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Performance of different pruning methods, GA_3 application and transplant densities on quality attributes of *rabi* onion (*Allium cepa* L.) under Chhattisgarh plains

Nisha Jangre, Vijay Kumar, Rajshree Gayen and SS Porte

Abstract
A field trial was carried out at farm of Sant Kabir College of Agriculture and Research Station, Kawardha (C.G.) to assess the quality parameters of *rabi* onion as influenced by seedling pruning, Gibberellic acid and transplant densities during *rabi* season 2017-18 and 2018-19 under Chhattisgarh plains. The treatments comprised of 24 treatments which include four methods of pruning (*i.e.* no pruning, leaf pruning, root pruning and leaf and root pruning), two level of GA_3 (without GA_3 application and GA_3 at 150 ppm) and three level of transplant densities (20 x 15 cm, 20 x 10 cm and 15 x 10 cm). Among the seedling pruning, the quality parameters was recorded significantly higher under P_1 *i.e.* (leaf pruning) during both the year *i.e.* Total Soluble Solids (12.72 and 12.76 Brix^o), Sulphur content in bulb (8.44% and 8.42%), Chlorophyll content "a" (0.54 and 0.57) and "b" (0.67 and 0.78). Among GA_3 application the quality parameters was recorded significantly higher under G_1 *i.e.* (GA_3 150 ppm) during both the year *i.e.* Total Soluble Solids (12.36 and 12.40 Brix^o), Sulphur content in bulb (8.63 and 8.51%), Chlorophyll content 'a' (0.50 and 0.51) and 'b' (0.60 and 0.64). Among transplant densities the quality parameters was recorded significantly higher under D_1 *i.e.* (20 x 15 cm) during both the year *i.e.* Total Soluble Solids (12.14 and 12.12 Brix^o), Sulphur content in bulb (8.07 and 8.01%), Chlorophyll content "a" (0.48 and 0.50) and 'b' (0.55 and 0.62). Where in case of interaction the treatment $P_1G_1D_1$ *i.e.* (leaf pruning, 150 ppm GA_3 and 20 x 15 cm spacing) recorded maximum value during both the year on the basis of mean data.

Keywords: *Allium cepa*, pruning methods, GA_3, *rab*i onion

Introduction
Onion (*Allium cepa* L.) belongs to the family Alliaceae, genus Allium. It is important bulb crop and cultivated as a cool season vegetable crop. It is valued for its green leaves, immature and mature bulbs. The onion is preferred mainly because of its green leaves, immature and mature bulbs are either eaten raw or cooked as a vegetable. Onion is used as raw salad, bulbs and leaves are used as vegetable, pickle, culinary, soups, cooked, fried and dried or roasted as vegetable cum spice. The volatile oil allyl-propyl-disulphide ($C_6H_{12}S_2$) is responsible for odour, pungency and flavour in bulb whereas the colour of the outer skin of onion bulbs is due to quercetin (Augusti, 1990 and Hanley and Fenurick, 1985) [1, 4]. Onion has many uses as folk medicine and recent reports suggests that onion plays an important role in preventing heart diseases and other ailments (Augusti, 1990) [1]. Pruning is the direct way of orienting different parts of the plant for providing and dispersal of food materials into foliage or reproductive mechanism (Gardner, 1966) [3]. Pruning is done mainly for balancing and influencing the nutrients and hormones. More nutrients and hormones are transported to the plant and they produce bigger, heavier and healthy bulb and seeds. Pruning associated with proper age of seedling is an important factor for successful onion production. GA_3 is one of the important growths stimulating substances which promote cell elongation and cell division thus help in the growth and development of many plants. However, the improvement in the yield and quality of the crops mainly depends on the concentration of plant growth regulator and time of application (Singh, 1995) [8]. Plant densities influence the plant growth, bulb size, yield and also the quality of the product (Purewal and Dargan, 1962 [6]; Badarudin and Haque, 1977 [2] and Rahim *et al.*, 1983) [7]. The total bulb yield can be maximizing as plant population increases (Kantona *et al.*, 2003) [5]. Therefore, the present investigation was carried out to study the effect of seedling pruning, Gibberellic acid (GA_3) and transplant densities on quality

Attributes of onion in Chhattisgarh.

