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Response of pruning intensity and time on growth, yield and quality attributes of phalsa under hot arid condition

Kamlesh Kumar*, S. M. Haldhar[1] and D. Singh
ICAR-Central Institute for Arid Horticulture, Bikaner-334 006 (Rajasthan)
[1]Central Agriculture University, Imphal- 795004 (Manipur)
*Corresponding author's email: kamlesh.kumar2@icar.gov.in
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Abstract

Recently phalsa is gaining popularity in arid and semi-arid regions due to drought tolerance, nutritional and medicinal value; and can be grown successfully in adverse climatic conditions of arid regions with limited supplemental irrigations and fertilizer application. Pruning is an essential cultural operation in phalsa for good flowering and fruiting. Therefore, present experiment was carried out during 2017 to 2019 to study the response of different pruning intensities and timings on vegetative growth, yield and quality attributes of phalsa 'CIAH-P-1'. The phalsa bushes were pruned on four dates *viz*., 30th November, 15th December, 30th December and 15th January at four intensities, *i.e*. 0.00 cm, 20 cm and 40 cm, and 60 cm height from ground level. It was observed that pruning timings and intensities had significant effect on sprouting period, bush height, number of twigs, number of fruiting clusters, number of fruits per cluster, fruits weight, total soluble solids and fruit yield per plant. Maximum average fruit yield (4.91 kg/plant), average fruit weight and diameter (1.14 g and 1.26 cm) and total soluble solids (25.02°Brix) were obtained when pruned the bushes at 20 cm from ground level on 15th of January, which was significantly higher from rest of the treatment combinations. On the findings of the study, it may be concluded that pruning in phalsa should be done on 15 to 20th of January at 20 cm height from ground level under Bikaner agro-climatic conditions of western Rajasthan.

Key words: Phalsa, pruning intensity, pruning time, yield, quality attributes

Introduction

Phalsa is a crop of hot arid and semi-arid regions. For fruit and colour development, fruit ripening and quality it requires optimum sunlight and warm temperatures. It can be grown in various types of soils. However, sandy loam soil having good drainage facility is ideal for good growth and development of the plant. In India, it is grown commercially in states like Punjab, Uttar Pradesh, Madhya Pradesh, Haryana, Rajasthan and the Himalayan regions, and is found up to 3,000 feet above sea level and also grown on smaller scale in Karnataka, Maharashtra, Andhra Pradesh, Gujarat, West Bengal and Bihar. Traditionally, it is cultivated as subsistence farming and hence it is mostly consumed in fresh fruits and juices. In India, ripen fresh fruits consumed during summer months and also preparation of refreshing cool beverage (Sarolia *et al*., 2019). Ripe fruits are sour-sweet in taste and good source of vitamin A and C. Fruits rich in antioxidants and are good source of iron and phosphorus. It comes under underutilized fruit crops but have nutritional and medicinal value. The nutritional and medicinal value of phalsa is due to its high phenolic compounds, organic acids, tannins, anthocyanins, and flavonoids. Despite the highly nutritional value of the fruit, it is not cultivated commercial scale. It is an ideal plant for multi-story cropping. However, its popularity is restricted owing to highly perishable nature, small size of fruit and non-synchronous maturity, which necessitates repeated harvesting. Therefore, the plantation is mainly confined to the surroundings of big cities. Its cultivation is also possible with the minimum or no use of synthetic chemical nutrients that also has a sustainable effect on environment and the soil. Due to this reason, organic production is also possible with excellent quality fruits (Kumar and Haldhar, 2019).

