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Full Length Article

Peas 2009: A High Yielding Pea Variety for Early, Mid and Late Growing Seasons in Punjab

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Abstract

There was a dire need to develop such a pea variety which may be suitable for all the seasons. 'Peas-2009' is not only a high yielding and early maturing pea (*Pisum sativum* L.) variety but also suitable for mid and mid-late planting seasons. It was developed from the cross of Knight × Arkle by following pedigree selection procedure. The line was tested extensively in the station trials for early, mid and late seasons. In Punjab, 'Peas-2009' can be sown as early as in the second week of October. For mid-season plantation, first to second week of November is recommended. It gave a significantly high green pod yield potential (13.16 t ha^{-1}) as compared to 'Meteor Faisalabad' (12.25 t ha^{-1}) when planted in second week of November. The average percent increase in green pod yield from both in early and mid-season trials was estimated to be as 35.34% over 'Meteor Faisalabad' and 92.52% over 'Climax'. The plant to plant distance of 5 cm was found the most appropriate for achieving the highest green pod yield. On the basis of the two years performance of 'Peas-2009' in National Uniform Yield Trials (NUYT) across the provinces; the average increase in yield over the check was estimated to be 9.48%. A moderate level of resistance against powdery mildew, pea wilt and root rot diseases was justified as by the low rate of plant mortality (11–25%) affecting the variety (Peas-2009). Minute attack of army worm per plant and jassid per leaf was noticed on the Peas-2009 which can be easily managed through suitable insecticide dosage. Moreover, cooking had no drastic effect on its sweetness and texture. It was therefore approved from the Punjab Seed Council in its 38th meeting for general cultivation in 2009. © 2019 Friends Science Publishers

Keywords: Peas 2009; High yield; Disease tolerant; Variety

Introduction

Pea (*Pisum sativum* L.) is a popular winter season crop with high nutritive value containing reasonable amount of protein and minerals which is consumed fresh, dried and in frozen state. High yielding, early production, insect/pest and disease resistant/tolerant varieties are ideal for cultivation. In Pakistan, pea crop covers a total area of 22436 hectares with a total production of 144422 tons. Punjab has got a lion's share of 78% in its production followed by Khyber Pakhtunkhwa (8.65%), Balochistan (8.50%) and Sindh with 5.1% (GOP, 2015). The average green pod yield (6.60 t/ha) is far below than the world's average yield of pea. Pea is grown in plains as a winter crop and in summers it is grown on highlands (Habib and Zamin, 2003). Crop yield and quality are highly dependent upon biological, environmental and genetic factors (Kakar *et al*., 2002). Wilt, root rot and powdery mildew are well pronounced diseases of pea in Pakistan. Wilt and root rot are the most prominent diseases associated with high temperature of the early planted pea (Anonymous, 2010). However, powdery mildew is a serious disease of the main/late season pea crop in Pakistan. This disease comes in the transitory period between the end of winter and the onset of the spring season, under hot and dry weather conditions (Thompson and Kelly, 1982). It reduces green pod yield and causes seed quality to deteriorate (Agrios, 1988; Azmat and Khan, 2014). In peas, from 1964 to 1990 four varieties (H-57, P-8, Samrina Zard and Climax Improved) were released with a yield potential of 4.0, 4.5, 6.0 and 10 t ha^{-1}, respectively. In 2008, a high yielding pea variety 'Meteor Faisalabad' with a yield potential of 12.25 t ha^{-1} was released (Nawab and Rashid, 2014).

The improvement in the yield potential is therefore, the need of the hour to achieve the ultimate goal of yield. The high yielding variety 'Peas-2009' (14.57 t ha^{-1}) under the registration name of 2001-55 was bred through hybridization at the Vegetable Research Institute (VRI), Faisalabad, Pakistan from the Italian pea germplasm introduced by the Provincial Coordinated Research Program of Pakistan Agricultural Research Council, Islamabad, Pakistan. Yield testing and improvement was started during 2002–2008. It has early maturity and produces pods at 50

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days after sowing. This variety competes to all season pea varieties and hence, suitable for early, mid and late season plantation.

Its bold grain and attractive size and shape of its pods have made it popular among the masses. The most appealing/distinguishing trait of this variety is its attractive pod length, better 100-seed weight and green pod yield which made its superiority over the existing varieties. Moreover, this variety is tolerant to high temperature, root rot and powdery mildew. No, serious insect/pest has been yet recorded or reported so far. Thus, this developed variety has the edge of its better yield, earliness, versatility of planting seasons and tolerance to diseases and insects. The commercial release of this variety has significantly contributed to overall pea production in the country and is now considered to be as a bench mark for pea green pod yield in Pakistan.

