Indian J. Pl. Genet. Resources 10(1): 85-90, 1997

PERFORMANCE OF ALMOND GERMPLASM UNDER HIGH HILL TEMPERATE WET ZONE OF HIMACHAL PRADESH

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Almond cultivation in high hill temperate wet zone of Himachal Pradesh is attributed mainly to green almond marketing. Sixteen almond cultivars which were introduced at Temperate Horticultural Research Station, Kotkhai (National Hortorium) from 1961 to 1968 were evaluated for their growth, flowering, yield and resistance to insect, pest and diseases. Cultivars namely Dhebar, Kashmir Seedling, I. X. L. and Drake were recorded as vigorous. About 25 per cent twigs of all the trees showed gummosis, however gum exudation on fruit was very less in Kashmir Seedling (3.0 per cent). All thin shelled cultivars were highly infested with gummosis on fruit and nut and kernel rotting was also more prevalent. No particular relationship exists in bacterial leaf spot and extent of gummosis. Stem gummosis was more associated with attack of flat headed peach tree borer and its attack was more serious in varieties introduced from Kinnaur district. Kashmir Seedling, I.X.L., Drake, Afghanistan Seedling were comparatively less affected.

Key words: Almond germplasm, evaluation, gummosis, leaf spotting, flat headed borer

Almond is an important nut fruit crop which occupy pride place among the temperate fruit plants. It has so far been grown mostly as seedling plantations in the hilly areas of Jammu and Kashmir and Himachal Pradesh. The commercial cultivation of this nut could not be spread in these areas on account of intrinsic problems like damage by rains, wind, frost and hails during the blossoming time and lack of any standard cultivar. There exist vast potential for extending almond cultivation from subtropical to dry temperate areas of Himachal Pradesh, and other states. In high hill temperate wet zone of Himachal Pradesh, sizeable crop is grown for green almond market.

Though large number of germplasm collections are available at various centres but their systematic information on growth and productivity is quite scanty. Keeping this in view, germplasm collection of almond varieties available

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at Temperate Horticultural Research Station, Kotkhai were studied in detail and results are presented in this text.

MATERIALS AND METHODS

Sixteen almond varieties were introduced at Temperate Horticultural Research Station, Kotkhai (National Hortorium) during 1961 to 1968. These varieties are existing in satatisfactory condition of growth. The station is located in temperate wet zone of the state which is moderately suited for green almond production. Each variety comprising four trees is planted at 1800 m elevation at a south-western aspect of the station. These trees were trained to modified central leader system and cultural as well as manurial schedules were standard as per recommendation.

Data on growth, flowering and yield were recorded as per standard practices. Cumulative yield record of green almonds were made for 15 years (1981-1995). Varieties were also studied for the incidence of flat headed peach tree borer (*Sphenoptera lafertei* Thompson) which is a serious pest of stone fruits and mainly responsible for gummosis in these fruit plants. Oozing of gum from the main trunk and limbs with elliptical adult emergence holes (old attacks) were also considered. The attack was arbitrarily graded into five categories on the basis of gum oozing and adult emergence holes as healthy (0), low (1 to 10), moderate (11-12), heavy (21-30) and very heavy (31-50).

The data on fruit gummosis were recorded on 100 randomly selected green almonds, at harvest. Stem gummosis, leaf spotting and shot hole were recorded on visual key and depending upon the incidence and intensity were categorised as light, medium, heavy and very heavy incidence.

RESULTS AND DISCUSSION

The data on tree growth and yield parameters are given in Table 1.

Trunk girth and tree height: Maximum growth in terms of trunk girth (50 cm) was recorded in Dhebar followed by Kashmir Seedling (46.0 cm). Merced was least in growth (13.0 cm). Tree height was maximum (5.85 m) in Kashmir Seedling, followed by *I.X.L.* and Drake. Spillo and Sadwant Raj were least in height.