Materials and Methods

The experiment was conducted at farm of Sant Kabir College of Agriculture and Research Station, Kawardha (C.G.) during Rabi season 2017-18 and 2018-19. The experiment was design in Factorial Randomize Block Design (FRBD) with three replication, keeping four pruning level *i.e.* (no pruning, leaf pruning, root pruning and leaf and root pruning), two level of GA_3 (without GA_3 application and GA_3 at 150 ppm) and three level of transplant densities (20 x 15 cm, 20 x 10 cm and 15 x 10 cm).

Quality parameters

The quality parameters of onion *i.e.* TSS content in bulb, Sulphur content in bulb and chlorophyll 'a' and 'b' content in leaf are described with the help of data given in table 1-2 and shown in fig 1 to 4.

T.S.S. (Brix^o) content in onion bulb

The data pertaining to TSS (Brix^o) content in onion bulb were estimated from matured bulb by ERMA hand refractometer and data were presented in table 1, 2 and fig 1.

Response of pruning

The result observed that significant difference among different pruning methods during first and second year and pooled mean. The maximum TSS content was recorded under the P_1 *i.e.* Leaf pruning (12.72, 12.79 and 12.76 Brix^0) in first, second year and pooled mean on the basis of mean data. The minimum value of Total Soluble Solids recorded in P_0 *i.e.* no pruning (11.45, 11.46 and 11.46 Brix^0, respectively) in first, second year and pooled mean.

Response of GA_3

The treatment G_1 *i.e.* GA_3 at 150 ppm recorded significantly higher the total soluble solids (12.43, 12.36 and 12.40 Brix^0) in first, second year and pooled mean. However, the lower the Total Soluble Solids was noted under treatment G_0 *i.e.* no GA_3 (11.55, 11.70 and 11.63 Brix^0) in respective years and on the basis of mean data.

