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EVALUATION OF AONLA CULTIVARS UNDER SEMI ARID CLIMATIC CONDITIONS OF VIDARBHA REGION

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KEYWORDS

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ABSTRACT

The present investigation was carried out on seven varieties of Aonla *viz*., Krishna, NA-10, Francis, NA-7, Chakaiya, Banarasi and NA-9 under Akola conditions of Vidarbha region to test the extent of correlation between different parameters and their effect on the yield of Aonla. The experiment was laid out in analysis of variance one way classification with three replications of each variety. The results were obtained for the correlation coefficient. The study revealed that fruit yield per hectare exhibited highly significant and positive correlation with plant height (R^2 = 0.407), tree volume (R^2 = 0.416), number of fruits per tree, fruit weight (R^2 = 0.195), fruit volume (R^2 = 0.465), pulp: seed ratio (R^2 = 0.400) and ascorbic acid (R^2 = 0.411). Significantly maximum fruit yield per plant and per hectare was recorded in variety NA-7 (146.15 kg and 298.14 q.) respectively with followed by Krishna (112.41 kg and 229.31q) and Francis (92.56 kg and 188.82q). On the basis of above findings, the significant variation was noted in performance of different aonla varieties under Akola conditions in respect to yield and yield attributing characters and fruit quality.

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INTRODUCTION

Aonla or Indian gooseberry (*Emblica officinalis* Gaertn.) is indigenous to Indian sub continent, belongs to the family Euphorbiaceae. Owing to its hardy nature, suitability to various wastelands, high productivity, nutritive and therapeutic values, aonla has become an important fruit. Aonla has been cultivated in India since time immemorial (Singh *et al.,* 2009). Besides India, naturally growing aonla trees are also found in different parts of the world viz., Sri Lanka, Cuba, Puerto Rico, China, Thailand and Japan (Bakshi *et al*., 2015).The trees are quite hardy and can be grown even in sodic and saline soils upto 35 ESP and EC 9 dSm-1 respectively (Pathak and Pandey, 1985).

The scope of cultivation of this crop is increasing day by day in wasteland degraded land which is not considered suitable for major fruit crops. Knowledge of association between growth and yield contributing characters are of great value in planning a breeding programme. Selection of these characters is effective when these characters are highly heritable and positively correlated (Kumar *et al.,* 2009). A positive correlation between two desirable traits makes the job of the plant breeder easy for improving both traits simultaneously.(Jambhale *et al.,* 2014).

As there are many varieties of aonla, the varietal testing is important aspect in pomological improvement. Though several aonla varieties are available now, systematic evaluations of these and of their yield potentials have not been done under Akola conditions. The different varieties do not perform equally well in all regions due to differences in varietal adaptability in varietal eco-physiological conditions. The varietal character in respect of growth parameters, flowering, fruit development and maturity varies under each variety. On the basis of yield potential and quality attributes the following aonla cultivars are recommended for commercial cultivation these include early cultivars, Krishna and NA-10, medium maturity cultivars, NA-6 and NA-7 and late modering cultivars Chakaiya and Kanchan (Pathak, 2003).Therefore an attempt is made to find out the suitability of some of them under Akola conditions with objective to find out the suitable variety(s) for maximum production and better fruit quality of aonla under Akola conditions and to study the correlations among the different fruit characters of seven aonla cultivars grown semi arid climatic conditions of Vidarbha.

MATERIALS AND METHODS

The evaluation of nine years old aonla cultivars was carried out during the year 2013-14 comprising seven different varieties *viz*., Krishna, NA-10, Francis, NA-7, Chakaiya, Banarasi and NA-9 at Demonstration farm, Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is situated at 307.42 meter altitude from sea level of 22.42º latitude and 77.02ºE longitude and having marginal subtropical climate. The mean annual precipitation on the basis of last fifteen years is 699.5 mm which receives almost from south west monsoon during June to December and actual precipitation was 946.4 mm during the year 2012-13. During the period of investigation the mean annual minimum and maximum temperatures are 20.2ºC and 33.0ºC, respectively. The bright sunshine hours ranges between

1.3 to 8.3 hrs per day and wind speed 0.5 to 14.5 km/hr. The humidity ranges from 24.3 per cent in summer and 82.7 per cent in rainy seasons. Thus Akola has hot and dry summer with moderate cold winter.

