Madras Agric. J., 100 (4-6): 295-298, June 2013
https://doi.org/10.29321/MAJ.10.001293

Performance of Parents and Hybrids of Onion (*Allium cepa* L.) for Purple Blotch Disease and Yield

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The performance of parents and their hybrids in onion assessed at IIHR, Bangalore during July-2011 to May-2012. The parents used PBRC-337 (T_3),PBRC-339 (T_5) and PBRMS-319 (L_3) were found high yielding with 21.50, 20.33 and 20.67 total bulb yield tonnes per hectare respectively. The hybrids PBRMS-319 x PBRC-339 (L_3 x T_5) and PBRMS-318 x PBRC-338 (L_2 x T_4) recorded high yield of 27.40 and 26.33 total bulb yield tonnes per hectare respectively along with low PDI for purple blotch disease in onion. The hybrid PBRMS-319 x PBRC-339 (L_3 x T_5) was most promising for various traits which contribute to higher yield. Based on their performance these parents can be used for further breeding programme and promising hybrids could be explored for cultivation.

Key words: onion, hybrids, purple blotch disease, yield.

Onion (*Allium cepa* . L) belongs to family Alliaceae, is one of the most important bulbous vegetable crop cultivated extensively in India. India ranks first in area (1.06 million hectares) in the world and second in total production with 15.11 million tonnes after China (Anon., 2011). Maharashtra is leading state with an area 4.15 lakh hectare with the production 49.05 lakh tonnes and productivity of 11.8 tonnes per hectare (Anon., 2011). Even though India ranks first in area under onions in the world and second in production, its productivity is low (14.2 t/ ha) as against the world productivity of (17.47 t/ha). Among several factors, diseases are most important associated with low productivity in onion. Purple blotch caused by *Alternaria porri* is one among the serious fungal diseases that affects onion, causing yield loss ranging from 2.5 to 87.8 per cent during *kharif* season (Srivastava *et al.,* 1994). The disease can cause the yield loss of 30% (Everts and Lacy 1990) and 100% of the seed crop when the weather is favourable (Singh *et al.,* 1992; Havey 1996). At present there is no purple blotch disease resistant variety or hybrid in onion for commercial cultivation in India; hence there is need to breed a resistant variety, coupled with higher yield. With these points in view, performance of parents and hybrids for purple blotch disease, yield and yield attributing characters in onion were undertaken for varietal improvement and commercial purposes.

Materials and Methods

The present investigation was undertaken at the Division of Vegetable Crops, Indian Institute of Horticultural Research (IIHR), Hessaraghatta, Bangalore. The experimental field is located at an altitude of 890 meters above MSL, 13°58' N latitude and 78°E longitude. The parents and the hybrids were evaluated during the period between July-2011 to May-2012. The experimental material consists of four parents viz; PBRMS-317(L_1), PBRMS-318(L_2), PBRMS- 319(L_3) and PBRMS-379(L_4) used as lines and seven as testers namely PBRG-282(T_1), PBRG-285(T_2), PBRC-337(T_3), PBRC-338(T_4), PBRC-339(T_5), PBRC-340(T_6) and PBRC- 341(T_7). Line x Tester mating design was adopted to develop 28 hybrids by making crosses between lines and the testers during Kharif 2011. All the 28 hybrids along with their corresponding 11 parents were evaluated in a randomized block design in three replications during summer 2012. Observations on ten randomly selected plants were recorded for purple blotch disease incidence and various yield attributing traits to study the performance of parents and hybrids.