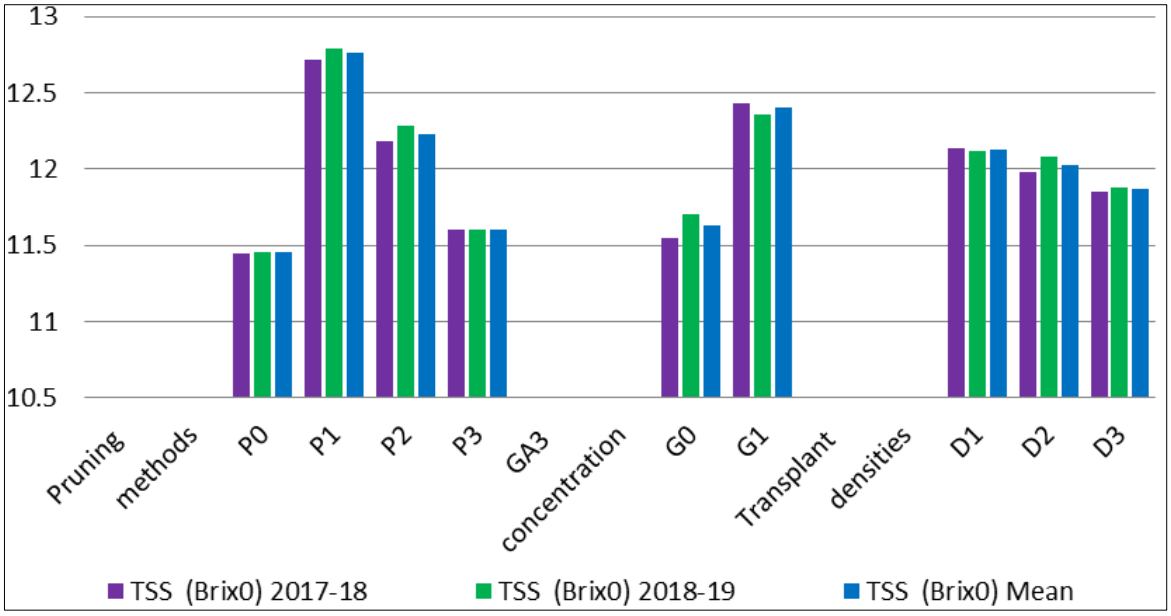

Fig 1: Effect of seedling pruning, GA_3 and transplant densities on TSS (Brix^0), in onion Response of transplant densities

Among transplant densities, treatment D_1-20 x 15 cm recorded significantly higher the Total Soluble Solids (12.14, 12.12 and 12.13 Brix^0) in bulbs respectively in first, second year and pooled mean. However, minimum TSS (11.85, 11.88 and 11.87 Brix^0 respectively) in bulb was recorded in treatment D_3-15 x 10 in first, second year and pooled mean.

Response of interaction effects

The interactions effect among ($P_1G_1D_1$) *i.e.* P_1-leaf pruning X G_1- GA_3 150 ppm X D_1-20 x 15 noticed highest value (13.16, 13.32 and 13.24 Brix^0 respectively) in first, second year and pooled mean, followed by ($P_1G_1D_2$) P_1-leaf pruning X G_1-GA_3 150 ppm X D_2-20 x 10 (13.10, 13.15 and 13.13 Brix^0 respectively).

Sulphur content in bulb (%)

The parameter measured was elemental Sulphur content of the onion bulbs and data were presented in table 1, 2 and fig. 2.

Response of pruning

The results stated that P_1 *i.e.* Leaf pruning has highest value of Sulphur content (8.44%, 8.42% and 8.43% respectively) in first, second year and pooled mean, followed by root pruning. The minimum value of Sulphur recorded in P_0 *i.e.* no pruning (7.19%, 7.06% and 7.13% respectively) in first, second year and pooled mean.

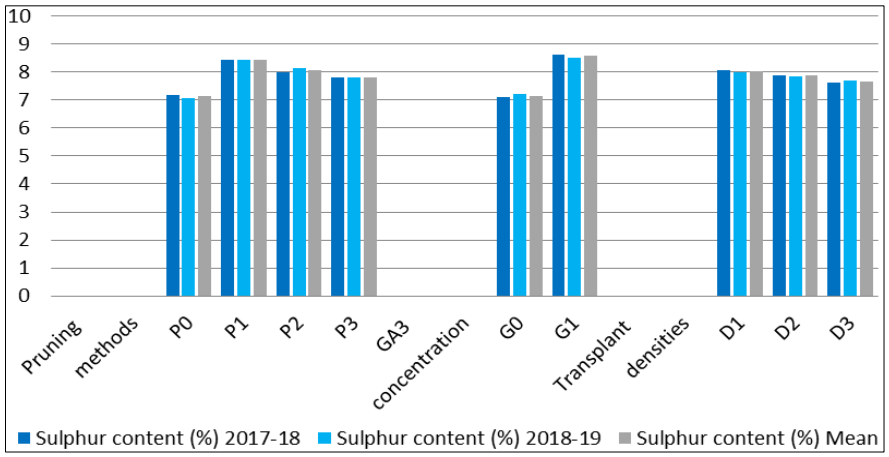

Fig 2: Effect of seedling pruning, GA_3 and transplant densities on sulphur content (%) in onion

Response of GA_3

Perusal of data indicated that treatment G_1 *i.e.* GA_3 at 150 ppm recorded significantly higher Sulphur content (8.63%, 8.51% and 8.57%) in first, second year and pooled mean. However, the lower Sulphur content was noted under treatment G_0 *i.e.* no GA_3 (7.09%, 7.20% and 7.15% respective) in first, second year and pooled mean. The result of the finding can be supported by Singh *et al.* (2013) [9] who reported maximum allyl propyl disulphide at higher concentration of GA_3. Abd El Gawad *et al.* (1986) [10] have reported that Gibberellic acid slightly increased pungency in onion bulbs.

