1.06	12.22	11.46	12.53	12.07
Mean	49.42	56.51	53.55	53.16	1.17	1.24	1.22	1.21	11.06	10.08	11.06	10.73

	S.Em±	C.D. @ 5 %	S.Em±	C.D. @ 5 %	S.Em±	C.D. @ 5 %
Training (S)	0.70	2.14	0.03	0.09	0.12	0.36
Bioformulations (B)	1.40	4.25	0.04	0.12	0.20	0.59
Interactions (S×B)	3. 56	NS	0.05	NS	0.23	NS

Table 5. Influence of training and bioformulations on aril characters of pomegranate cv. Bhagwa

Treatments	Number of Arils/ Fruit				Number of Arils/ 100g				100 Arils wt (g)			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
B_1	537.53	581.20	558.86	559.20	277.45	296.12	291.28	288.28	26.67	31.20	29.37	29.08
B_2	538.36	598.53	562.20	566.36	281.41	296.75	292.41	290.19	28.34	32.29	30.75	30.46
B_3	535.70	580.36	557.36	557.81	275.84	292.00	288.84	285.56	25.30	29.77	29.39	28.15
B_4	537.20	596.86	559.70	564.59	278.98	298.15	293.48	290.20	27.55	31.47	29.92	29.65
B_5	597.86	636.20	609.53	614.53	290.19	307.86	304.19	300.75	32.47	34.16	32.32	32.98
B_6	563.36	617.03	593.03	591.14	285.20	302.86	296.86	294.97	29.17	32.71	31.01	30.96
B_7	581.86	629.03	601.03	603.97	286.64	305.97	299.31	297.31	30.89	33.21	31.71	31.94
B_8	623.70	664.20	649.86	645.92	297.59	313.92	308.76	306.76	35.63	38.78	34.40	36.27
B_9	510.03	538.53	528.36	525.64	265.57	272.24	271.90	269.90	23.44	28.61	25.61	25.89
Mean	558.40	604.66	579.99	581.02	282.10	298.43	294.11	291.55	28.83	32.47	30.50	30.60

	S.Em±	C.D. @ 5%	S.Em±	C.D. @ 5%	S.Em±	C.D. @ 5%
Training (S)	4.20	12.64	2.50	7.51	0.25	0.76
Bioformulations (B)	6.30	18.95	2.40	7.21	0.80	2.41
Interactions (S×B)	10.23	NS	6.58	NS	3.25	NS

Table 6. Influence of training and bioformulations on aril weight and seed weight of pomegranate cv. Bhagwa

Treatments	Aril Weight (g)				100 Seeds Weight (g)			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
B_1	176.23	187.06	182.23	181.84	4.17	3.72	4.09	3.99
B_2	178.08	189.75	186.42	184.75	4.17	3.65	4.10	3.97
B_3	175.55	188.40	182.40	182.12	4.14	3.74	4.08	3.99
B_4	177.58	190.58	184.91	184.36	4.15	3.70	4.10	3.98
B_5	189.44	204.44	201.94	198.61	4.10	3.54	4.04	3.89
B_6	183.18	195.18	193.35	190.57	4.13	3.62	4.11	3.95
B_7	185.59	200.92	196.92	194.48	4.13	3.61	4.08	3.94
B_8	198.81	220.98	211.48	210.42	4.02	3.49	4.01	3.84
B_9	164.52	170.19	165.52	166.74	4.35	3.90	4.23	4.16
Mean	176.23	187.06	182.23	181.84	4.17	3.72	4.09	3.99

	S.Em±	C.D. @ 5 %	S.Em±	C.D. @ 5 %
Training (S)	3.21	9.65	0.01	0.03
Bioformulations (B)	4.20	12.64	0.05	0.15
Interactions (S×B)	7.47	NS	0.12	NS

The interaction effect had shown non-significant results for number of arils per 100g. However, highest number of arils per 100g was noticed in S_2B_8 and lowest in S_1B_9 treatments combination. Significantly highest 100 arils weight (32.47g) was recorded in (S_2) training, which was followed by S_3. The lowest 100 arils weight (28.83g) was recorded in (S_1) training system. 100 arils weight was found significantly different among the different bioformulations level. Significantly highest 100 arils weight was recorded in B_8 (36.27g), followed by B_5 (32.98g), B_7 (31.94g) and the lowest 100 arils weight recorded in B_9 (25.89g) level.

The interaction effect had shown non-significant results for 100 arils weight. The highest 100 arils weight was noticed in S_2B_8 and lowest in S_1B_9 treatments combination.