Successful phalsa production is mainly depends upon training and pruning operations. This crop is trained in such a way that it can take the shape of a bush. Because, bush gives more fruiting branches, which results in the higher yield. It is pruned once in North India and twice in South Indian conditions (Kumar and Haldhar, 2020). Pruning is an essential cultural operation since flowers are borne as axillary cyme on new growth, which is induced by pruning. The presence of mature leaves inhibit axillary bud sprouting in un-pruned shoots. The flowering and fruiting is confined to 15-20 nodes from the base depending on vigour (Meghwal, 2006). Pruning and plant growth regulators have been commonly used in modifying various physiological processes with advantage in plant growth, flowering, fruit yield and other attributes in several horticultural crops. Right time pruning and at optimum level in phalsa gives the significant results like increasing the yield and quality of fruits. In addition to manures and fertilizers, pruning has also been reported to manage plant canopy and enhance the flowering, fruiting, yield and quality of many fruit crops (Lakra *et al*., 2018). Pruning in phalsa is considered as an essential operation since the fruit buds are

found on current season's growth to get good yield. Besides, severity of pruning, the optimum time of pruning, may also be very important for improving yield and quality of fruits. It has also been reported that the time of pruning may regulate fruit maturity in phalsa which ultimately result into orderly marketing of this perishable fruit, which can prove to be advantageous to both the fruit growers and consumers (Abid *et a*l., 2012).

In recent years, phalsa is becoming popular in arid and semi-arid regions due to drought tolerance, high returns and live fence cheep material. Side by side the optimum intensity of pruning and time has not been well established under Bikaner condition of western Rajasthan. Therefore, present experiment was carried out to study the optimum time and severity of pruning on vegetative growth, yield and quality attributes of phalsa 'CIAH-P-1'. In the present study, the pruning time and intensity of pruning was standardized at ICAR-Central Institute for Arid Horticulture, Bikaner.

Materials and Methods

Pruning intensity and right time of pruning are necessary practices for getting optimum yield in phalsa. For the standardization of pruning intensity and pruning time of phalsa 'CIAH-P-1'; an experiment was conducted during 2017 to 2019 in Entomology Block of ICAR-CIAH, Bikaner. The institute is located on 28^0 N latitude, $73^0 18^0$ E longitude and at altitude of 234.84 m above sea level. The location of experimental site is very hot and dry and receiving scanty rains. There were four intensities of pruning *viz*., H_1-0, H_2-20, H_3-40 and H_4-60 cm height from ground level and four time of pruning such as T_1-30th November, T_2-15th December, T_3-30th December and T_4-15th January (Table 1). The field experiment was conducted in randomized block design and data were analyzed using online software developed by Sheoran *et al*., 1998.

The observations were recorded with respect to bush sprouting, flower bud initiation/flowering, fruiting, yield and quality parameters. The uniform five years old phalsa bushes were selected for recording bush height, canopy spread, sprouting period (days), required days for pruning to flowering, required days for harvesting, length of harvesting period, number of twigs per bush, length of twigs (cm), number of fruiting clusters per twig, number of fruits per cluster, yield per bush (kg), fruit weight (g), fruit diameter (mm), total soluble solids (°Brix). The selected phalsa bushes were pruned on 30th November, 15th December, 30th December and 15th January during 2017-18 and 2018-19. There were sixteen treatments having two bushes in each treatment. Fruits were harvested from April to June during both the years for recording yield and quality parameters.

Results and Discussion

All the vegetative growth parameters were significantly influenced by pruning intensity and timing. Minimum average period (15 and 21 days) taken for sprouting was observed in treatment T_4H_1 during 2018 and 2019, respectively followed by in T_3H_4 (34 days) while maximum average days taken (87.50 days) for sprouting bushes was noted in treatment T_1H_4 (Table 2). Maximum average bush height (1.48 and 1.65 m) was measured in T_4H_2 during both the years of study with pooled height of 1.57 m followed by T_4H_4 and minimum bush height (1.18, 1.16 and pooled 1.17 m) recorded in treatment T_1H_2. Maximum fruiting twigs per bush (206 and 198) was observed in treatment T_3H_4 followed by T_4H_4 (199 and 193) during both years of experimentation, respectively while in pooled data it was noted 202. Minimum average number of twigs was found in treatment T_1H_1 (120 and 126) with pooled data 112. In 2018, highest twig length was measured 122 cm in T_4H_1 which is at par with T_4H_2 (121 cm) followed by T_1H_1 (112 cm) while in 2019, it was noted maximum (124 cm) in T_4H_2 followed by T_4H_1 (119 cm). In pooled data, maximum twig length was recorded 122.50 cm in T_4H_2 followed by T_4H_1 (120.50 cm). Least average length of fruiting twigs per bush (86 cm) in first year was observed in T_1H_4 which is at par with T_3H_4 (87 cm) followed by T_3H_3 (92