Materials and Methods

The variety (Peas-2009) was developed as a result of selection from the cross "Knight × Arkle" at the Vegetable Research Institute, Ayub Agricultural Research Institute, Faisalabad Pakistan. The salient characteristics of the parental material are described in the Table 1. During its phase of development, seed samples were sown by planting on both sides of 6 meters long beds with plant-to-plant and row-to-row distances of 5 and 75 cm, respectively in blocks. Recommended seed rate of 15–20 kg/acre was followed (Dhall, 2017). Filial generations were studied by adopting Pedigree selection procedure. The development history is described in Table 2. Among the progeny of the selected plants the pure line No. 55 was selected during 2000–2001. All the plants possessing desirable features from pure line No. 55 were selected and their seed was multiplied for yield evaluation against the check varieties. Selection was focused on plants exhibiting high yield with a good combination of all yield components. The Pedigree method of breeding was approached for the development of this variety which had already been reported by many breeders (Ahmad *et al*., 2010; Mahmood *et al*., 2013). The yield performance of this variety was tested in preliminary yield trial during 2001–2002 and 2002–2003 at Vegetable Research Institute, Faisalabad under triplicate RCB design with the check of Meteor Faisalabad. The data on various morphological parameters such as plant height, days to 50% flowering, number of pods per plant, number of seeds per pod, pod length, pod width, 100-seed weight and green pod yield were recorded.

Due to its encouraging performance it was being tested in the National Uniform Yield Trial since 2003–2004 under RCB design with three replications having plot size of 6.0 × 1.5 m. Coordinated yield trials of the advance line (2001-2055) were progressed at the National Agricultural Research Centre, Islamabad; the Vegetable Research Station, Mirpurkhas, in Sindh province; the Agriculture Research Institute, Quetta, in Balochistan province; the Agriculture Research Station, Mingora, Swat, in Khyber Pakhtun Khwa province and VRI, Faisalabad, Pakistan. Agronomic trials were also carried out to optimize the sowing time and plant to plant distance. Sowing date trials from early October to mid-November for 'Peas-2009 (2001-2055)' occurred in 2004 and 2006 to assess its earliness and yield. Similarly, the plant to plant distance was standardized on the basis of green pod yield assessment. 'Peas-2009' was also tested at plant-to-plant distances of 2.5, 5.0, 7.5 and 10.0 cm in 2006 and 2008. 'Peas-2009' was screened against pea wilt, root rot, and powdery mildew in the research area of the Vegetable Research Institute, Faisalabad and at the laboratory of Plant Pathology Section of Ayub Agricultural Research Institute (AARI), Faisalabad, Pakistan from 2002 to 2006. Data on disease severity were recorded according to the standard evaluation scale as designed by Mayee and Datar (1986) and Mahmood *et al.* (2011) as described in Table 3. The disease incidence was compared to the standard varieties *i.e*., Meteor Faisalabad, Samrina Zard, Olympia, Climax, and PF-400. All yield trials were designed in randomized complete block design. The organoleptic characteristics of pea varieties/lines were studied after cooking at VRI, Faisalabad. After a cross-discipline examination of '2001-2055' the variety was finally approved for general cultivation by the Punjab Seed Council in its 38th meeting as Peas 2009.

Statistical Analysis

Data for all quantitative traits from all the yield trials were analyzed using analysis of variance (Steel *et al*., 1997) using MSTATC software (ver. 1.5, Michigan State University, East Lansing). The differences among the means were tested by the least significant difference test at 0.05 probability level.

Results

Plant Descriptor of Peas-2009

The plants of 'Peas-2009' are mostly single stem, determinate and flowers in a month after sowing (Table 4). Seeds are green, round in shape and sweet in taste. Pod length of 'Peas-2009' varies from 9.5–11.0 cm in length with an average of 9.0 seeds per pod. The average overall green pod yield in both of the early and mid-season plantation is 7.20 t ha^{-1}.

On-station Trials

The yields are relatively low in early season trials as compared to those achieved in the mid-season production.

Early season varietal evaluation trials: The performance of the pea variety 'Peas-2009' in early season varietal evaluation trial is given in Table 5. In Punjab, the first fortnight of October is considered to be the early season

Table 1: Distinctive characteristics of the parental material of variety Peas-2009

Sr. No.	Parental lines	Distinct characteristics	Origin
1	Knight	High yielding, early maturing, medium stature plant, sweet in taste, long pod (8.8 cm) with smooth/bold seed having bright green pod color	U.S.A.
2	Arkle	High yielding, early maturing, medium stature, long pod (8.5 cm) dark green pod color and wrinkled small seed	France

Table 2: Development history of variety Peas-2009

Year	Generation/Trial
1992-1993	F_0
1993-1994	F_1
1994-1995	F_2
1995-1996	F_3
1996-1997	F_4
1997-1998	F_5
1998-1999	F_6
1999-2000	F_7
2000-2001	Pure line No. 55 selected (2001-55)
2001-2008	Preliminary/station yield trial testing
2002-2005	Bio stress studies
2003-2005	National Uniform Yield Trials (NUYT)
2004-2007	Agronomic trials
2008-2009	Quality assessment studies

Table 3: Standard evaluation scale of Mayee and Datar (1986) for disease severity

