Pak. J. Bot., 39(2): 551-559, 2007.

THE YIELD AND YIELD COMPONENTS OF PEA (*PISUM SATIVUM* L.) AS INFLUENCED BY SALICYLIC ACID

GHULAM MURTAZA[*], REHANA ASGHAR[1], SHAHBAZ AHMAD[2] AND SYED ABDUL MAJID

Department of Botany, University of Azad Jammu Kashmir, Muzaffarabad, Pakistan
[1]Department of Botany, University of Arid Agriculture, Rawalpindi, Pakistan.
[2]Department of Agronomy, University of Arid Agriculture, Rawalpindi, Pakistan.

Abstract

The effects of 0 M, 10^{-5} M and 10^{-4} M salicylic acid (SA) applied by three different modes (seed treatment, seed treatment plus foliar spray and foliar spray) in four pea (*Pisum sativum* L.) varieties viz., Meteor, Climax, Greenfeast and Rondo were evaluated. Among the varieties the highest green pod yield of 5255 Kg ha^{-1} was obtained in variety Meteor followed by variety Greenfeast (4452 Kg ha^{-1}). The maximum increase in all the yield and yield components was observed in the pea plants treated with SA concentration 10^{-4} M over SA 10^{-5} M and SA 0 M. Moreover the increase in the yield and yield components was more pronounced in the plants that received the SA twice (seed treatment and foliar spray) at two different stages of development.

Introduction

Pea (*Pisum sativum* L.) is grown throughout the world for diverse uses as food and fodder. Pea is the world's third most significant legume grain after soybean and common beans (Timmerman-Vaughan *et al*., 2005). Although it has been long recognized as a significant crop, its production has been rather low for a long time. The average fresh grain yield of pea in Pakistan was 596 Kg ha^{-1} during 2001 (Anon., 2002). The pea cultivars cultivated by the vegetable growers in Pakistan are very low in yield and their quality does not compete with the varieties grown in advanced countries (Khokhar *et al.*, 1988). Continued and well organized efforts are needed for the improvement of pea from genetic and management viewpoints.

Salicylic acid (SA) and related compounds have been reported to induce significant effects on various biological aspects in plants (Raskin, 1995). There are reports on the effect of salicylic acid on growth in *Vicia faba* (Manthe *et al*., 1992) and increase in flower size of *Campanula* (Serek, 1992). Exogenous application of SA to different crops has been shown to elicit yield and yield components. An increase in number of pods and yield has been found in *Vigna radiata* (Sing & Kaur, 1980) and in *Brassica juncea* (Fariduddin *et al*., 2003). According to Senaratna *et al*., (2003), SA is effective in inducing tolerance to heat, drought and chilling stress in bean and tomato plants. Such a multiple and diverse nature of functions have been reported in the literature and efforts are being made to identify and classify the SA as growth hormone. The present work was designed with the objective to investigate the effects of SA on yield and yield components of the pea (*Pisum sativum* L.) varieties.

[*]E-mail: gmurtazaq@hotmail.com

Materials and Methods

The experiments were carried out during two consecutive growing seasons of 2003-04 and 2004-05 at Muzaffarabad, Azad Kashmir, Pakistan. The seeds of four varieties of pea *viz*., Meteor, Climax, Greenfeast and Rondo were obtained from Ayub Agricultural Research Institute (AARI), Faisalabad, Pakistan. The soil, previously analysed from Soil Testing Lab., Gojra, Muzaffarabad, was silt loam with pH 7.2 at Chattar Klas and loamy silt with pH 7.1 Jalalabad. After thoroughly preparing, the soil was added with N: P: K @ 45: 90: 90 kg ha^{-1} as urea, single super phosphate (SSP) and sulphate of potash (SOP). Half of the amount of urea was added at soil preparation and other half at 45 days after germination.