Table 1. Treatment combinations, dates and intensities of pruning of phalsa

Treatment combinations	Pruning Time		Pruning intensity (cm)
	First year	Second year	
T_1H_1	30.11.2017	30.11.2018	0
T_1H_2	30.11.2017	30.11.2018	20
T_1H_3	30.11.2017	30.11.2018	40
T_1H_4	30.11.2017	30.11.2018	60
T_2H_1	15.12.2017	15.12.2018	0
T_2H_2	15.12.2017	15.12.2018	20
T_2H_3	15.12.2017	15.12.2018	40
T_2H_4	15.12.2017	15.12.2018	60
T_3H_1	30.12.2017	30.12.2018	0
T_3H_2	30.12.2017	30.12.2018	20
T_3H_3	30.12.2017	30.12.2018	40
T_3H_4	30.12.2017	30.12.2018	60
T_4H_1	15.01.2018	15.01.2019	0
T_4H_2	15.01.2018	15.01.2019	20
T_4H_3	15.01.2018	15.01.2019	40
T_4H_4	15.01.2018	15.01.2019	60

cm). During 2019, minimum twigs per bush (92 cm) were noted in T_3H_4 followed by T_1H_4 (94 cm) while in pooled data it was 89.50 cm in T_3H_4 which is at par with T_1H_4 (90.00 cm) followed by 94.50 cm in T_3H_3.

Effect of intensity of pruning and time on flowering and fruiting attributes

Intensity of pruning and time had significant effect on flowering and fruiting parameters. During both the years of experimentation, treatment T_4H_1 had taken minimum average number of days (45 and 51 days) for flowering after pruning and in pooled data it was noted 48 days followed by in T_4H_3 (50.50 days) which was at par (equal) with T_4H_2 and T_4H_4 (51 days). On the other side, maximum period had been taken for flowering in T_1H_3 and T_1H_4 (equal days) which were 94 days during 2018 while second year it was observed maximum (equal days) in treatment T_1H_2 and T_1H_3 (106 days) followed by T_1H_1 (100 days). In pooled data, maximum mean flowering time (100 days) was recorded in T_1H_3 followed by (91.50 days) T_1H_1. Similarly, harvesting period had also affected significantly due to pruning intensity and time of pruning. During first year of study, 15th January pruned bushes had taken minimum number of days (equal) for harvesting (104 days) in all four treatment combination *i.e.* T_4H_1, T_4H_2, T_4H_3 and T_4H_4 followed by T_3H_2 and T_3H_3 (112 days) which was equal period while maximum period was taken for picking of fruits in treatment T_1H_4 (148 days). In second year, Minimum time (120 days) for harvesting was recorded in treatment T_4H_4 followed by T_4H_1 (126) and maximum period was taken in T_1H_4 (168 days). In pooled data, minimum harvesting time (112 days) was observed in T_4H_4 followed by T_4H_1 (115 days) which was at par with T_4H_2 and T_4H_3. Likewise, length of harvesting period was also noted in all treatment combinations. During both the years of pooled data, longest harvesting period (27.50 days) was observed in treatment T_3H_3 which was at par with T_4H_4 and shortest period was found in treatment T_1H_3 (13.50 days) which was also at par with T_1H_4 (14.00 days).