Score	Disease %	Disease reaction
0	0	Immune (I)
1	<1	Highly resistant (HR)
3	1-10	Resistant (R)
5	11-25	Moderately resistant (MR)
7	26-50	Moderately susceptible (MS)
9	51-70	Susceptible (S)
11	>70	Highly susceptible (HS)

plantation. 'Peas-2009' gave significantly high green pod yield (5.18 t ha^{-1}) as compared to the standard variety (Meteor Faisalabad) with 3.78 t ha^{-1} and all other genotypes. 100-seed fresh weight (65.46 g) was found significantly higher than all of the genotypes including the check (40.28 g). This high yield was estimated to be as 37.04% more than that of the corresponding check when tested among eleven genotypes in early season during 2005–2006. In early season trial (2006–2007) the candidate variety again remained on top for its green pod yield and 100-seed fresh weight and gave significantly high green pod yield (6.01 t ha^{-1}) and 100-seed fresh weight (67.96 g) than all other genotypes including the check variety. The green pod yield was estimated to be 51% more over the check and nine other genotypes (Table 5). The same pattern was observed in the early season trial (2007–2008) where, the variety 'Peas-2009' not only gave significantly high green pod yield (6.37 t ha^{-1}) but also gave significantly high 100-seed fresh weight of 69.47 g than the entire contemporary genotypes tested including the check. The green pod yield of 'Peas-2009' was 42.50% more than the check. The average

Table 4: Plant descriptor of Peas-2009

Traits	Description
A. Seedling	
Seedling height (cm)	7.0
Seedling color	Green
Cotyledon color	Green
Auxiliary bud pubescence	NIL
B. Adult plant	
Growth habit	Erect
Growth type	Determinate
Plant height (cm)	55-60
Productive branches	2-3
Internode length (cm)	5-7
Plant shape	Erect
Anthocyanin	Absent
Leaf color	Green
Leaf type	Compound
Leaf pubescence	NIL
Leaf glossiness	Medium
Stipula attachment	Surrounds the stem
C. Flower	
Days to 50% flowering	32-34
Flower shape	Legume shape
Sepal size	Medium
Petal size	Medium
Calyx color	Green
No. of sepals	5
No. of petals	5
Anther color	Yellow
D. Fruit	
Pod color	Green
Pod length (cm)	9.5-11.0
Pod width (cm)	1.7-2.0
Pod angle	Drooping
Pod pubescence	Absent
Pod constrictions	NIL
Pod flavor	Sweet
No. of pods/plant	9-11
Av. Seeds/pod	9
Av. Green pod yield in early & mid-season (t ha^{-1})	7.2
Potential green pod yield (t ha^{-1})	14.0
E. Seed	
Seed color	Green
Seed shape	Round
Seed size	Bold
Seed surface	Smooth but a small dent on one side
100- seed weight (g)	72

percent increase in green pod yield of 'Peas-2009' as compared to the check in the three trials conducted was estimated as 43.73% (Table 5).

Mid-season varietal evaluation trials: The performance of 'Peas-2009' in the mid-season varietal evaluation trial is given in Table 6. The variety 'Peas-2009' gave 43.91% increase yield over the check and seven other genotypes when planted on 10th November, 2001. The variety 'Peas-2009' performed in the same manner and gave 32.84% increase in yield over the check when sown on 01st November, 2004 and 7.43% increase in yield over the check when sown on 13th November, 2004. In another trial conducted on 21st November 2006, the variety 'Peas-2009' gave significantly high performance among the ten genotypes tested, not only for its green pod yield but also for

Table 5: Performance of 'Peas-2009' in early season varietal evaluation trials compared to check(s) at Vegetable Research Institute, Faisalabad

Year	Variety/Line	Days to 50% flowering	100-seed fresh weight (g)	Green pod yield (t ha^{-1})
(2005-2006)	Peas-2009	31	65.46	5.18
	Samrina Zard	32	42.53	4.46
	Tere-2	58	39.58	4.26
	Meteor Fsd. (Check)	29	40.28	3.78
	9800-9810	32	56.53	3.78
	2001-2020	30	48.97	3.33
	2001-2035	35	55.33	3.29
	Olympia	33	52.73	3.25
	9200-9201	33	45.20	3.18
	9800-9805	31	46.53	2.74
	2001-2040	34	50.23	2.44
	LSD (0.05)	1.12	8.12	0.69
	Percent increase of yield over check (37.04 %)			
(2006-2007)	Peas-2009	31	67.96	6.01
	9800-9810	33	59.01	5.00
	Samrina Zard	33	44.70	4.98
	2001-2035	34	57.23	4.92
	Olympia	33	49.25	4.85
	9200-981	30	41.17	4.49
	2001-2040	33	47.98	4.17
	9800-9805	34	53.38	4.02
	Meteor Fsd. (Check)	30	44.61	3.98
	2001-2020	29	46.70	3.15
	LSD (0.05)	0.97	8.43	0.99
	Percent increase of yield over check (51.00%)			
(2007-208)	Peas-2009	34	69.47	6.37
	Meteor Fsd. (Check)	31	48.17	4.47
	Samrina Zard	33	43.77	4.33
	Olympia	32	44.40	4.28
	9200-9201	33	39.13	4.23
	2001-2035	33	61.47	3.70
	2001-2040	32	45.13	3.03
	2001-2020	30	43.13	2.87
	9800-9810	33	50.40	2.80
	9800-985	31	44.73	2.63
	2001-2060	70	31.40	1.67
	Sitara-620	27	41.53	1.15
	LSD (0.05)	1.25	6.99	0.81
	Percent increase of yield over check (42.50 %)			
	Av. percent increase of yield over check (43.73 %)			