The study was planned in a split-split plot experiment in randomized complete block design (RCBD) with three replicates. The main plots were assigned to pea cultivars (Meteor, Climax, Greenfeast and Rondo), with salicylic acid concentrations (0 M, 10^{-5} M and 10^{-4} M in water) as subplots and modes of application of salicylic acid (seed treatment (ST); seed treatment plus foliar spray (STFS) and foliar spray (FS)) as sub-sub-plots. The main plot was divided into subplots and sub-subplots. Each sub-subplot measured 3 x 1.8 m^2 (5.4 m^2) with plant to plant distance 15 cm and row to row distance 90 cm (Hussain & Badshah, 2002). There were two rows in each sub-subplot and 20 plants in each row. Weeding, hoeing and other agronomic practices were carried out uniformly as and when needed. The seeds were soaked in 0, 10^{-5} and 10^{-4} M aqueous solutions of SA for six hours. The plants were sprayed at phenological growth stage BBCH 60 with aqueous solutions of 0, 10^{-4} and 10^{-5} M SA in the early morning when the plants had their 3rd leaf completely expanded. The sprays in all the cases were carried out with a manual spray pump. Data were collected on number of pods $plant^{-1}$, seeds pod^{-1}, 100-seed weight (g), biological yield (Kg ha^{-1}) and green pod yield (Kg ha^{-1}).

Data from the two years combined were subjected to analysis of variance using computer package MSTATC. The Duncan's Multiple Range Test was used to separate the means.

Results

Number of pods $plant^{-1}$: Number of pods $plant^{-1}$ is an important trait attributing to fresh pod yield of green pea production. There was a statistically significant difference ($p<0.05$) among the pea varieties in terms of numbers of pods $plant^{-1}$ (Table 1). Maximum number of pods $plant^{-1}$ was produced by Meteor (29.48) followed by that of the Greenfeast (25.82), Climax (22.99) and Rondo (21.78). The varieties Meteor and Greenfeast were significantly different with all other varieties, while Rondo and Climax were non-significant from each other.

Different SA concentrations had significant effect on the number of pods $plant^{-1}$ during the study (Table 1). Plants treated with SA concentration 10^{-4} M produced maximum number of pods $plant^{-1}$ (27.51) which was significantly different from the plants treated with SA concentration 10^{-5} M (24.93) and 0 M SA (22.61) .The interaction was found non-significant between varieties and SA concentrations.

The modes of application had significant effect on the number of pods $plant^{-1}$. The maximum number of pods $plant^{-1}$ was recorded for the STFS (27.80) plants followed by FS (24.72) and ST (22.53) plants, all of which were significantly different from each other. A significant interaction between varieties and modes of application was recorded which ranged from 21.00 (Rondo, FS) to 32.34 (Greenfeast, STFS).

Table 1. Effect of SA on the number of pods plant^{-1} of pea (*Pisum sativum* L.) varieties

Varieties	Modes of application			
	ST	STFS	FS	Means
Meteor	27.88 c*	29.66 b	30.89 b	29.48 a*
Climax	24.11 d	21.87 f	23.00 e	22.99 c
Greenfeast	21.11 f	32.34 a	24.00 d	25.82 b
Rondo	17.00 g	27.33 c	21.00 f	21.78 c
SA concentrations				
0 M	21.67 a*	25.15 a	21.00 a	22.61 c*
10^{-4} M	23.80 a	31.13 a	27.60 a	27.51 a
10^{-5} M	22.11 a	27.13 a	25.55 a	24.93 b
Interactions				
Meteor x 0 M	23.67 a*	28.67 a	25.67 a	26.00 a*
Meteor x 10^{-4} M	27.65 a	32.67 a	32.00 a	30.77 a
Meteor x 10^{-5} M	24.67 a	33.88 a	29.20 a	29.25 a
Climax x 0 M	23.00 a	26.77 a	23.40 a	24.39 a
Climax x 10^{-4} M	22.00 a	25.90 a	23.67 a	23.86 a
Climax x 10^{-5} M	18.45 a	29.77 a	26.33 a	24.85 a
Greenfeast x 0 M	21.00 a	29.88 a	25.33 a	25.40 a
Greenfeast x 10^{-4} M	25.00 a	25.90 a	27.00 a	25.97 a
Greenfeast x 10^{-5} M	22.98 a	21.60 a	26.00 a	23.53 a
Rondo x 0 M	19.67 a	22.33 a	17.00 a	19.67 a
Rondo x 10^{-4} M	21.55 a	28.66 a	20.00 a	23.40 a
Rondo x 10^{-5} M	20.67 a	27.55 a	21.00 a	23.07 a
Means	22.53 c*	27.80 a	24.72 b	

*Any two means carrying the same letter(s) in a column or row are non- significantly different at P=0.05 by Duncan's Multiple Range Test, ST: Seed treatment, STFS: Seed treatment plus foliar spray and FS: Foliar spray

Number of seeds pod^{-1}: The varieties, SA concentrations and modes of application had significant difference with respect to the number of seeds pod^{-1} (Table 2). The variety Climax produced the maximum number of seeds pod^{-1} (7.92) followed by Meteor (7.26), Rondo (6.35) and Greenfeast (5.47). All the varieties were significantly different from each other in terms of number of seeds pod^{-1}.