The height observational plant was measured from ground level to the growing tip and after computing mean the plant height was recorded in meter. The plant volume of selected plants was computed using formula suggested by Westwood, 1963. Number of fruit on each branch of the observational plants was counted at regular intervals. Fruit and seed weight was recorded with the help of electronic balance in gram. The fruit volume of selected fruits was measured by water displacement method in cubic centimeter. TSS was determined by Digital refractrometer and expressed in ºBrix, acidity of fruits by AOAC method (Anon, 1984), total sugars of fruits were recorded by a method as suggested by Ranganna (1979) (Sundararajan *et al.,* 1969, Patil *et al.,* 2010, Hegazi *et al.,* 2011, Daberao *et al.,* 2015).Ascorbic acid content was estimated by method described by Majumdar and Majumdar (2003). The data recorded were subjected to analysis of variance as per procedure described by Gomez and Gomez (1983). Simple correlation coefficient (Karl Pearson's Coefficient) between the different characters was worked out by the formula given by Panse and Sukhatme (2000).

RESULTS AND DISCUSSION

Growth attributes

The maximum height of plant was recorded in the variety Francis (5.11 m), while, minimum plant height was recorded in variety Banarasi (4.23 m) (Table1). The significant variation in respect of plant height in different varieties might be due to growth performance of respective variety in particular climatic conditions. Significantly highest fruit yield was recorded in variety NA-7 (146.15 kg/tree) and (298.14q/ha.) followed by variety Krishna (112.41 kg/tree) and (229.31q/ha.). While the lowest fruit yield per tree and per ha. was recorded in variety NA-9 (31.38 kg/tree) and (64.01 q/ha.).

It might be attributed to the fact the variety might be suited to eco-physiological conditions of the region which reflects in higher percentage of fruit set and comparatively lower fruit drop which ultimately reflects in maximum fruit yield.

The present results are inconformity with the finding of Panchbhai *et al.* (2004) when they studied the varietal performance of eight aonla varieties under Vidarbha conditions.

The Plant height showed highly positive relation with yield per hectare (Yield/ha = 166.4 Plant height - 602.8 R^2 = 0.407) (Fig.1A). The association of plant height was very high with yield. Similarly according to Lakade *et al.,*2011 in the study of guava genotypes, height of tree was highly significant and positively correlated with yield per hectare (0.825, 0.710) . Thimmappaiah *et al.* (1985) observed positive and significant association between height of tree with fruit yield in guava (*Psidium guajava*), respectively at genotypic as well as phenotypic level. Kumar *et al.* (2009) in 'Apple colour' Guava also found that fruit yield per plant showed positive and significant correlation with plant height (0.309) and number of fruits (0.932)suggesting that these characters are the most important yield contributors and that the effective improvement in yield can be achieved through selection based on these characters. Similar trend of positive and significant association of fruit yield with number of fruits was observed by Borthakur and Bhattacharya (1999) and Hegde (1993) in Guava. Yield per plant exhibited highly significant positive correlation with plant height (r = 0.522) and number of fruits per plant (r = 0.869) in Papaya (Jambhale *et al.,2014*).

The data reveals that there was significant difference in plant volume of different aonla varieties (Table 1). The maximum plant volume was recorded in variety Francis (46.4 m^3) which was found at par with NA-7 (43.67 m^3), NA-10(43.1 m^3), Chakaiya (42.84 m^3) and Krishna (41.42 m^3), whereas the variety NA-9 recorded the minimum plant volume (28.99 m^3).

The present results are in harmony with Patil *et al.* (2010) noted maximum plant volume in variety Francis in their experiment on eight aonla cultivars at RFRS, Katol conditions and noted maximum plant volume in the variety Francis (43.13 m^3).