Meteor Fsd. = Meteor Faisalabad

some of the other yield contributing traits *i.e*., pods weight per plant and 100-seed fresh weight. The percent increase in yield of the candidate variety was estimated to be as 85.20% over the check. 'Peas-2009' also gave excellent performance among the thirteen genotypes including the check of 'Climax' when planted on 16th November, 2007. The variety 'Peas-2009' gave significantly high performance for pod length (11.71 cm), seeds per pod (8.5), 100-seed fresh weight (62.23 g) and green pod yield (6.13 t ha^{-1}) as compared to the check 'Climax'. The percent increase in green pod yield of 'Peas-2009' was estimated as 49.15% over the check (Climax). On 03rd November, 2008 a total of fifteen genotypes including two checks (Meteor Faisalabad and Climax) and the candidate variety (Peas-2009) were tested. The candidate variety 'Peas-2009' performed excellent for the major yield and yield contributing traits *i.e*., pod length (11.75 cm), seeds per pod (9.0), 100-seed fresh weight (69.10 g) and green pod yield (9.24 t ha^{-1}) as evident from the Table 6. The green pod yield of 'Peas-2009' was estimated to be as 70.80% higher than 'Meteor Faisalabad' and 'Climax' (173.37%). The average percent increase of green pod yield of 'Peas-2009' over 'Meteor Faisalabad' and 'Climax' was estimated as 30.34 and 128.60% respectively in the six varietal evaluation trials conducted (Table 6). The final and overall, average percent increase of green pod yield from both of the early and mid-season trials was estimated to be as 35.34% over 'Meteor Faisalabad' and 'Climax' (92.52%) as evident from the Table 7.

Biotic Stress Studies

Both the check variety 'Meteor Faisalabad' and the candidate high yielding variety 'Peas-2009' were found to be moderately resistant (tolerant) against root rot (*Fusarium solani*) and pea wilt (*F. oxysporum*) under the laboratory conditions (Table 8). In the open field screening against the powdery mildew disease (*Erysiphe polygoni*); both of the varieties were found moderately resistant to the disease as shown in the Table 8.

The response to attacks of aphid, leaf miner, pod borer and whitefly was also observed. A very minute number of army worm per plant and jassid per leaf were recorded on the Peas-2009 as compared to the check (Table 9).

National Uniform Yield Trials (NUYT)

'Peas-2009' significantly produced higher green pod yield than the other varieties when tested in NUYT during 2003–2004 and 2004–2005 at various ecological zones of the country (Table 10). In 2003–2004, it was tested over five locations of Pakistan and gave 8% increased yield over the check (Meteor Faisalabad). However, in 2004–2005 the candidate variety "Peas-2009' also produced 15% increased green pod yield over the check). The overall, average increase in yield during these two years over the check was estimated to be 11.67%.

Agronomic Trials

Sowing date and plant spacing trials were conducted separately for Peas-2009. Sowing date affected the yield in peas (Table 11). The trials on sowing dates were conducted in 2004–2005 and 2006–2007. The 'Peas-2009' was planted as early as in the 2nd week of October 2004 and 2006 and gave significantly high yields than the check. The percent increase of 'Peas-2009'over the check remained as 48% and 51% when planted in the 2nd week of October 2004 and 2006 respectively. The candidate variety (Peas-2009) also gave significantly higher average green pod yield than the check when planted in the 1st week of November 2004 and 2006. The percent increase in the green pod yield over the check was estimated to be as 33% and 37% for the years

Table 6: Performance of 'Peas-2009' in mid-season varietal evaluation trials compared to check(s) at Vegetable Research Institute, Faisalabad