During both the years of study, 15th January pruned bushes at 20 cm from ground level (T_4H_2) were observed with maximum number of fruiting clusters per twig (12.20 and 13.60, respectively) which were at par with T_4H_1 followed by in treatment T_4H_3 (11.50 and 12.40, respectively) while minimum fruit clusters per twig (10.10 and 10.60) were recorded in treatment T_2H_4 which was at par with T_2H_3 (10.20 and 10.80) followed by in T_2H_2 (10.60 and 11.10). In pooled data, maximum fruit clusters per twig (12.90) were found in T_4H_2 which was at par with T_4H_1 (12.30) and T_3H_1 (12.40) while minimum clusters (10.35) were recorded in treatment T_2H_4 which was at par with T_2H_3 (10.50). During 2018, highest numbers of fruits per cluster (19.80) were observed when bushes pruned on 15th January at 20 cm from ground level (T_4H_2) which was at par with T_4H_1 and T_4H_4 (19.50). Minimum numbers of fruits (15.20) were found when bushes pruned on 15th December and 30th November during both the years of experimentation. During 2019 also, maximum fruits per clusters (18.40) were recorded when bushes pruned on 15th January (T_4H_2) which was at par with all three treatments (18.10, 18.00 and 18.00) pruned on 15th January at 0, 40 and 60 cm from ground level. In pooled data of both years, highest numbers of fruits per cluster (19.10) were noted in T_4H_2 and lowest in T_2H3 (14.95) which were at par with T_1H_2 (15.00) (Table 3).

Yield and quality attributes were significantly affected by pruning time and severity of pruning during both the years of study (Table 4). During 2018, maximum average fresh fruit yield (4.89 kg/ bush) was recorded in treatment T_4H_2 followed by T_4H_3 (4.19 kg/ bush) and minimum in T_1H_4 (2.17

Table 2. Effect of pruning intensity and time on different characteristics of phalsa under hot arid ecosystem

Treatments	Sprouting period (days)			Required days from pruning to flowering			Required days for harvesting (days)			Length of harvesting period (days)			Bush height (m)		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
T1H1	63	80	71.50	83	100	91.50	135	156	145.50	23	25	24.0	1.23	1.27	1.25
T1H2	68	83	75.50	91	106	98.50	141	159	150.00	16	19	17.5	1.18	1.16	1.17
T1H3	74	86	80.00	94	106	100.00	146	159	152.50	11	16	13.5	1.18	1.19	1.19
T1H4	85	90	87.50	94	99	96.50	148	168	158.00	10	18	14.0	1.33	1.36	1.35
T2H1	34	43	38.50	70	79	74.50	126	144	135.00	16	21	18.5	1.18	1.20	1.19
T2H2	29	41	35.00	70	82	76.00	126	138	132.00	22	23	22.5	2.37	1.43	1.90
T2H3	46	52	49.00	73	79	76.00	128	150	139.00	27	25	26.0	1.32	1.26	1.29
T2H4	46	54	50.00	78	86	82.00	128	148	138.00	27	25	26.0	1.50	1.42	1.46
T3H1	31	40	35.50	67	76	71.50	122	140	131.00	21	23	22.0	1.13	1.18	1.16
T3H2	37	44	40.50	72	80	76.00	122	140	131.00	28	23	25.5	1.27	1.40	1.34
T3H3	41	45	43.00	67	71	69.00	112	132	122.00	31	24	27.5	1.28	1.38	1.33
T3H4	31	37	34.00	67	63	65.00	112	132	122.00	25	24	24.5	1.35	1.41	1.38
T4H1	15	21	18.00	45	51	48.00	104	126	115.00	17	23	20.0	1.37	1.50	1.44
T4H2	33	37	35.00	49	53	51.00	104	128	116.00	29	21	25.0	1.48	1.65	1.57
T4H3	39	42	40.50	49	52	50.50	104	128	116.00	24	21	22.5	1.36	1.48	1.42
T4H4	33	37	35.00	49	53	51.00	104	120	112.00	29	24	26.5	1.39	1.54	1.47
SEm±	2.07			2.55			1.70			2.41			1.30		
CD (5%)	6.31			7.77			5.17			7.33			N/A		