The Plant volume of different aonla varieties differed significantly but the does not have strong association with the yield per hectare (Yield/ha = 7.482 Plant volume - 125.0

R^2 = 0.416) (Fig.1B). The tree volume exhibited highly significant and positive correlation with the yield per hectare (0.949, 0.881) at genotypic and phenotypic level, respectively (Lakade *et al.,* 2011.)

Yield Attributes

Table1: Performance of different aonla varieties in respect of different growth, yield and quality parameters

Varieties	Flowering duration (Days)	Fruit per branch	Fruit weight (g)	Fruit volume (cm^3)	Pulp weight (g)	Average seed weight (g)	Pulp: seed ratio	Total Soluble Solids (ºB)	Titratable Acidity (%)	Ascorbic acid content (mg/100g mass)	Fruit yield	
											Per tree (kg)	Per ha (q.)
Krishna	24	953.25	29.96	23.33	28.06	1.90	14.79	6.56	1.64	535.00	112.41	229.31
NA-10	26	822.50	26.03	22.70	24.36	1.66	14.62	6.86	1.80	494.18	85.58	174.58
Francis	27	520.00	44.43	36.66	42.06	2.36	17.92	11.4	1.89	524.21	92.56	188.82
NA-7	23	1065.00	34.30	34.60	32.20	1.76	16.51	6.8	1.92	537.72	146.15	298.14
Chakaiya	19	463.33	30.23	23.43	28.43	1.80	15.69	8.36	1.81	535.38	55.83	113.89
Banarasi	22	542.50	30.60	23.76	28.83	2.10	15.38	7.23	1.91	513.05	66.38	135.41
NA.9	25	323.33	24.26	18.66	21.56	2.70	8.00	9.53	1.81	482.66	31.38	64.01
CD at 5 %	2.54	36.54	3.21	3.02	3.00	0.34	2.26	1.29	0.10	8.16	12.57	25.64