SA concentrations affected the number of seeds pod^{-1} during the study. The maximum number of seeds pod^{-1} were observed in the plants treated with SA concentration 10^{-4} M (7.25), which was significantly different from SA concentration 10^{-5} M (6.45) and 0 M (6.56), in terms of number of seeds pod^{-1}. Both later treatments were non-significant to each other in terms of number of seeds pod^{-1}. A significant interaction was found between varieties and SA concentrations. Number of seeds pod^{-1} ranged from 5.50 (Greenfeast, SA concentration 10^{-5} M) to 7.64 (Climax, SA concentration10^{-4} M).

Among the modes of application, STFS pea plants had maximum number of seeds pod^{-1} (7.06) followed by FS (6.60) and ST (6.60) plants. The STFS mode of application was significantly different from ST and FS modes while ST and SF were non-significant to each other.

Table 2. Effect of SA on the number of seeds pod^{-1} of pea (*Pisum sativum* L.) varieties.

Varieties	Modes of application			
	ST	STFS	FS	Means
Meteor	6.91 a*	8.08 a	6.80 a	7.26 b*
Climax	7.67 a	7.80 a	8.29 a	7.92 a
Greenfeast	5.62 a	5.30 a	5.50 a	5.47 d
Rondo	6.18 a	7.06 a	5.80 a	6.35 c
SA concentrations				
0 M	7.18 a*	6.49 a	6.00 a	6.56 b*
10^{-4} M	6.20 a	7.75 a	7.80 a	7.25 a
10^{-5} M	6.41 a	6.95 a	6.00 a	6.45 b
Interactions				
Meteor x 0 M	5.90 a*	7.37 a	7.30 a	6.86 ab*
Meteor x 10^{-4} M	7.63 a	7.60 a	7.40 a	7.54 a
Meteor x 10^{-5} M	7.43 a	7.10 a	6.53 a	7.02 a
Climax x 0 M	7.63 a	7.73 a	7.00 a	7.45 a
Climax x 10^{-4} M	8.13 a	7.40 a	7.40 a	7.64 a
Climax x 10^{-5} M	7.23 a	7.60 a	7.00 a	7.28 a
Greenfeast x 0 M	6.13 a	6.23 a	6.40 a	6.25 d
Greenfeast x 10^{-4} M	5.50 a	6.50 a	5.90 a	5.97 d
Greenfeast x 10^{-5} M	5.27 a	6.23 a	5.00 a	5.50 d
Rondo x 0 M	6.07 a	6.67 a	6.23 a	6.32 c
Rondo x 10^{-4} M	6.23 a	6.70 a	6.50 a	6.48 b
Rondo x 10^{-5} M	6.00 a	7.60 a	6.50 a	6.70 ab
Means	6.60 b*	7.06 a	6.60 b	

*Any two means carrying the same letter(s) in a column or row are non- significantly different at P=0.05 by Duncan's Multiple Range Test, ST: Seed treatment, STFS: Seed treatment plus foliar spray and FS: Foliar spray

Hundred-seed weight (HSW): Statistical analysis of the data obtained regarding HSW eexhibited that the means for varieties, SA concentrations and modes of application were significantly different during the study (Table 3). The variety Meteor gained maximum HSW (49.57 g) which was significantly different from all the other varieties. Rondo with HSW 44.71 g was ranked second followed by Greenfeast (39.07 g) and Climax (37.44 g). Rondo had significant difference with Meteor, Climax and Greenfeast, while the varieties Climax and Greenfeast were non-significant to each other in terms of HSW.

Various SA concentrations used were significantly different from each other in terms of HSW during both years of study. The HSW of the plants treated with SA concentration 10^{-4} M was the highest (46.21 g), which was statistically different from the plants treated with SA concentration 10^{-5} M (42.23 g) and 0 M (39.67 g). All the SA concentrations showed significant difference with each other in terms of HSW.