Results and Discussion

The *per se* performance of parents (Lines and Testers), hybrids and top three performing hybrids for different characters are presented (Table 1-3). Genotypes differed significantly among themselves for purple blotch disease incidence and it ranged from 14.00 (L_3) to 44.87 (L_2) per cent among the lines, 31.33 (T_3) to 78.33 (T_5) per cent among the testers (Table 1) and 15.00 (L_3 x T_5) to 21.00 (L_4 x T_2) per cent among the hybrids (Table 2). Lines, testers and hybrid combinations used in investigation differed significantly among themselves for ten bulb weight and it ranged from 201.33g (T_1) to 403.33g (T_3) among the testers and 365.00g (L_4) to 400.00g (L_2) among the lines (Table 1) and 241.67g (L_4 x T_2)

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Table 1. *Per se* performance of parents (Lines and Testers) for purple blotch disease, yield and yield attributing parameters

Parent	Purple blotch (PDI)	Plant height (cm)	No. of leaves / plant	Days to maturity	Bulb neck thickness (cm)	Ten bulb weight (g)	Polar bulb diameter (cm)	Equatorial bulb diameter (cm)	No. of rings/ bulb
LINES									
L_1	15.00	51.83	6.48	94.00	0.52	392.50	4.17	4.17	4.81
L_2	44.87	54.17	6.67	91.33	0.57	400.00	4.23	4.20	5.05
L_3	14.00	55.50	6.75	89.00	0.54	395.00	4.30	4.47	5.03
L_4	18.00	47.33	5.8	94.67	0.57	365.00	4.23	4.10	5.53
SEm±	0..21	0.14	0.003	0.24	0.31	0.97	0.020	0.017	0.034
CD@5%	15.53	1.15	0.27	1.74	0.66	8.99	0.15	0.14	0.25
CD@1%	20.12	1.53	0.36	2.13	0.88	11.87	0.20	0.18	0.33
TESTERS									
T1	73.33	36.00	5.85	77.00	0.33	201.33	2.83	2.93	4.89
T2	32.00	51.00	5.65	90.00	0.53	375.00	4.23	4.10	5.47
T3	31.33	53.00	6.85	90.00	0.55	403.33	4.33	4.20	5.43
T4	74.67	41.33	4.85	90.33	0.53	380.00	4.37	4.07	4.88
T5	78.33	40.40	5.10	89.33	0.51	370.00	3.97	3.97	5.70
T6	78.33	45.53	5.18	86.00	0.51	365.00	4.10	3.73	4.90
T7	64.00	49.17	5.30	89.00	0.46	350.00	4.00	3.80	4.91
SEm±	0.28	0.19	0.05	0.32	0.004	1.28	0.026	0.022	0.045
CD@5%	15.15	1.15	0.27	1.74	0.66	8.99	0.15	0.14	0.25
CD@1%	20.12	1.53	0.36	2.13	0.88	11.87	0.20	0.18	0.33

Table 1. (Cont..) *Per se* performance of parents (Lines and Testers) for purple blotch disease, yield and yield attributing parameters

Parent	No. of centers/ bulb	Total bulb yield (t/ha)	Marketable bulb yield (t/ha)	Unmarketable bulb yield (t/ha)	Per cent split bulbs	Per cent rotten bulbs	Per cent sprout bulbs	Total soluble solids (%)	% dry matter content
LINES									
L_1	1.25	18.00	15.83	2.20	10.00	9.50	9.50	11.00	9.00
L_2	1.10	18.37	16.17	2.20	8.00	8.00	9.00	10.83	8.83
L_3	1.08	20.67	18.67	2.00	8.20	7.50	8.75	10.17	8.27
L_4	1.10	19.00	15.33	3.77	8.23	11.67	10.50	9.50	7.20
SEm±	0.01	0.11	0.10	0.046	0.12	0.11	0.10	0.05	0.06
CD@5%	0.14	0.92	0.78	0.42	1.0	0.90	0.84	0.64	0.60
CD@1%	0.18	1.22	1.04	0.56	1.33	1.20	1.11	0.85	0.80
TESTERS									
T1	1.15	15.00	9.00	6.00	14.50	15.00	13.17	14.83	15.00
T2	1.15	17.93	15.83	2.00	8.00	9.50	9.67	9.33	8.00
T3	1.17	21.50	18.27	2.90	6.00	11.50	13.20	9.67	8.23
T4	1.02	19.90	16.20	3.83	10.33	12.13	10.00	9.00	7.93
T5	1.08	20.33	16.50	3.77	8.67	13.30	10.83	9.23	8.37
T6	1.27	18.27	14.42	4.00	11.00	14.47	11.60	9.00	7.33
T7	1.17	17.47	14.90	2.57	10.57	12.50	10.17	9.10	8.00
SEm±	0.02	0.15	0.14	0.62	0.16	0.15	0.13	0.07	0.08
CD@5%	0.14	0.92	0.78	0.42	1.0	0.90	0.84	0.64	0.60
CD@1%	0.18	1.22	1.04	0.56	1.33	1.20	1.11	0.85	0.80