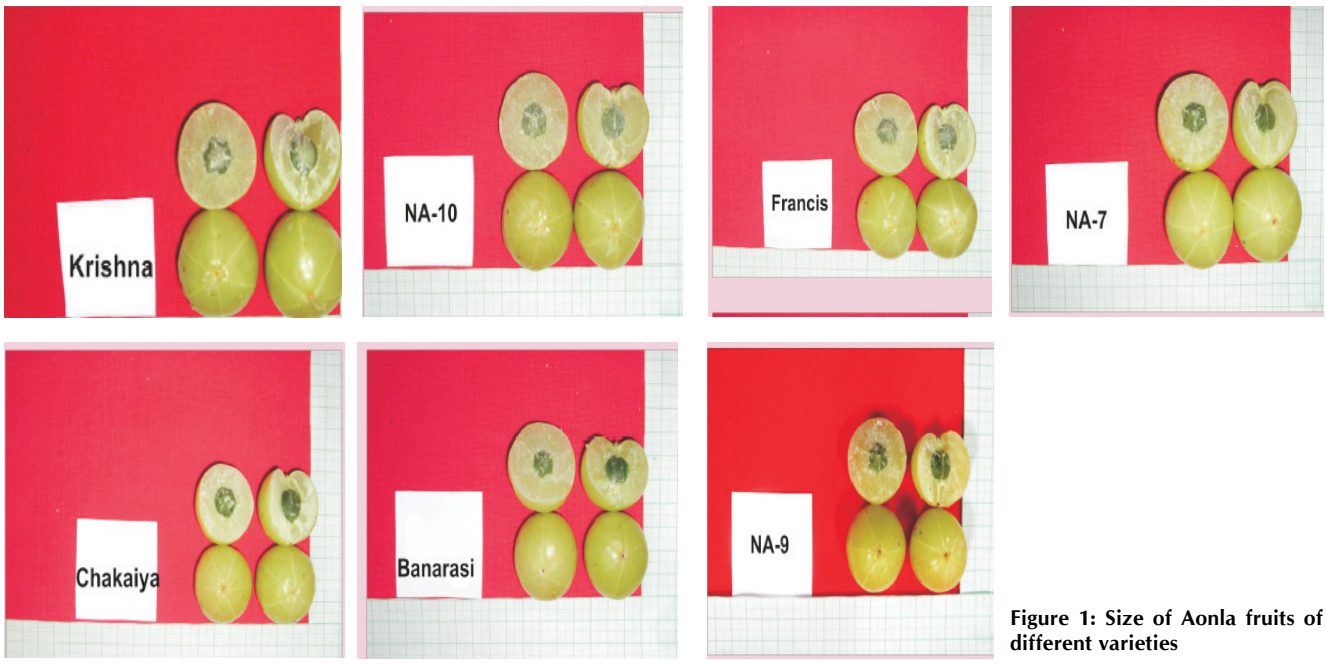

Figure 1: Size of Aonla fruits of different varieties

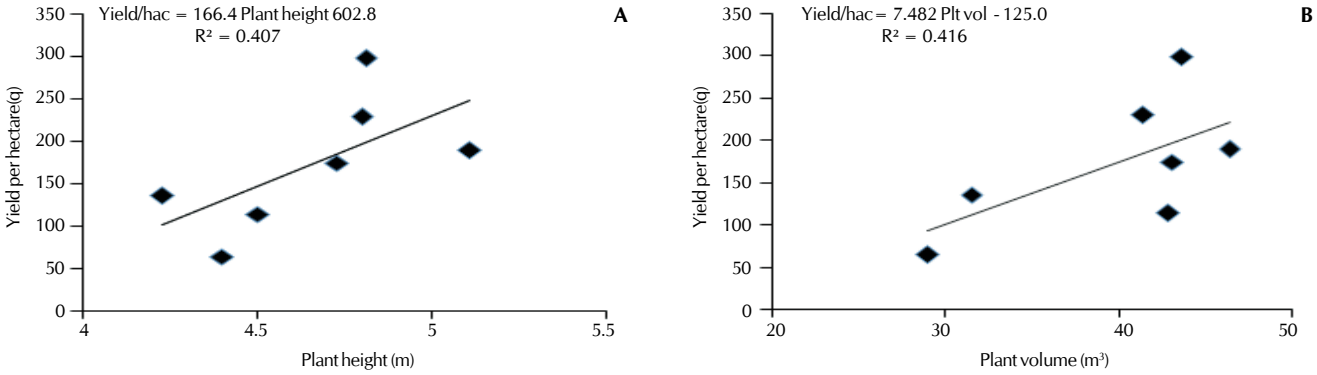

Figure 1: Relationships of, (A) Yield per hectare (q) vs. Plant height (m), (B) Yield per hectare (q) vs. Plant volume (m^3)

Significantly maximum number of fruit per branch recorded in variety NA-7 (1065 fruit/branch) which followed by Krishna (953.25 fruit/branch), NA-10 (822.50 fruit/branch), whereas minimum number of fruit per branch was observed in NA-9 (323.33 fruit/branch). Significantly maximum fruit weight was recorded in variety Francis (44.43 g) followed by variety NA-7 (34.30 g) and Banarasi (30.60 g) while minimum fruit weight was found in variety NA-9 (24.26 g).

The correlation studies for yield per hectare showed positive relation with number of fruits per branch (Yield/ha = 0.256 fruit per branch + 0.530,R^2 = 0.842), Fruit weight(Yield/ha = 5.177Fruit weight + 9.450 R^2 = 0.195), Flowering duration (Yield/ ha= 4.266Flower duration + 70.85 R^2 = 0.022)and fruit volume (Yield/ha = 7.849 fruit volume - 33.32,R^2 = 0.465).(Fig 2C,D,E,F) Similarly in Guava as reported by Lakade *et al.,* 2011 the correlation of number of fruits per tree was highly significant and positive with the yield per hectare (0.846, 0.844), respectively at genotypic and phenotypic level. The positive association of number of fruits per tree with fruit yield and weight of fruit showed positive correlation with yield per hectare (0.475, 0.456). Singh *et al.,* 2004 conducted the studies on correlation and path analysis of mango abstracted that yield per plant was positively and significantly associated with fruit weight. Volume of fruit was positively correlated with yield per hectare (0.482, 0.461) at both the levels was observed by Thimmappaiah *et al.*, (1985) in Guava. Yield per plant exhibited highly significant positive correlation with average fruit weight (r = 0.772) and pulp to seed ratio (r = 0.503) (Jambhale *et al.,* 2014). Significant correlation with total yield could be recorded in case of duration of rainy season flowering (r=0.85) and duration of winter season flowering (r=0.81) by Jana *et al.*, 2015.