kg/ bush) followed by T_1H_3 (2.67 kg/ bush). In 2019 also, highest yield per bush (4.93 kg/ bush) was obtained in T_4H_2 followed by T_4H_3 (4.32 kg/ bush) and lowest (equal) was found in T_1H_1 and T_3H_1 (2.84 kg/ bush). In pooled data, yield was recorded maximum (4.91 kg/ bush) in T_4H_2 treatment followed by T_4H_3 (4.26 kg/ bush) and minimum in T_1H_4 (2.53 kg/ bush) followed by T_1H_3 (2.83 kg/ bush).

The vegetative growth, flowering, yield and quality attributes were significantly affected by pruning intensities and time. The results of this study are in close conformity with the findings of Mishra and Deen (2015) in phalsa. The phalsa twigs (shoots) lengths and numbers were observed variably in different pruning intensities. Sprouting response of pruned bushes was significant increasing and decreasing in different time and intensities. Maximum number and length of twigs per bush was recorded when phalsa pruned on 15th of January and 30th of December. Similar results on vegetative growth parameters were also reported by Basith *et al*. (2018) in phalsa. The number of fruit clusters and fruits per cluster per bush were found to be significantly higher when pruning performed on 15th of January at 20 cm height from ground level as compared to other three dates and intensities of pruning during both the years. The results of the present experiment also confirm the findings of Basith *et al.*, (2018) in phalsa. Similarly, the fruit yield per bush, fruit weight, fruit diameter and TSS content were found significantly higher when bushes pruned on 15th of January at 20 cm height as compared to other treatments (Table 2). Increase in TSS content in January pruned bushes might be due to stimulatory effect of essential plant nutrients which increases the photosynthetic rate and metabolic activity in plant system, which might have helped in the translocation and

Table 3. Response of pruning intensity and timings on different characteristics of phalsa under hot arid ecosystem

Treatment	Number of twigs/ bush			Length of twig (cm)			Number of fruit clusters/ twig			Number of fruits / cluster		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
T1H1	120	126	123.0	112	119	115.50	11.30	11.60	11.45	16.20	15.30	15.75
T1H2	135	141	138.0	110	108	109.00	12.00	11.80	11.90	15.20	14.80	15.00
T1H3	149	146	147.5	105	101	103.00	11.10	11.20	11.15	15.80	15.00	15.40
T1H4	171	168	169.5	86	94	90.00	10.70	11.00	10.85	16.60	15.50	16.05
T2H1	140	152	146.0	107	110	108.50	10.90	11.70	11.30	16.80	16.20	16.50
T2H2	167.5	170	168.8	105	103	104.00	10.60	11.10	10.85	16.70	15.30	16.00
T2H3	177	174	175.5	103	98	100.50	10.20	10.80	10.50	15.20	14.70	14.95
T2H4	196	189	192.5	98	105	101.50	10.10	10.60	10.35	16.50	15.20	15.85
T3H1	162.5	165	163.8	111	115	113.00	12.20	12.60	12.40	18.10	17.50	17.80
T3H2	178	172	175.0	106	111	108.50	11.30	12.40	11.85	18.50	17.60	18.05
T3H3	192.5	190	191.3	92	97	94.50	11.70	12.60	12.15	18.20	17.30	17.75
T3H4	206	198	202.0	87	92	89.50	10.60	11.00	10.80	18.20	17.10	17.65
T4H1	165	173	169.0	122	119	120.50	11.90	12.70	12.30	19.50	18.00	18.75
T4H2	170	177	173.5	121	124	122.50	12.20	13.60	12.90	19.80	18.40	19.10
T4H3	189	188	188.5	104	99	101.50	11.50	12.40	11.95	19.30	18.00	18.65
T4H4	199	193	196.0	94	98	96.00	10.50	11.80	11.15	19.50	18.10	18.80
SEm±	3.05			2.28			0.21			0.17		
CD at 5%	9.28			6.95			0.65			0.54		