10th November, 2001		01st November, 2004		13th November, 2004	
Variety/Line	Green pod yield (t ha^{-1})	Variety/Line	Green pod yield (t ha^{-1})	Variety/Line	Green pod yield (t ha^{-1})
Peas-2009	7.44	Peas-2009	8.05	Peas-2009	13.16
9200-9201	6.82	Samrina Zard	6.87	Meteor Fsd.(Check)	12.25
9800-9805	6.32	2001-35	6.84	2001-40	12.10
2001-2035	6.00	9200-1	6.53	2001-35	11.38
Samrina Zard	5.89	Olympia	6.48	Olympia	10.11
9800-9810	5.41	2001-20	6.40	9200-1	9.92
Meteor Fsd.(Check)	5.17	Meteor Fsd.(Check)	6.06	2001-20	9.52
2001-2020	4.59	2001-40	6.00	9800-5	8.87
LSD (0.05)	1.10	9800-10	5.00	9800-10	6.75
Percent increase of yield over check 43.91 %		LSD (0.05)	1.10	LSD (0.05)	0.89
		Percent increase of yield over check 32.84 %		Percent increase of yield over check 7.43 %	
		21st November, 2006			
Variety/Line	Pod plant^{-1}	Pod wt. plant^{-1} (g)	Seed pod^{-1}	100-seed fresh weight (g)	Green pod Yield (t ha^{-1})
Peas-2009	11.53	36.70	8.90	64.78	7.26
Olympia	10.33	27.62	8.13	54.42	6.15
Samrina Zard (Check)	10.63	27.27	7.76	40.20	6.04
2001-2020	12.36	27.06	8.33	45.83	5.61
9800-9805	10.53	26.94	6.96	47.12	5.15
2001-2040	9.40	25.30	7.13	56.40	5.09
2001-2035	9.40	24.35	7.60	54.92	4.33
9200-9201	11.56	23.94	7.46	43.33	3.98
Meteor (Check)	14.63	23.18	7.30	39.77	3.92
9800-98010	7.86	22.67	7.56	55.00	2.13
LSD (0.05)	2.64	4.90	0.66	4.92	1.08
		Percent increase of yield over check 85.20 %			
		16th November, 2007			
Variety/Line	Days to 50 % flower	Pod length (cm)	Seed pod^{-1}	100- seed fresh weight (g)	Green pod yield (t ha^{-1})
Peas-2009	63.0	11.71	8.5	62.23	6.13
FS-21-87	90.3	8.38	6.5	40.60	4.77
Winner	50.0	7.93	6.8	45.83	4.73
Sprinter	87.3	7.87	6.8	33.87	4.42
GRW-45	85.7	8.36	6.2	48.13	4.42
PF-400	88.0	7.59	6.1	43.13	4.39
Green Arrow	85.7	8.62	6.5	45.80	4.31
Climax (Check)	89.7	8.26	6.0	38.20	4.11
Esprit	87.7	8.39	7.0	35.53	3.71
Ambassador	90.3	7.20	6.2	32.20	3.68
2001-2060	96.3	7.39	5.9	35.33	3.37
Kodiak	83.0	7.69	6.2	32.80	3.22
Premium	49.0	7.96	7.0	46.80	3.04
LSD (0.05)	1.35	0.60	0.96	4.73	0.53
		Percent increase of yield over check 49.15 %			
		03rd November, 2008			
Variety/Line	Days to 50 % flower	Pod length (cm)	Pod plant^{-1}	Seed pod^{-1}	100- seed fresh weight (g)	Green pod yield (t ha^{-1})
Peas-2009	51.3	11.75	12.0	9.0	69.10	9.24
Meteor Fsd. (Check)	49.0	8.21	9.5	6.5	42.87	5.41
Climax (Check)	72.0	7.30	33.6	5.5	38.47	3.38
10599	67.6	5.95	31.2	6.0	41.30	3.36
10696	74.0	6.55	52.1	5.9	30.43	3.19
DMR-4	82.0	5.16	27.1	5.4	37.78	2.46
FS-21-87	75.6	7.63	37.3	5.9	35.13	2.46
DMR-20	84.0	7.21	37.6	5.4	33.27	1.94
10694	86.0	4.57	30.1	4.5	35.03	1.90
PS-810240	78.0	6.34	31.2	4.7	35.03	1.83
94610191	77.3	4.95	43.7	5.3	31.07	1.83
PS-40	80.6	4.25	43.3	4.9	40.06	1.66
Fallon	74.0	4.70	47.4	4.9	34.76	1.65
10679	80.6	4.64	41.5	5.9	37.03	1.57
Shawnee	70.0	4.53	31.1	3.7	43.27	0.82
LSD (0.05)	5.87	0.36	8.54	0.82	2.70	0.39
Percent increase of yield over check (Meteor Fsd.) 70.80%						
Percent increase of yield over check (Climax) 173.37 %						
Av. percent increase of yield over check (Meteor Fsd.) 30.44%						
Av. percent increase of yield over check (Climax) 128.60%						

Meteor Fsd. = Meteor Faisalabad

2004 and 2006 respectively. The variety 'Peas-2009' gave a significantly high green pod yield potential (13.16 t ha^{-1}) as compared to 'Meteor Faisalabad' (12.25 t ha^{-1}) when planted in the 2nd week of November 2004. However, the percent increase of green pod yield over the check was about 7.43%. 'Peas-2009' also performed well in terms of green pod yield (7.26 t ha^{-1}) when planted on the 3rd week of November 2006 as compared to the check (3.92 t ha^{-1}). The

Table 7: Summary of the overall performance of 'Peas-2009' in early and mid-season varietal evaluation trials compared to check(s)