The significant variation in the number of fruit per branch might be due to varietal response to the climatic conditions. The above results are in agreement with finding of Rao and Subramanyam (2009) in the study conducted at Anantapur, Andhra Pradesh they observed that maximum number of fruit per plant in variety NA-10.

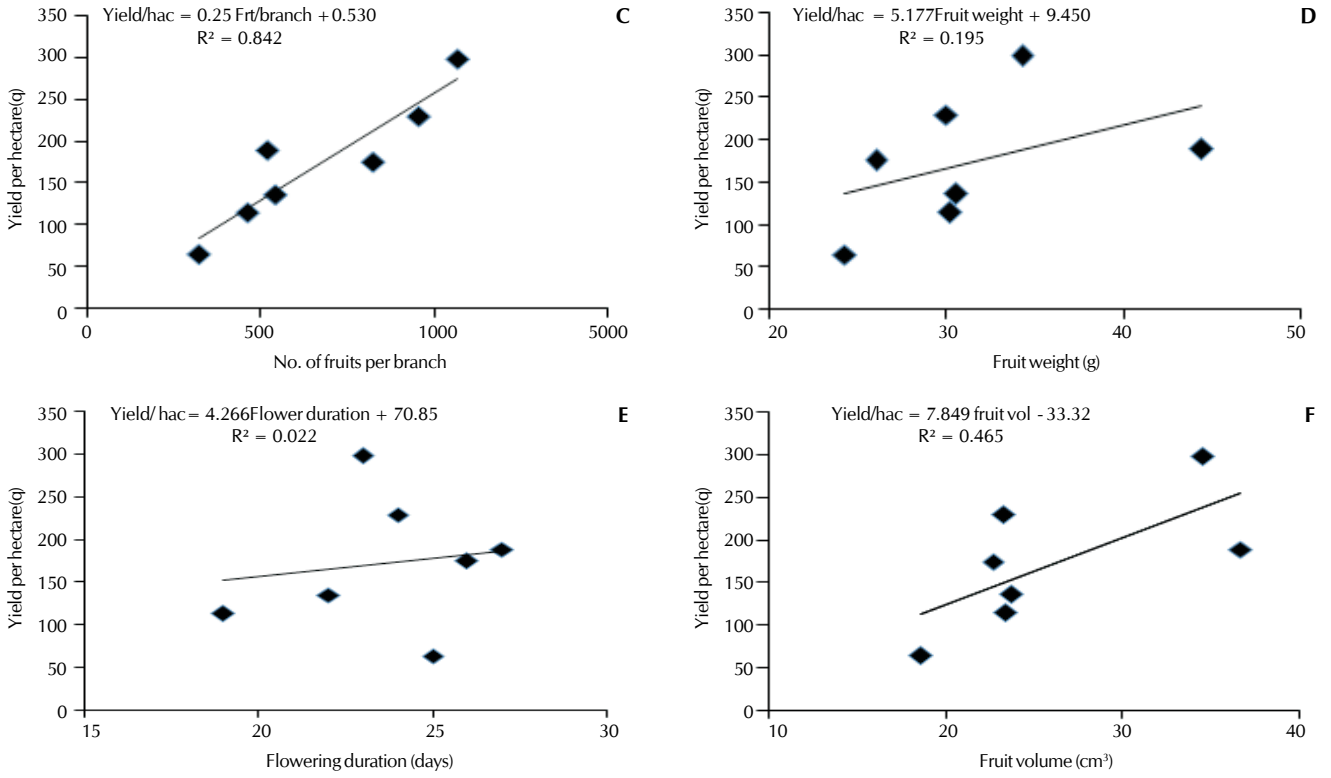

Figure 2: Relationships of, (C) Yield per hectare (q) vs. No. of Fruits per branch (D) Yield per hectare (q) vs. Fruit weight(g) (E) Yield per hectare (q) vs. Flowering Duration (Days) (F) Yield per hectare (q) vs. Fruit Volume (cm³)