Response of transplant densities

Treatment D_1-20 x 15 cm recorded significantly mximum Sulphur content (8.07%, 8.01% and 8.04% respectively) in first, second year and pooled mean. However, the minimum Sulphur content (7.63%, 7.70% and 7.67% respectively) in bulb was recorded in treatment D_3-15 x 10 cm in first, second year and pooled mean.

Response of interaction effects

The perusal of data revealed that the treatment ($P_1G_1D_1$) *i.e.* P_1-leaf pruning X G_1- GA_3 150 ppm X D_1-20 x 15 cm produced maximum Sulphur content (9.34%, 9.36% and 9.35% respectively) bulbs followed by interactions among P_1-leaf pruning X G_1- GA_3 150 ppm X D_2-20 x 10 cm (9.22%, 9.31% and 9.27% respectively) most of the treatment combination significantly increased the Sulphur content in bulb over the two years.

Chlorophyll content (a & b)

Chlorophyll content was expressed in mg per g of fresh weight by using formula (Arnon, 1949) [13]. Data were presented in table 1, 2 and fig. 3, 4.

Response of pruning

The results stated that P_1 *i.e.* Leaf pruning has highest chlorophyll content 'a' (0.54, 0.57 and 0.56 respectively) and "b" (0.67, 0.78 and 0.73, respectively) in first, second year and pooled mean. The minimum chlorophyll content 'a' recorded in P_0 *i.e.* no leaf and root pruning (0.38, 0.40 and 0.39, respectively) and 'b' (0.37, 0.45 and 0.41, respectively) in first, second year and pooled mean.

Table 1: Effect of seedling pruning, Gibberellic acid and transplant densities on Total Soluble Solids (Brix0), Sulphur content in bulb (%), Chlorophyll content 'a' and Chlorophyll content 'b' in onion

Treatment	Total Soluble Solids (Brix^0)			Sulphur content in bulb (%)			Chlorophyll content 'a'			Chlorophyll content 'b'		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
Pruning methods												
P_0	11.45	11.46	11.46	7.19	7.06	7.13	0.38	0.40	0.39	0.37	0.45	0.41
P_1	12.72	12.79	12.76	8.44	8.42	8.43	0.54	0.57	0.56	0.67	0.78	0.73
P_2	12.18	12.28	12.23	8.00	8.13	8.07	0.44	0.46	0.45	0.53	0.59	0.56
P_3	11.60	11.60	11.60	7.81	7.80	7.81	0.41	0.44	0.43	0.44	0.51	0.48
SE±	0.14	0.16	0.15	0.08	0.08	0.08	0.14	0.02	0.08	0.01	0.007	0.01
CD (5%)	0.42	0.46	0.44	0.23	0.24	0.24	0.04	0.06	0.05	0.03	0.020	0.03
Gibberellic acid concentration												
G_0	11.55	11.70	11.63	7.09	7.20	7.15	0.38	0.42	0.40	0.41	0.50	0.46
G_1	12.43	12.36	12.40	8.63	8.51	8.57	0.50	0.51	0.51	0.60	0.67	0.64
SE±	0.10	0.11	0.11	0.06	0.06	0.06	0.01	0.01	0.01	0.01	0.005	0.01
CD (5%)	0.29	0.32	0.31	0.16	0.17	0.17	0.03	0.04	0.04	0.03	0.014	0.02
Transplant densities												
D_1	12.14	12.12	12.13	8.07	8.01	8.04	0.48	0.50	0.49	0.55	0.62	0.59
D_2	11.98	12.08	12.03	7.89	7.85	7.87	0.44	0.46	0.45	0.50	0.59	0.55
D_3	11.85	11.88	11.87	7.63	7.70	7.67	0.41	0.44	0.43	0.46	0.54	0.50
SE±	0.13	0.14	0.14	0.07	0.07	0.07	0.01	0.01	0.01	0.03	0.006	0.02
CD (5%)	0.36	0.40	0.38	0.20	0.21	0.21	0.03	0.05	0.04	0.07	0.018	0.04