Yield: Drake recorded maximum cumulative yield (196 kg) as well as average yield per tree (13.06) and yield efficiency (0.146). I.X.L. and Non Pareil ranked second in this aspect and can be catagorized as medium producer. Various selections from Kinnaur district namely *Spillo, Ribba* etc. showed very poor performance in this region. Although Non Pareil, I.X.L. Merced have been recommended for cultivation in the zone (Anon. 1994), but performance of Merced is not satisfactory.

Table 1. Growth and yield of almond germplasm (under Kotkhai conditions)

Sr. No.	Cultivar	Tree girth (cm)	Tree height (m)	Cumulative yield of green almond (kgs) (1981-1995)	Av. yield (kg) (per year/ tree)	Yield efficiency (kg/cm^2)
	Planted on 1961					
1.	Non Pareil	31.0	4.70	125.50	8.38	0.109
2.	Drake	33.0	5.21	196.00	13.06	0.156
3.	I.X.L.	39.3	5.62	135.00	9.00	0.077
4.	Dhebar	55.3	5.00	16.93	1.21	0.005
5.	Thinshelled	18.0	3.50	51.37	3.67	0.142
6.	Tree No. 37	26.0	3.50	42.00	3.00	0.056
7.	Afghanistan Seedling	39.0	4.95	12.80	0.91	0.008
8.	Kashmir Seedling	46.0	5.85	57.60	4.11	0.024
9.	Spillo No. 16	31.0	3.40	2.50	0.18	0.002
10.	Spillo No. 18	25.0	2.00	4.50	0.32	0.006
11.	Riba Selection	34.0	3.20	2.00	0.14	0.002
12.	Sadwant Raj	25.0	2.10	2.02	0.14	0.002
13.	Brigg's Hardshell	33.0	3.00	1.35	0.09	0.001
14.	*Amygdalus communis*	23.0	2.50	2.92	0.21	0.005
15.	Merced	13.0	2.15	4.10	0.29	0.022
16.	E.C.24199	29.0	3.50	15.03	1.07	0.016

Flowering: Data on flowering parameters are given in Table 2. Kashmir Seedling was the earliest to flower followed by Afghanistan Seedling. According to bloom period, the varieties can also be classified (Table 3).

Early flowering varieties had more flower duration than late ones. Since the region cold winters persist with late spring frosts and snow, hence most of these early flowering varieties failed to crop in most of the years and were considered unfit for this zone in particular.

Disease reaction: Incidence of stem gummosis was rated light to medium in all cultivars except, *Merced* and *Spillo* No. 18 which were almost completely free from the disease. Two to three gumming lesion were present in 25 per cent limbs of susceptible cultivars.

Table 2. Flowering period of almond germplasm (under Kotkhai conditions)

Cultivar		First Flower			Full bloom date			Flowering period			(Duration) (Mean)
		1991	1992	1993	1991	1992	1993	1991	1992	1993	
	Planted in 1961										
1.	Non Pareil	3/2	2/15	2/23	3/10	2/26	3/8	16	22	25	21.0
2.	Drake	2/24	2/18	2/15	3/4	2/25	3/3	17	13	33	21.0
3.	I.X.L.	3/1	2/15	2/21	3/9	2/26	3/9	16	16	30	20.6
4.	Dhebar	2/26	2/19	2/6	3/10	3/24	3/15	15	21	26	21.3
5.	Thinshelled	3/2	3/18	2/15	3/12	2/25	3/1	22	33	36	24.0
6.	Tree No.31	3/1	2/13	2/1	-	-	2/10	-	-	-	-
7.	Afghanistan seedling	1/15	1/2	3/1	2/10	2/15	3/10	35	32	18	28.3
8.	Kashmir seedling	1/13	2/12	1/25	1/30	1/20	2/5	36	24	35	31.7
9.	Spillo No.16	1/30	2/28	2/27	2/16	2/26	3/9	18	19	24	20.3
10.	Spillo No.18	2/28	3/1	2/28	3/6	3/9	3/8	30	18	22	20.0
11.	Riba selection	3/8	2/20	2/10	2/26	2/24	2/23	16	13	32	20.3
12.	Sadwant Raj	3/1	2/29	2/26	3/8	3/10	3/10	17	19	24	20.3
13.	Brigg's Hardshell	2/18	2/20	3/2	2/26	3/2	3/12	20	22	19	20.3
14.	*Amygdalus communis*	2/26	2/25	3/1	3/8	3/1	3/10	24	19	24	22.3
15.	Merced	2/20	2/24	2/22	3/1	3/6	3/3	20	18	31	23.7
16.	E.C. 24199	2/22	2/25	1/18	3/2	3/6	2/25	19	18	34	23.7