to 427.00g (L_2 x T_4) among the hybrids (Table 2). These parameters are important for contributing the total yield. Similar findings were reported by Gowda (1988) and Evoor *et al.* (2007).

The genotypes differed significantly among themselves for equatorial bulb diameter and it ranged from 2.93 (T_1) to 4.20 cm (T_3) among the testers (Table 1), 4.10 (L_4) to 4.47 cm (L_3) among the lines (Table 1) and 3.73 (L_2 x T_1) to 4.67 (L_3 x T_6) among the hybrids (Table 2). Similar findings were also reported by Gowda (1988) Mallikarjun (2006) and Evoor *et al.* (2007). Any deviation in the results with findings of others is attributed to differences in the genotypes under study, environmental condition and stage of bulb harvest. For number of centers per bulb it ranged from 1.02 (T_4) to 1.27 (T_6) among the testers and 1.08 (L_3) to 1.25 (L_1) among the lines (Table 1) and 1.05 (L_3 x T_5) to 1.40 (L_1 x T_1) among the hybrids (Table 2). These parameters are important for contributing the total yield. Similar findings were reported by Evoor *et al.* (2007).

For total bulb yield tonnes per hectare, genotypes

Table 2. *Per se* performance of hybrids for purple blotch disease, yield and yield attributing parameters

Hybrid	Purple blotch (PDI)	Plant height	No. of leaves per plant	Days to maturity	Bulb neck thickness	Ten bulb weight (g)	Polar bulb diameter (cm)	Equatorial bulb diameter (cm)	No. of rings/ bulb
$L_1 \times T_1$	20.00	50.27	6.67	86.00	0.55	400.00	4.33	4.43	5.52
$L_1 \times T_2$	18.00	51.90	7.27	88.67	0.53	362.00	4.23	4.17	5.67
$L_1 \times T_3$	18.00	53.00	6.77	91.00	0.45	368.67	4.47	4.33	5.77
$L_1 \times T_4$	19.00	52.43	7.23	89.67	0.40	350.00	4.57	4.07	5.45
$L_1 \times T_5$	20.00	53.90	6.17	92.00	0.44	400.00	4.80	4.37	5.48
$L_1 \times T_6$	17.50	51.83	6.97	90.00	0.41	343.00	4.23	4.43	5.92
$L_1 \times T_7$	17.33	51.60	6.73	88.00	0.41	361.67	4.33	4.40	5.46
$L_2 \times T_1$	18.50	51.93	7.05	83.00	0.41	388.00	3.85	3.73	5.05
$L_2 \times T_2$	16.50	52.17	7.10	86.00	0.41	393.67	4.43	4.53	5.82
$L_2 \times T_3$	18.00	51.50	6.12	91.00	0.45	392.67	4.47	4.33	5.61
$L_2 \times T_4$	17.50	55.77	6.63	90.00	0.42	427.00	4.73	4.57	6.67
$L_2 \times T_5$	19.50	50.00	7.13	89.00	0.41	408.67	4.70	4.47	5.99
$L_2 \times T_6$	17.50	54.17	6.27	85.00	0.44	352.67	4.17	3.77	5.35
$L_2 \times T_7$	18.17	53.00	6.03	88.00	0.43	368.33	4.47	4.13	5.65
$L_3 \times T_1$	19.00	48.83	6.80	82.00	0.40	408.00	4.73	4.03	5.63
$L_3 \times T_2$	18.00	51.83	6.83	85.00	0.40	400.00	4.63	4.53	6.75
$L_3 \times T_3$	19.00	53.33	6.33	88.00	0.50	369.00	4.43	4.17	6.03
$L_3 \times T_4$	15.50	52.43	5.93	85.00	0.43	407.00	4.57	3.90	6.55
$L_3 \times T_5$	15.50	43.60	6.57	84.00	0.38	410.00	4.60	4.43	5.80
$L_3 \times T_6$	18.00	50.33	6.90	84.00	0.40	364.00	3.83	4.67	5.53
$L_3 \times T_7$	18.17	46.17	5.80	83.33	0.40	333.33	4.17	4.50	5.59
$L_4 \times T_1$	20.50	50.83	6.77	85.00	0.38	354.33	3.70	4.27	5.23
$L_4 \times T_2$	21.00	50.40	7.00	89.33	0.40	241.67	3.10	3.83	5.30
$L_4 \times T_3$	20.50	50.83	5.87	93.00	0.47	342.67	4.07	3.97	5.50
$L_4 \times T_4$	19.00	50.90	6.67	91.00	0.55	366.33	4.63	4.07	5.54
$L_4 \times T_5$	20.00	50.90	7.00	93.00	0.46	400.00	4.57	4.13	5.60
$L_4 \times T_6$	19.50	52.17	7.03	88.00	0.40	390.00	4.67	4.10	4.85
$L_4 \times T_7$	19.67	47.50	6.03	90.67	0.45	368.33	4.47	4.20	5.05
SEm±	0.21	0.14	0.03	0.24	0.0031	0.97	0.020	0.017	0.034
CD@5%	15.15	1.15	0.27	1.74	0.66	8.99	0.15	0.14	0.25
CD@1%	20.12	1.53	0.36	2.13	0.88	11.87	0.20	0.18	0.33