P_0 - (No pruning), P_1 -LP (Leaf pruning), P_2- RP (Root Pruning), P_3- LP+R (Leaf + Root Pruning), G_0 - (No GA3 spray), G_1- (GA3 150 ppm), D_1 - (20X15cm), D_2 - (20X10cm), D_3 - (15x10 cm)

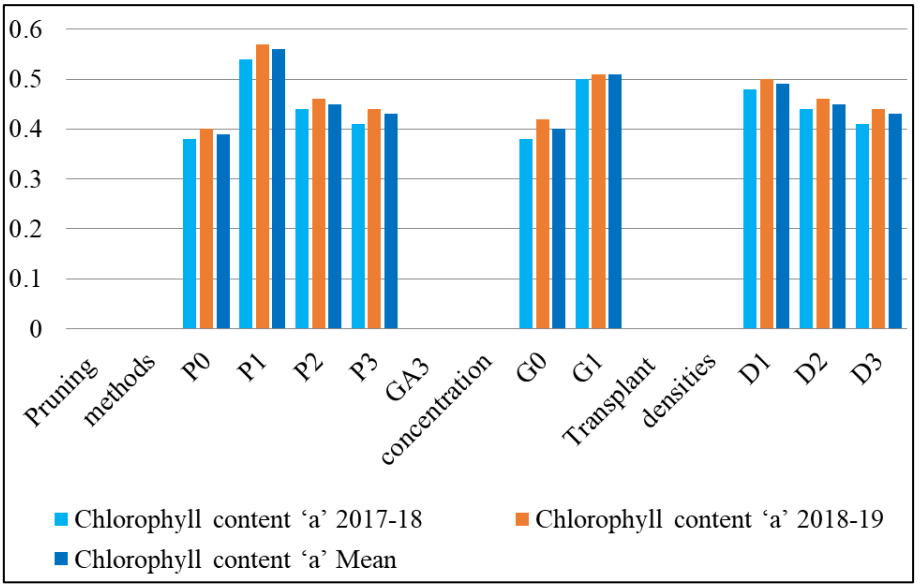

Fig 3: Effect of seedling pruning, GA_3 and transplant densities on Chlorophyll content 'a' in onion