Discussion

Significantly minimum days for initiation of flowering, maximum number of flowers per plant at 30, 45 and 60 DAT respectively, maximum number of fruits per plant and lowest days for maturity after fruit set were recorded in four stem (S_2) training, results are superior over three stem (S_1) and five stem (S_3) training (table 1 and 2).

Lower number of flower bud and fruits per plant plants seems to be due to lesser photosynthetic activity, because of exposure of less number of leaves to sunlight and reduced fruiting area due to reduced number of stems per plant and lesser photosynthetic activity caused lower yield per plant. These results are in agreement with the findings of (Bhagawati *et al.,* 2015) in guava, (Marialicznarm and Alanczuk, 2004 and Hassan *et al.,* 2010) in apple, (Ram *et al.,* 2013) in mango. The findings of present investigation are also in accordance with results obtained by (Suleman *et al*., 2006 and Bhagawati *et al*., 2015) in guava. They indicated that, early initiation of flowering is due to immediate loss of apical dominance and early shoot production and these shoots attained the desired maturity to give rise to early inflorescence emergence.

Results obtained on maximum number of flowers per plant by the current study is contrary to results with (Suleman *et al*., 2006) in guava that, moderately trained and pruned shoots showed maximum number of inflorescence compared to heavy trained and pruned shoots which produces least number of inflorescence due to heavy vegetative growth, hence moderate training, pruning favors better shoot to root ratio which balances desired vegetative and reproductive growth. Results obtained regarding least days for maturity after fruit set are similar with findings of (Bhagawati *et al.,* 2015) in guava. Who opined that, as stem and shoot retention is more, inter fruit competition for nutrients increases.

Hence, optimum ground stem retention decreases inter fruit competition for nutrients, increases fruit size and increases leaf to fruit ratio consequently that advances the fruit maturity at faster rate. The minimum days for initiation of flowering, maximum number of flowers per plant at 30, 45 and 60 DAT respectively, maximum number of fruits per plant and lowest days for maturity after fruit set (table 1 and 2) were recorded in B_8 consisting of Amrithpani (4%) + Panchagavya (5%) + Jeevamruth (6%) + *P. fluorescens* (25g/ plant). The maximum days for initiation of flowering, minimum number of flowers per plant at 30, 45 and 60 DAT respectively and highest days for maturity after fruit set were noticed in B_9 consisting of only RDF + FYM (Control).

Similar results by (Sau *et al.,* 2017) in mango reported that, the liquid organic formulations combined with biofertilizers tends to accelerate the metabolic activities of the plant by increasing the meristematic activities which in turn increases the vegetative growth in favour of accumulating organic acids, early flower bud differentiation favors higher leaf to fruit ratio, provides maximum nutrients for reproductive development, better photosynthesis recording good growth and formation of more number of flowers. Similar results were also reported by (Kulapati *et al.,* 2009 and Bhalerao *et al.,* 2009) in banana. The interaction effect revealed non-significant results for initiation of flowering, number of flowers per plant, number of fruits per plant and days to maturity after fruit set among all training and bioformulation combinations. However, early initiation of flowering (15.45 days), maximum number of flowers per plant, maximum number of fruits per plant and minimum days to maturity after fruit set were recorded in S_2B_8. The highest fruit length, diameter, volume, rind weight, maximum rind thickness and lowest rag weight were recorded in (S_2) training, whereas, lowest fruit length diameter and volume were recorded in (S_1) training (table 3 and 4).

The maximum values for fruit physical parameters may be ascribed to the fact that larger and more open canopies allowing the entry of more solar radiation and air which aids in active and rapid cell division and better development of internal fruit physiology. Results are in confirmation with findings of (Gill *et al.,* 2011) in pomegranate. Sharma and Niranjan Singh (2018) also noted that, training and pruning intensity has positive correlation with fruit physical parameters in pomegranate. Retention of optimum ground stems with primary and secondary shoots population has positive effect on improving the internal physiology of developing fruit. Least values for five and three stems due to lesser and over-crowded canopy, in adequate supply of solar radiation, internal fruit competition for nutrients. Significant results obtained by the study finds the conformity with findings of (Mir *et al*., 2012) in pomegranate. The highest fruit length, diameter, volume, highest rind weight, maximum rind thickness, and lowest rag weight were recorded in B_8 consisting of Amrithpani (4%) + Panchagavya (5%) + Jeevamruth (6%) + *P. fluorescens* (25g/ plant) and least values noticed in B_9 (table 3 and 4).