Table 2. (Cont..) *Per se* performance of hybrids for purple blotch disease, yield and yield attributing parameters

Hybrid	No. of centers/ bulb	Total bulb yield (t/ha)	Marketable bulb yield (t/ha)	Unmarketable bulb yield (t/ha)	Per cent split bulbs	Per cent rotten bulbs	Per cent sprout bulbs	Total soluble solids (%)	% dry matter content
$L_1 \times T_1$	1.40	21.47	15.97	5.80	14.60	8.80	15.00	9.97	9.60
$L_1 \times T_2$	1.08	19.30	16.93	2.37	4.00	7.10	7.30	8.90	8.40
$L_1 \times T_3$	1.27	19.83	17.17	2.67	6.00	10.73	12.70	9.80	8.00
$L_1 \times T_4$	1.32	17.83	14.83	3.03	7.00	13.83	10.70	9.60	6.83
$L_1 \times T_5$	1.12	23.80	20.50	3.30	6.50	12.20	8.90	9.20	9.07
$L_1 \times T_6$	1.25	15.20	12.93	2.30	8.70	16.00	11.50	8.77	7.60
$L_1 \times T_7$	1.17	20.73	18.10	2.63	8.90	11.50	12.17	9.10	9.00
$L_2 \times T_1$	1.35	22.67	16.33	6.17	16.40	10.67	12.40	10.07	8.37
$L_2 \times T_2$	1.12	18.57	16.57	2.00	5.63	7.50	6.80	8.87	8.63
$L_2 \times T_3$	1.10	19.83	17.07	2.77	5.83	9.50	10.00	9.87	7.13
$L_2 \times T_4$	1.08	26.33	23.30	3.03	7.17	11.00	9.10	9.10	8.97
$L_2 \times T_5$	1.05	24.17	18.20	5.97	7.17	14.50	11.50	8.73	8.67
$L_2 \times T_6$	1.10	23.40	21.07	2.33	11.00	13.00	9.60	8.70	7.37
$L_2 \times T_7$	1.20	22.90	20.47	2.77	10.83	10.50	10.50	9.17	8.13
$L_3 \times T_1$	1.32	21.37	15.00	6.40	13.43	10.67	13.70	9.47	9.10
$L_3 \times T_2$	1.20	18.83	16.20	2.63	6.00	6.50	7.30	9.10	8.60
$L_3 \times T_3$	1.15	17.50	15.00	2.50	7.47	8.50	10.60	8.30	6.70
$L_3 \times T_4$	1.08	22.67	19.00	3.63	8.70	12.63	10.00	8.73	7.13
$L_3 \times T_5$	1.05	27.40	23.80	3.60	5.50	8.60	8.80	9.30	6.40
$L_3 \times T_6$	1.20	16.67	13.67	3.00	6.00	10.70	12.00	9.50	7.50
$L_3 \times T_7$	1.19	18.50	16.30	2.33	5.90	9.53	9.60	9.07	8.30
$L_4 \times T_1$	1.30	17.23	12.90	4.33	15.60	17.77	15.50	9.23	7.70
$L_4 \times T_2$	1.08	15.53	13.23	2.30	7.87	7.70	8.70	7.43	6.58
$L_4 \times T_3$	1.15	15.87	12.63	3.23	8.80	8.90	12.00	9.00	7.23
$L_4 \times T_4$	1.02	17.67	14.43	3.23	9.50	10.00	10.50	8.20	7.00
$L_4 \times T_5$	1.08	19.33	16.33	3.00	8.73	11.90	10.30	9.40	7.67
$L_4 \times T_6$	1.18	19.33	17.27	2.07	10.60	10.90	12.70	8.00	7.00
$L_4 \times T_7$	1.20	20.50	18.07	2.43	10.10	9.70	9.93	9.17	7.93
SEm±	0.01	0.11	0.10	0.046	0.12	0.11	0.10	0.05	0.06
CD@5%	0.14	0.92	0.78	0.42	1.00	0.90	0.84	0.64	0.60
CD@1%	0.18	1.22	1.04	0.56	1.33	1.20	1.11	0.83	0.80