Modes of application of SA had a significant effect on the HSW of pea varieties. Maximum HSW (47.51 g) was found for the STFS plants, which was significantly different from the FS (42.35 g) and ST plants (38.24 g), which were also statistically different to each other.

Table 3. Effect of SA on 100-seed weight (g) of pea (*Pisum sativum* L.) varieties.

Varieties	Modes of application			
	ST	STFS	FS	Means
Meteor	46.11 a*	52.11 a	50.48 a	49.57 a*
Climax	33.13 a	44.20 a	35.00 a	37.44 c
Greenfeast	34.70 a	43.60 a	38.90 a	39.07 c
Rondo	39.00 a	50.12 a	45.00 a	44.71 b
SA concentrations				
0 M	36.00 a*	44.52 a	38.48 a	39.67 c*
10^{-4} M	39.73 a	54.00 a	44.90 a	46.21 a
10^{-5} M	39.00 a	44.00 a	43.68 a	42.23 b
Interactions				
Meteor x 0 M	43.50 a*	48.80 a	45.00 a	45.77 a*
Meteor x 10^{-4} M	46.70 a	54.90 a	51.10 a	50.90 a
Meteor x 10^{-5} M	43.67 a	54.50 a	51.70 a	49.96 a
Climax x 0 M	30.65 a	40.80 a	31.00 a	34.15 a
Climax x 10^{-4} M	35.90 a	48.73 a	40.10 a	41.58 a
Climax x 10^{-5} M	38.80 a	36.73 a	34.00 a	36.51 a
Greenfeast x 0 M	28.80 a	40.77 a	37.10 a	35.56 a
Greenfeast x 10^{-4} M	36.66 a	46.78 a	38.10 a	40.51 a
Greenfeast x 10^{-5} M	33.98 a	38.87 a	43.00 a	38.62 a
Rondo x 0 M	36.80 a	43.90 a	42.10 a	40.93 a
Rondo x 10^{-4} M	43.80 a	64.47 a	51.00 a	53.09 a
Rondo x 10^{-5} M	39.60 a	50.90 a	44.00 a	44.83 a
Means	38.24 c*	47.51 a	42.35 b	

*Any two means carrying the same letter(s) in a column or row are non- significantly different at P=0.05 by Duncan's Multiple Range Test, ST: Seed treatment, STFS: Seed treatment plus foliar spray and FS: Foliar spray

Biological yield (BY): The varieties, SA concentrations and modes of application showed significant differences among them in terms of BY (Table 4). Among the varieties, Meteor produced highest BY (7637 Kg ha^{-1}) which was significantly different from Greenfeast (6383 Kg ha^{-1}), Climax (5872 Kg ha^{-1}) and Rondo (4324 Kg ha^{-1}).

The biological yield was also influenced by different SA concentrations. The plants treated with SA 10^{-4} M produced highest (6542 Kg ha^{-1}) which was significantly different from that of SA 10^{-5} M (6008 Kg ha^{-1}) and SA 0 M (5614 Kg ha^{-1}).

Mode of application of SA had significant effect on the BY in pea varieties The STFS plants revealed highest BY (6804 Kg ha^{-1}), while the FS plants (5863 Kg ha^{-1}) and ST plants (5496 Kg ha^{-1}) ranked 2nd and 3rd respectively (Table 4). All three means were significantly different to each other. A significant interaction between SA concentrations and mode of application was recorded. The BY ranged from 4860 Kg ha^{-1} (SA 0 M, ST) to 7243 Kg ha^{-1} (SA 10^{-4} M, STFS). Similarly a significant interaction between varieties and SA concentration was also recorded, which ranged from 3371 Kg ha^{-1} (Rondo, SA 0 M) to 8487 Kg ha^{-1} (Meteor, SA 10^{-4} M).

Green pod yield (GPY): The effects of SA on pea varieties by different modes of application were observed and the results are presented in Table 5. The highest GPY was obtained from Meteor (5255 Kg ha^{-1}) followed by Greenfeast (4452 Kg ha^{-1}), Climax (3183 Kg ha^{-1}) and Rondo (2767 Kg ha^{-1}). All the varieties were significantly different to each other (Table 5).