Peas-2009 Vs Checks	Early season trials	Mid-season trials	Average yield (t ha^{-1})	Overall Av.% increase of yield over check(s)
	Av. green pod yield (t ha^{-1})	Av. green pod yield (t ha^{-1})		
Peas-2009	5.85	8.55	7.20	
Meteor Fsd. (Check)	4.07	6.56	5.32	35.34%
Climax (Check)	-	3.74	3.74	92.52%

Meteor Fsd. = Meteor Faisalabad

Table 8: Screening of 'Peas-2009' against root rot (*Fusarium solani*), pea wilt (*Fusarium oxysporum*) and powdery mildew (*Erysiphe polygoni*)

Genotype	Mortality (%)	Root rot (*Fusarium solani*)	Pea wilt (*Fusarium oxysporum*)	Powdery mildew (*Erysiphe polygoni*)
Peas-2009	11-25	Moderately Resistant	Moderately Resistant	Moderately Resistant
Meteor Faisalabad (Check)	11-25	Moderately Resistant	Moderately Resistant	Moderately Resistant

Table 9: Entomological studies on 'Peas-2009' at Entomological Research Institute, Faisalabad Pakistan

Variety	Armyworm/plant	Jassid/leaf
Peas-2009	0.53	0.14
Meteor Faisalabad (Check)	0.93	0.26

Table 10: Performance of 'Peas-2009' in National Uniform Yield Trials at different locations

Coordinating units	Green pod yield (t ha^{-1}) of various varieties/lines									
	Peas-2009		Meteor Fsd. (Check)		9200-1		9800-5		2001-20	
	2003-2004	2004-2005	2003-2004	2004-2005	2003-2004	2004-2005	2003-2004	2004-2005	2003-2004	2004-2005
NARC, Islamabad	0.50	2.20	0.84	2.03	0.90	1.56	1.65	1.76	0.68	1.26
SHRI, Mirpurkhas	14.57	8.13	11.73	5.96	4.60	2.96	12.70	7.26	10.57	6.23
ARS, Swat	7.86	9.16	7.30	8.33	6.72	8.60	6.44	7.43	4.36	5.33
ARI,Quetta	8.56	3.98	8.12	4.81	11.66	5.34	7.03	4.90	3.05	4.38
VRI,Faisalabad	2.97	8.05	3.85	6.15	2.53	6.20	3.89	6.18	2.07	6.00
Average	6.89	6.30	6.37	5.46	5.28	4.93	6.34	5.50	4.15	4.64
Percent increase/decrease over check	↑8%	↑15%	-		↓17%	↓9.7%	↓0.5%	↑0.7%	↓34%	↓15%
Combined Averages of two years	6.60		5.91		5.10		5.92		4.40	
Overall percent increase over check	↑11.67%		-		↓13.70%		↑0.16%		↓25.60%	

Meteor Fsd. = Meteor Faisalabad

Table 11: Effect of different planting dates on average green pod yield in pea varieties at Vegetable Research Institute Faisalabad

Variety/Line	Green pod yield at different planting dates (t ha^{-1})					
	October 2nd week (2004)	October 2nd week (2006)	November 2nd week (2004)	November 1st week (2006)	November 2nd week (2004)	November 3rd week (2006)
Peas-2009	4.22	6.01	8.05	8.20	13.16	7.26
Meteor Fsd (Check)	2.85	3.98	6.06	6.00	12.25	3.92
LSD (0.05)	1.02	0.99	1.10	1.20	0.89	1.78
Percent increase in yield over check	48.00	51.00	33.00	37.00	7.43	85.20

Meteor Fsd. = Meteor Faisalabad

percent increase of its green pod yield over 'Meteor Faisalabad' remained as 85.20% when planted on 3rd week of November 2006. The variety 'Peas-2009' was extensively tested on 2.5 cm, 5.0 cm, 7.5 cm and 10 cm plant to plant distances. The highest average green pod yield of 7.55 t ha^{-1} during these two years was achieved when planted at plant to plant distance of 5.0 cm (Table 12).

Quality Assessment Studies

'Peas-2009' maintained its sweetness as compared to the check with a green seed color and a round shape after cooking (Table 13).

Discussion

The pod of this variety is longer than its parents *i.e.*, Knight and Arkle (Table 4). Number of seeds per pod, pod length and average 100-seed weight (fresh) are actually the real yield determining traits for Peas-2009. It can even attain a potential yield up to 13.0–14.0 t ha^{-1} (Anonymous, 2010).

On the basis of season; pea is grown in early and mid-seasons and there are separate genotypes designated for each of the planting seasons. But the attractiveness of this variety is its suitability for both of the early and mid-season planting. From the station trials; it was deduced that this variety can perform well in early and mid-season plantings.