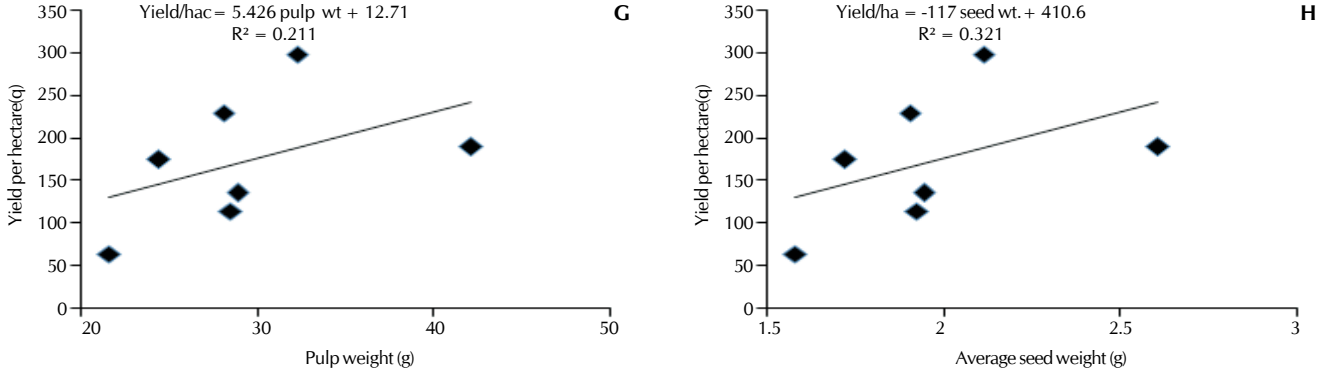

Figure 3: Relationships of, (G) Yield per hectare (q) vs. Pulp weight (g), (H) Yield per hectare (q) vs. Average Seed weight (g)

Variability in fruit weight might possibly be due to varietal character and suitability of varieties to climatic conditions. The present results are in according to findings of Kumar and Singh (2013) when they evaluated the ten aonla cultivars and reported fruit weight varied from 29.5 to 46.4 g in different aonla cultivars. Similarly Krishnamoorthy (2009) studied the performance of different varieties of aonla under sodic soil and recorded maximum fruit weight in variety NA-7.

The data pertaining to fruit volume presented in Table1 showed significant variation for fruit volume. Significantly higher fruit volume was recorded in the Francis variety (36.66 cm^3) which was at par with variety NA-7 (34.60 cm^3), whereas lower fruit volume was observed in variety NA-9 (18.66 cm^3). Results are in close conformity with the findings of Kumar *et al*. (2011) when they conducted the performance of aonla cultivars for yield and physico-chemical properties eight aonla cultivars reported that, maximum fruit volume observed in cv. Krishna (35.83 cm^3) and minimum in cv. BSR-1 (20.17 cm^3).

Quality attributes

The data presented in Table 1 showed that the variety Francis showed the significantly maximum average pulp weight (42.06 g) followed by variety NA-7 (32.2 g), whereas minimum average pulp weight was recorded in variety NA-9 (21.56 g). Significantly minimum average seed weight was observed in variety NA-10(1.66 g) which was found at par with NA-7 (1.76), Chakaiya (1.80 g) and Krishna (1.90 g) whereas maximum seed weight