Table 4. Effect of SA on biological yield (Kg ha^{-1}) of pea (*Pisum sativum* L.) varieties.

Varieties	Modes of application			
	ST	STFS	FS	Means
Meteor	7181 a*	8352 a	7378 a	7637 a*
Climax	5442 a	6725 a	5450 a	5872 c
Greenfeast	6017 a	7042 a	6091 a	6383 b
Rondo	3343 a	5095 a	4533 a	4324 d
SA concentrations				
0 M	4860 h*	6410 c	5571 g	5614 c*
10^{-4} M	6066 e	7243 a	6317 d	6542 a
10^{-5} M	5563 g	6760 b	5701 f	6008 b
Interactions				
Meteor x 0 M	7380 a*	8326 a	7405 a	7704 ab*
Meteor x 10^{-4} M	7461 a	9668 a	8331 a	8487 a
Meteor x 10^{-5} M	7160 a	7640 a	7480 a	7427 b
Climax x 0 M	5528 a	6613 a	5831 a	5991 cd
Climax x 10^{-4} M	7470 a	8529 a	6280 a	7426 b
Climax x 10^{-5} M	6148 a	7034 a	6751 a	6644 e
Greenfeast x 0 M	5216 a	6726 a	5310 a	5751 d
Greenfeast x 10^{-4} M	5361 a	7910 a	6411 a	6561 c
Greenfeast x 10^{-5} M	4190 a	4310 a	3812 a	4104 g
Rondo x 0 M	3544 a	3320 a	3250 a	3371 h
Rondo x 10^{-4} M	3340 a	6463 a	5053 a	4952 e
Rondo x 10^{-5} M	3156 a	5110 a	4443 a	4236 f
Means	5496 c*	6804 a	5863 b	

*Any two means carrying the same letter(s) in a column or row are non- significantly different at P=0.05 by Duncan's Multiple Range Test, ST: Seed treatment, STFS: Seed treatment plus foliar spray and FS: Foliar spray

The SA concentrations were significantly different in terms of GPY during the study period (Table 5). The plants treated with SA 10^{-4} M produced maximum GPY (4555 Kg ha^{-1}), that was significantly different from the 10^{-5} M SA concentration (3999 Kg ha^{-1}) and SA 0 M (3189 Kg ha^{-1}). All three SA concentrations were significantly different to each other in terms of GPY.

Modes of application also affected the GPY during both the years (Table 5). The STFS plants gave maximum GPY (5078 Kg ha^{-1}) followed by the FS plants (3806 Kg ha^{-1}) and the ST plants (2858 Kg ha^{-1}). All three modes of application had significant difference among them. A significant interaction between varieties and modes of application was found, which ranged from 1599 Kg ha^{-1} (Rondo, ST) to 6442 Kg ha^{-1} GPY (Meteor, STFS). Similarly the interaction between SA concentrations and modes of application was also found significant, ranging from 2088 Kg ha^{-1} (0 M, ST) to 6150 Kg ha^{-1} (10^{-4} M, STFS).

Table 5. Effect of SA green pod yield (Kg ha^{-1}) of pea (*Pisum sativum* L.). varieties

Varieties	Modes of application			
	ST	STFS	FS	Means
Meteor	3512 ef*	6442 a	5810 b	5255 a*
Climax	2586 f	4350 d	2613 f	3183 c
Greenfeast	3734 e	5310 c	4312 d	4452 b
Rondo	1599 h	4211 de	2490 g	2767 d
SA concentrations				
0 M	2088 f*	4270 c	3210 e	3189 c*
10^{-4} M	3196 e	6150 a	4320 c	4555 a
10^{-5} M	3290 e	4820 b	3888 d	3999 b
Interactions				
Meteor x 0 M	2650 a*	5580 a	4219 a	4150 a*
Meteor x 10^{-4} M	3360 a	6690 a	5510 a	5187 a
Meteor x 10^{-5} M	4680 a	7390 a	6012 a	6027 a
Climax x 0 M	1707 a	3580 a	2918 a	2735 a
Climax x 10^{-4} M	2238 a	4380 a	3701 a	3440 a
Climax x 10^{-5} M	2350 a	3490 a	3110 a	2983 a
Greenfeast x 0 M	2787 a	4390 a	3303 a	3493 a
Greenfeast x 10^{-4} M	4480 a	5267 a	5610 a	5119 a
Greenfeast x 10^{-5} M	2270 a	4488 a	4070 a	3609 a
Rondo x 0 M	2880 a	4340 a	2097 a	3106 a
Rondo x 10^{-4} M	2918 a	6780 a	3101 a	4266 a
Rondo x 10^{-5} M	1976 a	4560 a	2018 a	2851 a
Means	2858 c*	5078 a	3806 b	