differed significantly and it ranged from 15.00 (T_1) to 21.50 (T_3) among the testers, 18.00 (L_1) to 20.67 (L_3) among the lines (Table 1) and 15.20 (L_1 x T_6) to 27.40 (L_3 x T_5) among the hybrids (Table 2). Genotypes differed significantly among themselves for marketable bulb yield and it ranged from 9.00 t/ha (T_1) to 18.27 t/ha (T_3) among the testers, 15.33 t/ha (L_4) to 18.67 t/ha (L_3) among the lines (Table 1) and 12.63 t/ha (L_4 x T_3) to 23.80 t/ha (L_3 x T_5) among the hybrids (Table 2). These results are in confirmation with Gowda (1988), Divakara (2001), Mallikarjun (2006) and Evoor *et al.*(2007).

Table 3.The best performing top three parents (Lines & Testers) and hybrids of onion for purple blotch disease, yield and yield attributing parameters

Character	Parents			Hybrids		
	I	II	III	I	II	III
Purple blotch (PDI)	L_3(14.00)	L_2(15.00)	L_3(18.00)	L_3 x T_4 (15.00)	L_3 x T_5 (15.50)	L_2 x T_2 (16.50)
Plant height (cm)	L_3(55.50)	L_2(54.17)	T_3(53.00)	L_2 x T_4 (55.77)	L_2 x T_6 (54.17)	L_1 x T_5 (53.90)
Number of leaves per plant	T_3(6.85)	L_3(6.75)	L_2(6.67)	L_1 x T_2 (7.27)	L_1 x T_4 (7.23)	L_2 x T_5 (7.13)
Days to maturity	T_1(77.00)	T_6(86.00)	L_3(89.00)	L_3 x T_1 (82.00)	L_2 x T_1 (83.00)	L_3 x T_7 (83.33)
Neck thickness (cm)	T_1(0.33)	T_7(0.46)	T_5(0.51)	L_3 x T_5 (0.38)	L_1 x T_4 (0.40)	L_1 x T_6 (0.41)
Ten bulb weight (g)	T_3(403.33)	L_2(400.00)	L_3(395.00)	L_2x T_4 (427.00)	L_3 x T_5 (410.00)	L_3 x T_1 (408.00)
Polar diameter (cm)	T_4(4.37)	T_3(4.33)	L_3(4.30)	L_1 x T_5 (4.80)	L_2 x T_4 (4.73)	L_4 x T_4 (4.63)
Equatorial diameter (cm)	L_3(4.47)	L_2(4.27)	L_1(4.20)	L_3 x T_6 (4.67)	L_2 x T_4 (4.57)	L_3 x T_2 (4.53)
Number of rings per bulb	T_5(5.70)	L_3(5.53)	T_2(5.47)	L_3 x T_2 (6.75)	L_2 x T_4 (6.67)	L_3 x T_4 (6.55)
Number of centers per bulb	T_4(1.02)	L_3(1.08)	L_2(1.10)	L_4 x T_4 (1.02)	L_3 x T_5 (1.05)	L_1 x T_2 (1.08)
Total bulb yield (t/ha)	T_3(20.67)	L_3(18.27)	T_5(16.50)	L_3 x T_5 (27.40)	L_2 x T_4 (26.33)	L_2 x T_5 (24.17)