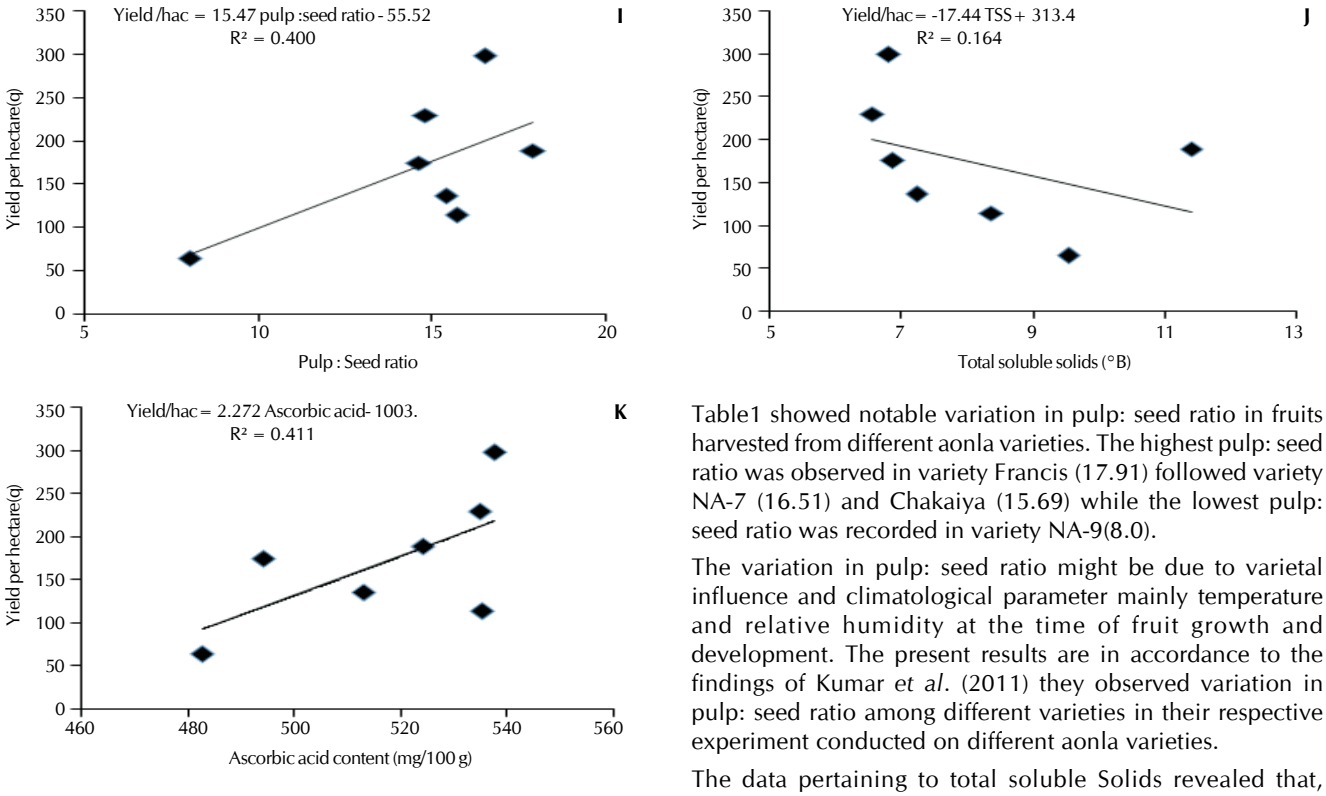

Figure 4: Relationships of, (I) Yield per hectare (q) vs. Pulp:Seed ratio, (J) Yield per hectare (q) vs. Total Soluble Solids (°B) (K) Yield per hectare (q) vs. Pulp: Seed ratio

was in variety NA-9(2.7 g).

This difference in weight of seed content might be due to genetic characteristics of the variety. The variation in average pulp weight might be due to the varietal character and also the prevailing weather conditions at the time of fruit development stage of respective variety.

The results of present investigation are in similar line with the findings of Rao and Subramanyam (2009) maximum pulp weight was recorded in cv.NA-7 and lowest in cv. Chakaiya. However minimum seed weight in cv. Chakaiya (1.44 g) followed by NA-10 (1.62 g) in their experiment conducted on aonla.