*Any two means carrying the same letter(s) in a column or row are non- significantly different at P=0.05 by Duncan's Multiple Range Test, ST: Seed treatment, STFS: Seed treatment plus foliar spray and FS: Foliar spray

Discussion

The number of pods plant^{-1} has been studied extensively (Kokhar *et al.*, 1988; Hussain & Badshah, 2002), and it was revealed that number of pods plant^{-1} is variable in pea varieties under different climatic conditions. During the present study the maximum number of pods plant^{-1} were observed in Meteor which ultimately emerged as number one variety in terms of green pod yield. The variation among the varieties regarding the number of pods might be attributed to the genetic makeup of the varieties. The number of pods plant^{-1} was high in plants treated with SA 10^{-4} M as compared to that of 0 M and 10^{-5} M. It is evident that SA 10^{-4} M had a pronounced effect on the number of pods plant^{-1} as compared to other concentrations used during the study.

Furthermore the numbers of pods plant-1 were higher in the STFS plants as compared with ST and FS modes of application. Although there is no literature available about the effects of SA on pea yield and yield components, however the results of the present study can be compared with that of Fariduddin *et al*., (2003). They concluded that there was 13.7% increase in the number of pods plant^{-1} in SA treated mustard (*Brassica juncea*). Similarly in this study the increase in the number of pods plant^{-1} 14.92% was recorded in pea plants treated with SA 10^{-4} M as compared to no SA.

It has been reported that the number of seeds pod^{-1} range from 1 to 12 in cultivated peas. The number of seeds pod^{-1} is an important yield component and contributes to the final yield. Decrease in seeds pod^{-1} may result due to the genetic characteristics or environmental unsuitability, which may hinder the process of pollination, fertilization or cause abortion. Pea cultivars with higher number of seeds pod^{-1} are demanded by commercial growers (Peksen *et al.,* 2004). Number of seeds pod^{-1} has been extensively studied for different cultivars of pea (Peksen *et al.,* 2004). In the present study the maximum number of seeds pod^{-1} were recorded for the variety Climax followed by Meteor. These results are slightly different from earlier report (Haq *et al.,* 1997) where the variety Meteor was ranked above Climax. This means that variety Meteor respond better to SA treatment as compared to other varieties.

The plants treated with SA concentration 10^{-4} M produced more seeds pod^{-1} as compared to the plants treated with SA 10^{-5} M and SA 0 M; moreover the plants treated twice (STFS) produced maximum number of seeds pod^{-1} as compared with other modes of application. In general 7.84% increase in the number of seeds pod^{-1} was noted in SA treated plants over untreated.

Seed weight is an important yield component; an increase in seed weight ultimately leads to high yield. This important yield component has been studied in different pea varieties by a number of researchers (Khokhar *et al*., 1988; Hatam & Amanullah, 2002; Peksen *et al*., 2004). During the present study the maximum HSW was obtained by variety Meteor as compared to other varieties, whereas, the plants treated with SA concentration 10^{-4} M exhibited maximum HSW over 0 M and the plants treated with SA concentration 10^{-5} M. Moreover the increase in HSW was more obvious in STFS plants as compared to ST and FS plants. These results revealed that best results were obtained by treating the pea plants with SA 10^{-4} M and the plants treated by SA concentration twice during their life cycle. Moreover the FS plants gained higher HSW as compared to ST plants, indicating that the foliar spray is more effective than the seed treatment. There are no reports available on the effect of SA on HSW in the literature.

During present study the maximum BY was obtained for the variety Meteor. There was a significant increase in the BY for the plants treated with SA concentration 10^{-4} M over the plants treated with SA 10^{-5} M and 0 M suggesting a role of SA as a growth regulator during development. The maximum biological yield was recorded for the variety Meteor ultimately emerged as number one with respect to green pod yield, followed by Greenfeast. This increase in biological yield can be accredited to SA application. The variety Meteor treated with SA concentration 10^{-4} M and STFS gave best results as compared to other varieties and treatments. The SA had a positive effect on the biological yield of pea varieties treated with SA 10^{-4} M.