Marketable bulb yield (t/ha)	L_3(20.00)	T_3(18.27)	T_5(16.50)	L_3 x T_5 (23.80)	L_2 x T_4 (23.30)	L_2 x T_6 (21.07)
Unmarketable bulb yield (t/ha)	L_3(2.00)	T_2(2.00)	L_1(20.20)	L_2 x T_2 (2.00)	L_4 x T_6 (2.07)	L_1 x T_6 (2.30)
Per cent split bulbs	T_3(6.00)	L_2(8.00)	L_3(8.20)	L_1 x T_2 (4.00)	L_3 x T_5 (5.50)	L_2 x T_2 (5.63)
Per cent rotten bulbs	L_3(7.50)	L_2(8.00)	L_1(9.50)	L_3 x T_2 (6.50)	L_1 x T_2 (7.10)	L_2 x T_2 (7.50)
Per cent sprout bulbs	L_3(8.75)	L_2(9.00)	L_1(9.50)	L_2 x T_2 (6.80)	L_1 x T_2 (7.30)	L_4 x T_2 (8.70)
Total soluble solids (%)	T_6(9.23)	T_7(9.10)	T_4(9.00)	L_2 x T_1 (10.07)	L_1 x T_1 (9.97)	L_2 x T_3 (9.87)
Bulb dry matter content (%)	T_1(15.00)	L_1(9.00)	L_2(8.83)	L_1 x T_1 (9.60)	L_3 x T_1 (9.10)	L_1 x T_5 (9.07)

Genotypes differed significantly among themselves for unmarketable bulb yield and it ranged from 2.00 t/ha (T_2) to 6.00 t/ha (T_1) among the testers, 2.00 t/ha (L_3) to 3.77 t/ha (L_4) among the lines (Table 1) and 2.00 (L_2 x T_2) to 6.40 (L_3 x T_1) among the hybrids (Table 2). The results are in confirmation with Sundari *et al.* (2003). Parents differed significantly among themselves for total soluble solids and it ranged from 9.00 (T_4) to T_3 (14.83 per cent) among the testers, 9.50 (L_4) to 11.00 per cent (L_1) among the lines (Table 1) and 7.43 to 9.97 per cent (L_1 x T_1) among the hybrids (Table 2). The results are in confirmation with Sundari *et al.* (2003) and Mallikarjun (2006).

In this study, the parents L_2, L_3, T_2, T_4 and T_5 were good performing for various characters and can be exploited further in breeding programme. The hybrid L_3 x T_5 also recorded law PDI for purple blotch. The promising hybrids L_2 x T_4 and L_3 x T_5 can be further subjected to selection to isolate desirable genotypes in onion.

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Received: September 6, 2012; Accepted: April 9, 2013