Yield per hectare showed significant positive correlation with weight of pulp (Yield/ha = 5.426 pulp weight + 12.71R^2 = 0.211)(Fig 3G) and pulp: seed ratio (yield /ha = 15.47 pulp: seed ratio -55.52R^2 = 0.400) whereas it shows negative correlation with average seed weight (yield/ha = -117 seed weight + 410.6 R^2 = 0.321) (Fig 4I).The results are in conformity with Lakade *et al.,*2011 in his correlation studies in Guava reported that weight of pulp was positively correlated with yield per hectare (0.481. 0.460) at both the level. Pulp: seed ratio had highly significant and positive correlation with the yield per hectare (0.980, 0.901) at genotypic and phenotypic level. However weight of seeds per fruit showed negative correlation with yield per hectare (-0.0.75, -0.092) at genotypic as well as phenotypic levels.

The data pertaining to average pulp: seed ratio presented in Table1 showed notable variation in pulp: seed ratio in fruits harvested from different aonla varieties. The highest pulp: seed ratio was observed in variety Francis (17.91) followed variety NA-7 (16.51) and Chakaiya (15.69) while the lowest pulp: seed ratio was recorded in variety NA-9(8.0).

The variation in pulp: seed ratio might be due to varietal influence and climatological parameter mainly temperature and relative humidity at the time of fruit growth and development. The present results are in accordance to the findings of Kumar *et al*. (2011) they observed variation in pulp: seed ratio among different varieties in their respective experiment conducted on different aonla varieties.

The data pertaining to total soluble Solids revealed that, significant variation exists in TSS of aonla fruits harvested from different varieties. The significantly highest T.S.S. was found in variety Francis (11.4 ºB), which was followed by variety NA-7 (9.53 ºB), Chakaiya (8.36ºB) and Banarasi (7.23ºB). While the lowest TSS was observed in variety Krishna (6.56ºB). The variation in TSS in present study might be due to the varietal character and weather condition at the time of maturity and harvesting of fruits. Significantly maximum titratable acidity was observed in variety NA-7 (1.92 %) which was found at par with Banarasi (1.91 %) and Francis (1.89 %) whereas the minimum acidity was found in variety Krishna (1.64 %) (Table 1).

Results in close conformity with the findings of Jaiswal *et al.* (2007) they observed minimum TSS in variety NA-10 while, maximum in variety NA-7 and recorded highest acidity in cultivar NA-7 followed by Chakaiya and NA-10 while Kumar *et al*. (2011) reported the highest TSS in cv.BSR-1 (14°B) and lowest in cv. Krishna (7.60°B).

The data presented in Table 1 showed that maximum ascorbic acid (537.72 mg/100 g) was found in variety NA-7 which was at par with variety Chakaiya (535.38 mg/100 g) and variety Krishna (535 mg/100 g) while the lowest ascorbic acid content was recorded in variety NA-9 (482.66 mg/100 g).

Wide range of variation in ascorbic acid contents might be due to differences in cultivars, location and weather condition at the time of harvesting. The present results are in agreement with the Jaiswal *et al.* (2007), Yadav and Yadav (2010) and Dhaliwal *et al.* (2012) in aonla.

Yield per hectare exhibited significant but negative correlation with TSS (yield/ha = -17.44 TSS + 313.4 R^2 = 0.164), Acidity (yield/ha = 32.11 Acidity + 113.3 R^2 = 0.001)and ascorbic acid (yield/ha = 2.272 ascorbic acid -1003. R^2 = 0.411) (Fig

4J,K)The results are in agreement with finding of Lakade *et al.,*2011 in Guava., T.S.S. exhibited significant and positive correlation with the yield per hectare (0.641, 0.611) at both the levels. Acidity also showed highly significant but negative correlation with the yield per hectare (-1.129, -0.712) at genotypic and phenotypic level. Ascorbic acid exhibited highly significant and positive correlation with yield per hectare (0.887, 0.884) at genotypic and phenotypic level. Similarly Singh *et al.,* 2004 in mango reported that Percent acidity was negatively but non significantly associated with all the traits.

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