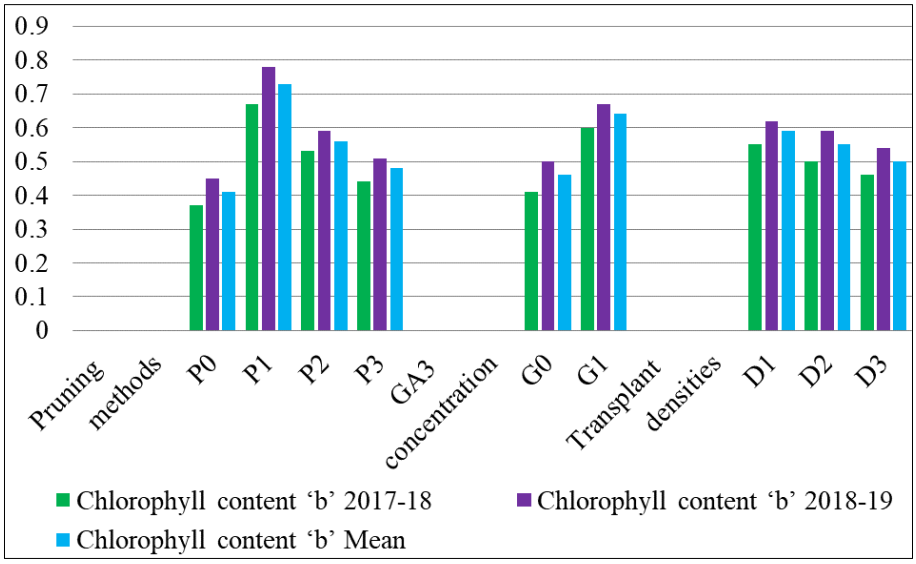

Fig 4: Effect of seedling pruning, GA_3 and transplant densities on Chlorophyll content 'b' in onion

Table 2: Interaction effect of seedling pruning, Gibberellic acid and transplant densities on Total Soluble Solids (Brix0), Sulphur content in bulb (%), Chlorophyll content 'a' and Chlorophyll content 'b' in onion

Treatment	Total Soluble Solids (Brix^0)			Sulphur content in bulb (%)			Chlorophyll content 'a'			Chlorophyll content 'b'		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
$P_0G_0D_1$	10.98	11.16	11.07	6.95	6.96	6.96	0.35	0.37	0.36	0.31	0.41	0.36
$P_0G_0D_2$	10.57	10.98	10.78	6.12	6.76	6.44	0.33	0.35	0.34	0.28	0.36	0.32
$P_0G_0D_3$	10.46	10.76	10.61	6.10	6.33	6.22	0.31	0.33	0.32	0.25	0.34	0.30
$P_0G_1D_1$	12.50	12.11	12.31	7.50	7.64	7.57	0.45	0.47	0.46	0.49	0.55	0.52
$P_0G_1D_2$	12.16	11.99	12.08	7.25	7.38	7.32	0.42	0.44	0.43	0.47	0.53	0.50
$P_0G_1D_3$	12.01	11.73	11.87	7.21	7.27	7.24	0.40	0.42	0.41	0.45	0.51	0.48
$P_1G_0D_1$	12.65	12.69	12.67	7.96	7.61	7.79	0.53	0.56	0.55	0.63	0.72	0.68
$P_1G_0D_2$	12.44	12.59	12.52	7.75	7.58	7.67	0.48	0.53	0.51	0.60	0.70	0.65
$P_1G_0D_3$	12.42	12.45	12.44	7.45	7.48	7.47	0.45	0.52	0.49	0.58	0.67	0.63
$P_1G_1D_1$	13.16	13.32	13.24	9.34	9.36	9.35	0.65	0.66	0.66	0.84	0.86	0.85
$P_1G_1D_2$	13.10	13.15	13.13	9.22	9.31	9.27	0.57	0.59	0.58	0.71	0.83	0.77
$P_1G_1D_3$	12.52	12.55	12.54	8.95	9.19	9.07	0.54	0.56	0.55	0.66	0.78	0.72
$P_2G_0D_1$	11.93	12.01	11.97	7.22	7.55	7.39	0.40	0.42	0.41	0.46	0.52	0.49
$P_2G_0D_2$	11.90	11.99	11.95	7.12	7.43	7.28	0.36	0.38	0.37	0.43	0.51	0.47
$P_2G_0D_3$	11.89	11.96	11.93	7.11	7.35	7.23	0.33	0.35	0.34	0.41	0.48	0.45
$P_2G_1D_1$	12.52	12.72	12.62	9.08	9.01	9.05	0.58	0.60	0.59	0.70	0.74	0.72
$P_2G_1D_2$	12.44	12.55	12.50	9.01	8.79	8.90	0.49	0.51	0.50	0.61	0.67	0.64