Table 12: Performance of 'Peas-2009' at different plant spacing at Agronomic Research Institute, AARI, Faisalabad

Plant spacing(s)	Green pod yield at different planting spacing (t ha^{-1})		Average green pod yield (t ha^{-1})
	2006-07	2008-09	
2.5 (cm)	-	6.84	6.84
5.0 (cm)	7.02	8.08	7.55
7.5 (cm)	6.16	5.50	5.83
10.0 (cm)	5.32	4.82	5.07
LSD (0.05)	0.69	0.60	

Table 13: Organoleptic studies and seed colour/shape of 'Peas-2009' after cooking

Sr. No.	Variety/Line	Seed color	Seed shape	Seed taste
1	Peas-2009	Green	Round/ Bold/wrinkled	Sweetest
2	Meteor Fsd (Check)	Bright green	Round/smooth	Sweet

Meteor Fsd. = Meteor Faisalabad

The early and mid-season plantation can be best utilized for getting green pod yield. However, the late mid-season plantation can be best utilized for green pod yield and seed production simultaneously. The early season pea production fetch high price in the market due to earliness. The yields in the early season pea production are low because of the high temperatures which hamper the yield as well as the growth period (Amjad and Anjum, 2002; Vocanson and Jeuffroy, 2008; Khan *et al*., 2013). The variety 'Peas-2009' was at an edge for its 100-seed fresh weight and fresh green pod yield which was significantly higher than that of the check as evident from the early season station trials. This high seed weight was the actual cause of high yield in Peas-2009 (Rasaei *et al*., 2011). The mid-season is the peak season for pea production and the yields were relatively high as compared to those achieved in the early season production. The cold environment favors the pea production during the mid-season plantation. The mid-season in Punjab for pea sowing is considered to be from first week to last week of November. From the mid-season station trials it was clearly evident that not only environment but also genetics played a vital role in elevating the performance of 'Peas-2009' through the expression of its supporting yield attributing traits. Therefore, 'Peas-2009' is considered as a versatile performing variety suitable for its cultivation in early as well as mid-seasons. It can even attain a potential yield up to 13–14 t ha^{-1} (Anonymous, 2010).

Powdery mildew is a serious disease of pea which predominantly affects the mid-season and late mid-season pea crop especially at the seed development stage. The screening against the powdery mildew disease (*Erysiphe polygoni*) was made in the open field and was found moderately resistant. The same procedure for screening against the powdery mildew was adopted by Nawab and Rashid (2014). Their level of tolerance against this disease was also been reported by Azmat *et al*. (2010). The level of tolerance/resistance is defined through the genetics. Cultural and timely protective measures can overcome this disease easily. Root rot and pea wilt are also important fungal diseases appear on the early season crop. The standard evaluation scale of Mayee and Datar (1986) was used to screen the pea genotypes against root rot (*Fusarium solani*) and pea wilt (*F. oxysporum*) under the laboratory conditions. The same procedure of screening against root rot and pea wilt was also reported by Nawab and Rashid (2014). A level of moderate resistance against these two diseases was justified by the low rate of plant mortality (11–25%) effecting the variety (Peas-2009).

No, serious insect/pest on pea variety 'Peas-2009' was recorded. Only a minute attack of army worm per plant and jassid per leaf were noticed on the Peas-2009 which can be easily controlled or overcome through suitable insecticide dosage. National Uniform Yield Trials (NUYT) on pea was conducted at the various ecological zones of the country in order to test the adaptability of the candidate variety. There existed variation in yields which might be due to varying environments. The characteristics of a cultivar along with a combination of traits differ according to the varying climatic conditions of different localities (Kakar *et al*., 2002). Not only the environment played a vital role in the performance of the variety (Peas-2009) in the various ecological zones of the country but at the same time the role of genetics cannot be not over looked.

Sowing date trials were conducted to optimize the planting date for its maximum potential (Khan *et al*., 2014). The data as presented here supported that 'Peas-2009' could perform well when planted early during the second week of October. In Punjab, the second week of October is the best early sowing time for 'Peas-2009' but the highest potential yield can also be achieved when planted in the second week of November which is supposed to be the mid-season time (Nawab and Rashid, 2014). This variety 'Peas-2009' also performed well even in the third week of November which was considered to be the late mid-season planting. The highest average green pod yield was achieved at the plant to plant distance of 5.0 cm. This distance was justified because the plants of 'Peas-2009' are erect and mostly single stem and this allowed more number of plants per hectare, resulting in a significantly higher green pod yield as compared to the plant to plant distances of 7.5 cm and 10.0 cm. However, the reason for low yield at the planting distance of 2.5 cm as compared to the planting distance of 5.0 cm was mainly due

to exhaustive competition among the plants. Similar findings were also been reported by Nawab and Rashid (2014).

Quality assessment studies were also conducted and it was found that cooking had no drastic effect on the sweetness and texture of 'Peas-2009'. Moreover, it has also been reported in literature that cooking has no drastic effect on the nutritive quality of pea (Amarakoon, 2009).