Table 4 . Response of pruning intensity and timings on yield and quality attributes of phalsa

Treatment	Yield/ bush (kg)			Fruit weight (g)			Fruit diameter (mm)			Total soluble solids (^{0}Brix)		
	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
T1H1	2.88	2.84	2.86	0.82	0.83	0.83	10.83	10.65	10.74	19.95	19.78	19.87
T1H2	3.08	3.08	3.15	0.92	0.91	0.92	10.97	10.90	10.94	20.86	20.64	20.75
T1H3	2.67	2.99	2.83	0.62	0.60	0.61	10.70	10.66	10.68	20.58	20.82	20.70
T1H4	2.17	2.88	2.53	0.53	0.45	0.49	10.61	10.59	10.60	19.20	19.40	19.30
T2H1	2.99	3.10	3.05	0.93	0.88	0.91	10.96	10.83	10.90	20.36	20.44	20.40
T2H2	3.26	2.87	2.88	0.96	0.97	0.97	11.02	11.05	11.04	21.12	21.24	21.18
T2H3	2.9	2.98	2.94	0.94	0.97	0.96	10.88	10.97	10.93	20.82	21.02	20.92
T2H4	2.87	2.90	2.89	0.90	0.88	0.89	10.86	10.79	10.83	20.72	20.52	20.62
T3H1	2.69	2.84	2.77	0.80	0.79	0.80	10.71	10.41	10.56	21.88	21.59	21.74
T3H2	3.82	3.94	3.88	0.97	0.95	0.96	11.92	11.86	11.89	22.20	21.76	21.98
T3H3	3.74	3.34	3.54	0.83	0.84	0.84	11.69	11.81	11.75	21.48	21.08	21.28
T3H4	2.9	3.41	3.16	0.76	0.73	0.75	10.91	10.71	10.81	22.06	21.77	21.92
T4H1	3.46	3.96	3.71	0.83	0.82	0.83	11.09	11.01	11.05	23.10	22.90	23.00
T4H2	4.89	4.93	4.91	1.13	1.14	1.14	12.62	12.75	12.69	25.42	24.62	25.02
T4H3	4.19	4.32	4.26	1.01	1.02	1.02	12.15	12.30	12.23	22.63	22.23	22.43
T4H4	3.52	4.04	3.78	0.85	0.83	0.84	11.23	11.02	11.13	22.78	22.58	22.68
SEm±	0.06	0.03	0.15	0.03	0.04	0.01	0.17	0.25	0.06	0.62	0.51	0.14
CD at 5%	0.19	0.09	0.45	0.09	0.11	0.04	0.50	0.73	0.20	1.77	1.45	0.43

accumulation of more chemical metabolites in mature fruits. Similar kinds of results on yield and quality parameters were also reported by Ali *et al*. (2001) and Basith *et al*. (2018) in phalsa when pruning performed after 20 December to 20 January. The optimum weather conditions prevailing during last week of December to first fortnight of January as a result pruning might have assisted the phalsa bushes to produce early and more number of sprouts, flowers and fruiting clusters which have significant positive response in giving higher yield with better quality fruits.

The pruning intensity at 20 cm height from ground level on 15th of January had significantly maximum bush height (1.57 m), length of twigs/ shoots (122.50 cm), number of fruit clusters /shoot (12.90), number of fruits/ cluster (19.10), which ultimately yields to maximum fruit weight (1.14 g), fruit diameter (12.69 mm), fruit yield (4.91 kg/ bush) and total soluble solids (25.02°Brix). On the findings of the present study, it may be recommended that to obtain highest yield of good quality fruits, phalsa bushes should be pruned at 20 cm height from above ground level between 15 to 20 January *every year* under Bikaner agro-climatic conditions. However, response of pruning intensity and different dates of pruning may vary to change in agro-climatic zones and thus, result may differ accordingly

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