$P_2G_1D_3$	12.41	12.46	12.44	8.48	8.65	8.57	0.46	0.49	0.48	0.57	0.62	0.60
$P_3G_0D_1$	11.20	11.49	11.35	6.85	7.19	7.02	0.38	0.42	0.40	0.38	0.47	0.43
$P_3G_0D_2$	11.08	11.27	11.18	7.08	7.10	7.09	0.36	0.40	0.38	0.36	0.46	0.41
$P_3G_0D_3$	11.06	11.08	11.07	7.35	7.03	7.19	0.33	0.39	0.36	0.29	0.32	0.31
$P_3G_1D_1$	12.16	11.48	11.82	8.72	8.73	8.73	0.48	0.50	0.49	0.59	0.65	0.62
$P_3G_1D_2$	12.12	12.15	12.14	8.49	8.43	8.46	0.47	0.49	0.48	0.54	0.61	0.58
$P_3G_1D_3$	12.01	12.10	12.06	8.38	8.34	8.36	0.45	0.44	0.45	0.49	0.58	0.54
SE±	0.36	0.39	0.38	0.20	0.21	0.21	0.03	0.05	0.04	0.02	0.018	0.02
CD (5%)	1.02	1.13	1.08	0.57	0.60	0.59	0.09	0.15	0.12	0.07	0.050	0.06

Response of GA_3

Among Gibberellic acid, treatment G_1 *i.e.* GA_3 at 150 ppm recorded significantly higher chlorophyll content 'a' (0.50, 0.51 and 0.51) and "b" (0.60, 0.67 and 0.64, respectively) in first, second year and pooled mean. However, the lower chlorophyll content 'a' was noted under treatment G_0 *i.e.* no GA_3 (0.38, 0.42 and 0.40) and "b" (0.41, 0.50 and 0.46) in respective years and on the basis of mean data. Our observations indicated that there was increase in chlorophyll content due to foliar application of Gibberellic acid. This increase undoubtedly might have helped to improve the photosynthetic efficiency. The applications of growth regulators may prove beneficial for improvement of growth and productivity of economically important vegetable onion. Batra *et al.* (1992) [11] observed that foliar application of plant growth regulator which might have better penetration into leaves and increased the leaf chlorophyll content which increased in the photosynthetic rate and which in turn increased the growth of plants resulting in to higher yield attributes and yield than seed treatment method in potato. Similar findings have also been obtained by Tomar and Ramgiry (1992) [12].

Response of transplant densities

Among transplant densities, treatment D_1-20 x 15 cm recorded significantly higher chlorophyll content 'a' (0.48, 0.50 and 0.49, respectively) and 'b' (0.55, 0.62 and 0.59 respectively) in first, second year and pooled mean data. However, the lowest chlorophyll content 'a' (0.41, 0.44 and 0.43, respectively) and 'b' (0.46, 0.54 and 0.50, respectively) was recorded in treatment D_3-15 x 10 cm in first, second year and pooled mean.

Response of interaction effects

The interactions treatment ($P_1G_1D_1$**)** *i.e.* P_1-leaf pruning X G_1-GA_3 150 ppm X D_1- 20 x 15 produced maximum chlorophyll content 'a' (0.65, 0.66 and 0.66, respectively) and 'b' (0.84, 0.86 and 0.85, respectively). But chlorophyll 'a' was *at par* to interactions among P_1-leaf pruning X G_1- GA_3 150 ppm X D_2-20 x 10 (0.57, 0.59 and 0.58, respectively). The minimum chlorophyll content 'a' and 'b' was noticed under all planting densities without no pruning and GA_3 application.

Conclusion

On the basis of investigation the following conclusion are presented: Among the pruning methods, leaf pruning (P_1) perform better as compared to root pruning (P_2), leaf and root pruning (P_3) and no pruning(P_0). Where, among Ga3 application recorded maximum value as compared to without GA_3 application. Among transplant densities 20 x 15 cm recorded maximum value for quality parameters. However, interaction among leaf pruning, GA_3 @150 ppm and transplant densities of 20 x 10 cm recorded highest value in all quality parameters.

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