Conclusion

'Peas-2009' is a high yielding and well adapted variety suitable for both early and mid-season plantation. The seed of this variety is sweet, bold, and green in color; fetches high market price due to attractive pod size and shape. This variety has also shown tolerance against powdery mildew, root rot and pea wilt. The overall, average percent increase in its green pod yield from the early and mid-season trials was estimated to be as 35.34% over the popular checks of 'Meteor Faisalabad' and 'Climax' (92.52%). The seed of this variety is available in the market and is also maintained by the Vegetable Research Institute, Faisalabad, Biological Conservation Institute, National Agricultural Research Centre, Islamabad and Punjab Seed Corporation, Pakistan.

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References

Agrios, G.N., 1988. *Plant Pathology*, 3rd edition. Academic Press, San Diego, California, USA

Ahmad, Z., M.Y. Mujahid, M.A. Khan, S. Yasmin, M. Asif and M. Qamar, 2010. NARC-2009: A high yielding wheat variety for rainfed areas of Pakistan. *Pak. J. Agric. Res*., 23: 1–4

Amarakoon, R., 2009. The effect of cooking on nutritive quality of selected legumes. *Ph.D. Dissertation*. Programme of Chemistry and Food Technology, Faculty of Technology, Tomas Bata University, Zlin, Czech Republic

Amjad, M. and M.A. Anjum, 2002. Performance of nine pea cultivars under Faisalabad conditions. *Pak. J. Agric. Sci.,* 29: 16–19

Anonymous, 2010. Achievements of Vegetable Research Institute, Faisalabad. Pakistan. (http://www.agripunjab.gov.pk/index.php?f=1&m=67&l=177&r=0)

Azmat, M.A. and A.A. Khan, 2014. Powdery mildew induced physiological and biochemical changes in pea (*Pisum sativum* L.). *Pak. J. Agric. Sci.,* 51: 893–899

Azmat, M.A., N.N. Nawab, S. Niaz, A. Rashid, K. Mahmood, A.A. Khan and S.H. Khan, 2010. Single recessive gene controls powdery mildew resistance in pea. *Intl. J. Veg. Sci*., 16: 278–286

Dhall, R.K., 2017. *Pea Cultivation*, 1st Edition. Punjab Agricultural University, Ludhiana. Bull. No. PAU/2017/Elec/FB/E/29

GOP, 2015. *Fruit, Vegetables and Condiments Statistics of Pakistan.* Government of Pakistan. Ministry of National Food Security and Research, Economic wing, Islamabad, Pakistan

Habib, N. and M. Zamin, 2003. Offseason pea cultivation in Dir Kohistan valley. *Asian J. Plant Sci.,* 2: 283–285

Kakar, A.A., M. Saleem, R. Shah and S.A.Q. Shah, 2002. Growth and marketable green pod yield performance of pea (*Pisum sativum* L.) under varying levels of NPK fertilizers. *Asian J. Plant Sci.,* 1: 532–534

Khan, M.A.A., F. Behnamfar, E.E. Rezaie and M. Bannayan, 2014. Assessment of sowing date impacts on productivity of different grass pea ecotypes. *Intl. J. Farm. Allied Sci.,* 3: 798–805

Khan, T.N., A. Ramzan, G. Jillani and T. Mehmood, 2013. Morphological performance of peas (*Pisum sativum*) genotypes under rainfed conditions of Potowar region. *J. Agric. Res.,* 51: 51–60

Mahmood, A., M.A. Mian, M. Ihsan, M. Ijaz, G. Rabbani and M.S. Iqbal, 2013. Chakwal-50: A high yielding and disease resistant wheat variety for rainfed region. *J. Anim. Plant Sci.,* 23: 833–839

Mahmood, K., M. Saleem and M. Ahsan, 2011. Inheritance of resistance to *Fusarium* wilts in chickpea. *Pak. J. Agric. Sci*., 48: 55–58

Mayee, C.D. and V.V. Datar, 1986. *Phyto-Pathometry. Tech. Bulletin. 1 (Special Bul. 3)*, p: 95. Marathwada Agricultural University Parbhani, Maharashtra, India

Nawab, N.N. and A. Rashid, 2014. "Meteor Faisalabad," a high yielding pea variety. *Intl. J. Veg. Sci*., 20: 141–149

Rasaei, A., M.E. Ghobadi, M. Ghobadi and K. Abdi-niya, 2011. The study of traits correlation and path analysis of the grain yield of the peas in semi-dry conditions in kermanshah. *In: International Conference on Food Engineering and Biotechnology*, Vol. 9, pp: 246–249. IACSIT Press, Singapore

Steel, R.G.D., J.H. Torrie and D.A. Dickey, 1997. *Principles and Procedures of Statistics: A Biometrical Approach*, 3rd edition. McGraw Hill Co., New York, USA

Thompson, H.C. and W.C. Kelly, 1982. *Vegetable Crops.* 5th Edition. Tata McGraw-Hill Publishing, New Delhi, India

Vocanson, A. and M.H. Jeuffroy, 2008. Agronomic performance of different pea cultivars under various sowing periods and contrasting soil structures. *Agron. J.,* 100: 748–759

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