Table 3. Classification of almond germplasm according to bloom period (in Kotkhai conditions)

Early flowering (In Jan.)	Mid season flowering (Start flowering in mid to end Feb.)	Late flowering (Flowering in March)
Kashmir seedling	Ribba Selection	Drake, Thinshelled, Non Pareil, I.X.L.
Afghanistan Seedling	Spillo No. 16	
Tree No.31.	E.C. 24199	Merced, Briggs Hardshell, Amygdalus communis, Spillo No.18, Sadwant Raj, Dhebar

Table 4. Insect, pest and disease incidence in almond germplasm (under Kotkhai conditions)

Name of cultivar	Gummosis			Bacterial leaf spotting	Stagmina blight	Incidence of flat headed borer
	Tree	Fruit (%)	Kernel (%)			
Non Pareil	L	80	10	L	M	
Drake	L	90	Nil	L	L	0
I.X.L.	L	70	20	Nil	H	+
Dhebar	M	25	Nil	L	H	+
Thinshelled	L	100	60	NH	Nil	+++
Tree No. 31	L	25	Nil	H	M	0
Afghanistan seedling	L	100	60	L	M	0
Kashmir seedling	L	3	Nil	Nil	L	0
Spillo No.16	M	65	Nil	L	M	+
Spillo No.18	Nil	10	Nil	L	L	+
Riba Selection	L	30	Nil	Nil	Nil	+++
Sadwant Raj	L	25	Nil	H	L	+
Brigg's Hardshell	L	80	80	L	L	+++
Amygdalus communis	L	75	Nil	Nil	Nil	+++
Merced	Nil	45	Nil	Nil	L	++++
E.C.42199	L	-	-	-	-	+++

Keys :-a) *Disease incidences*

L - Low

M - moderate

H - Heavy

VH - Very heavy/severe

b) Insect attack

0 - Free from insect attack

+ - Low

++ - Moderate

+++ - Heavy

++++ - Very heavy/dying trees

Hard shelled **Kashmir Seedling** showed very little fruit gummosis (3%), Dhebar, Tree No. 31 and Spillo No. 18 were next group of cultivars showing 10-25 per cent fruit gummosis. *Thin Shelled* and *Afghanistan Seedling* were highly susceptible. Kernel gummosis was also present in these cultivars.

Incidence of leaf spotting ranged from light to very high except **I.X.L.**, **Merced**, *Amygdalus communis*, **Briggs Hard Shell**, E.C. 24199, **Ribba Selection** and **Kashmir Seedling** which were free from the disease. Apparently there was no evidence of any clearcut relation between leaf spotting and fruit

gummosis in the field. Jindel and Sharma (1988) have also reported earlier that thin shelled cultivars were more susceptible to gummosis than those having thick shell. Hard shell were reported comparatively resistant to bacterial gummosis (Sharma, 1988).

Incidence of flat headed borer: Four cultivars namely **Drake, Tree No. 31, Afghanistan Seedling** and **Kashmir Seedling** were observed free from the attack of flat headed peach tree borer. **Non Pareil, I.X.L., Dhebur** and **Sadwant Rai** had low incidence of the insect. *Merced* was most badly affected followed by **Briggs Hardshell**, *Amygdalus communis*, E.C. 24199 and **Ribba Selection**. Gumming tendency in stone fruits was mainly associated with insect damage and trees planted in north eastern aspect were least affected. Trees of **Drake, Tree No. 31** and **Kashmir Seedling** had more spread with sufficient foliage which has reduced the attack of the insect at this site. Sharma *et al.* (1990) reported that tree of stone fruits with less spread are more susceptible to damage.

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