The increase in fruit length, diameter and volume might be due to increase in cell size and intercellular space. The increase in size of fruit as a result of application of liquid bioformulations combined with biofertilizers might be because, it makes the plant unavailable nutrients to mobilize and supply to developing fruit. It improves the internal physiology of developing fruit in terms of better supply of water, nutrients and other compounds vital for their proper growth and development. Investigated results are in accordance with the findings of (Athani *et al*., 2005) in guava, (Shivakumar *et al*., 2012) in papaya, (Sau *et al.,* 2017) in mango, (Duragannavar, 2005) in papaya. The interaction effect revealed non-significant results for fruit length, fruit diameter, fruit volume, rind weight, rind thickness and rag weight among all training and bioformulation combinations (table 3 and 4).

The highest number of arils per fruit, highest number of arils per 100g, highest 100 arils weight, highest aril weight and lowest seed weight were recorded in (S_2) training. Whereas, lowest aril weight and highest seed weight was observed in (S_1) training (table 5 and 6). It is clear by the study that, with increase in stem numbers in training, the seed number per fruit got increased. This may be ascribed to the fact that, larger and more open canopies allowing the entry of more light and air thereby changing the micro-climate affecting the pollen germination in vivo. Mir *et al*. (2012) and Gill *et al.* (2011) also reported the same regarding seed weight in pomegranate *i.e*, lowest seed weight was noticed in moderately trained plants with four scaffolds than bush trained plants. Higher results for arils character might be due to accumulation of dry matter provide optimum supply of proper plant nutrients and ultimately production of more photosynthates which accelerates the metabolic activities of the plant.

Results found are in tune with (Bhagawati *et al.,* 2015), who reported that, optimum placed stems and shoots on plant canopy have influence on rate of accumulation of dry matter, rate of photosynthates which accelerates the metabolic activities of the plant in guava. The highest number of arils per fruit, highest number of arils per 100g, highest 100 arils weight, highest aril weight and lowest seed weight were recorded in B_8 consisting of Amrithpani (4%) + Panchagavya (5%) + Jeevamruth (6%) + *P. fluorescens* (25g/ plant) and lowest in B_9 (table 5 and 6) consisting of only RDF + FYM (Control).

Significant values regarding aril characters and shelf life might be due to combination of bioformulations and biofertilizers encouraged better growth and accumulates optimum dry matter with induction of growth hormones stimulates cell division, cell elongation activate the photosynthesis process as well as energy transformation and increases the cell size and intercellular space. Similar results were obtained by (Dutta *et al*., 2014) in pomegranate, (Pilania *et al*., 2010) in guava, (Sau *et al.,* 2017) in mango, (Duragannavar, 2005) in papaya, (Hebbara *et al*., 2006) in sapota, (Kulapati *et al*., 2009) in banana and (Verma and Rao, 2013) in strawberry. Increased shelf life may be due to combination of bioformulations and biofertilizer role in the maintenance of fruit firmness, retardation of respiratory rates as well as transpiration and delayed senescence. Similar results were observed by (Madhavi *et al*., 2008) in mango. Results of current investigation are in tune with (Rao and Chundawat, 1991) in banana. Who quoted that, increased shelf life might be due to reduced rate of respiration and transpiration from fruit surfaces.

The decrease in respiration could be further attributed to lowering of succinate and malate dehydrogenase associated with TCA cycle as described by (Mehta *et al.,* 1986) in papaya. Duragannavar (2005) in papaya reported that, presence of some unidentified metabolite components like GA_3 in Panchagavya, Amritpani and Jeevamruth might had acted as ripening retardants leading to reduced respiration, transpiration and weight loss with extended shelf life, (Rao and Chundawat, 1991) who worked on banana also confirmed that GA_3 treatment extended the shelf life with delayed ripening, transpiration and respiration. The interaction effect revealed non-significant results for number of arils per fruit, number of arils per 100g, 100 arils weight, aril weight and seed weight among all training and bioformulation combinations (table 5 and 6). However, highest aril weight and lowest seed weight was recorded in S_2B_8 treatments combination.

Conclusion

Plants trained with three stems resulted in early flowering, higher number of flowers and fruits per plant, early fruit maturity with better fruit physical and quality parameters. Plants supplemented with Amrithpani (4%) + Panchagavya (5%) + Jeevamruth (6%) + *P. fluorescens* (25 g/plant) recorded maximum flowering, fruiting and fruit quality parameters.

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