The final harvest has a prime place in the yield and yield components. The green pods, harvest of the pea have been studied by different workers in Pakistan in different varieties under different climatic conditions (Kokhar *et al*., 1988; Hatam & Amanullah, 2002; Hussain & Badshah, 2002). All of them reported significant variation in yield and yield components of peas except seeds per pod. During the present study the highest green pod yield was recorded for the variety Meteor followed by Greenfeast. SA concentration 10^{-4} M was found the best among other concentrations, while STFS mode of application had significant increase in green pod yield. It is concluded that an increase in yield components was recorded for all the varieties studied, which ultimately resulted in an increase in green pod yield.

References

Anonymous. 2002. *Agricultural Statistics of Pakistan*. Ministry of food, Agriculture, and Livestock. Food and Livestock Division (Economic Wing), Islamabad. Pakistan. http://www.pakistan.goov.pk/food-division/publications/asp2001-02-publication.htm

Fariduddin, Q., S. Hayat and A. Ahmed. 2003. Salicylic acid influences net photosynthetic rate, carboxylation efficiency, nitrate reductase activity, and seed yield in *Brassica juncea*. *Photosynthetiac,* 41(2): 281-284.

Haq, I., H. Rehman and S.A. Hussain. 1997. Screening of suitable pea for spring cultivation at Chitral. *Sarhad J. Agric.,* 13: 31-34.

Hatam, M. and Amanullah. 2002. Grain yield potential of filed pea (*Pisum sativum* L.) germplasm. *Asian J. Plant Sci.*, 1(2): 180-181.

Hussain, S.A. and N. Badshah. 2002. Study on the adaptive behaviour of exotic pea (*Pisum sativum* L.) varieties under local conditions of Peshawar. *Asian J. Plant Sci.,* 1(5): 567-568.

Khokhar, K.M., M.A. Khan, S.I. Hussain, T. Mahmood and Hafeez-ur-Rehman. 1988. Comparative evaluation of some foreign and local pea cultivars. *Pak. J. Agric. Res.,* 9(4): 549-551.

Manthe, B., M. Schultz and H. Schnabl. 1992. Effects of salicylic acid on growth and stomatal movements of *Vicia faba* L. Evidence for salicylic acid metabolization. *J. Chem. Ecol*., 18: 1525-1539.

Peksen, E., A. Peksen, H. Bozoglu and A. Gulumser. 2004. Comparison of fresh pod yield and pod related characteristics in pea (*Pisum sativum* L.) cultivars sown in autumn and spring under Samsun ecological conditions. *Turk. J. Agric. For.*, 28: 363-370.

Raskin, I. 1995. Salicylic acid. In: *Plant hormones, Physiology, biochemistry and molecular biology*. (Ed.): P.J. Davies. Dordrecht, Kluwer. p. 188-205.

Sarkar, R.K. 1990. Studies on the association of several morphological characters with grain yield in pea. *Indian J. Pulses Res.*, 3: 168-170.

Senaratna, T., D. Merritt, K. Dixon, E. Bunn, D. Touchell and K. Sivasithamparam. 2003. Benzoic acid may act as the functional group in salicylic acid and derivatives in the induction of multiple stress tolerance in plants. *Plant Growth Regul.,* 39: 77-81.

Serek, M. 1992. Does salicylic acid affect the post-harvest characteristics of *Campanula carpatica*? *Gartenbauwissenschaft*, 57(3): 112-114.

Sing, G. and M. Kaur. 1980. Effect of growth regulators on podding and yield of mung beans (*Vigna radiata* (L.) Wilczek). *Indian J. Plant Physiol.*, 23: 366-370.

Timmerman-Vaughan, G.M., A. Mills, C. Whitfield, T. Frew, R. Butler, S. Murray, M. Lakeman, J. McCallum, A. Russell and D. Wilson. 2005. Linkage mapping of QTL for seed yield, yield components, and developmental traits in pea. *Crop Sci.,* 45: 1336-1344.

(Received for publication 26 November 2006)