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EFFECT OF HERBICIDES AND ROW SPACING ON THE GROWTH AND YIELD OF PEA

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ABSTRACT

To investigate the effect of herbicides and row spacing on growth and yield of pea (Pisum sativum L.), a field experiment was performed at the Horticulture Research Farm, Agricultural University Peshawar during winter 2005-06. The experiment was laid out in a randomized complete block design with spilt plot arrangement having three replications. The experiment was consisted of four pre-emergence herbicides [Dual gold 960 EC (S-metolachlor), Stomp 330 EC (Pendimethaline), Sencor 70 WP (Metribuzine) and Isoproturon 50 WP (Isoproturon)] and a weedy check as main plots and four row spacings (40, 60, 80 and 100 cm) allotted to sub-plots. The findings revealed that the greater pea seeds germination (83.17 %), weeds density (241 m^{-2}) and weed biomass (1082 g m^{-2}) and taller plants (100.1 cm) were produced in weedy check plots. Lengthy pods (7.99 cm), higher number of pods (43.67), seeds $pods^{-1}$(7.8), branches $plant^{-1}$ (2.41) and pods yield (4.577 t ha^{-1}) were obtained with application of Dual gold 960 EC (S-metolachlor). Dual gold 960 EC (S-metolachlor) and Stomp 330 EC (Pendimethaline)had 50 % while Sencor 70 WP (Metribuzine) had 25 % phytotoxicity on pea crop. The highest weed density (96.87 m^{-2}) and biomass (748.2 g m^{-2}) were recorded when peas were planted at 40 cm row spacing; whereas, the lower pod length (7.3 cm), number of seeds $pods^{-1}$ (7.1) and pods yield (3.165 t ha^{-1}) were obtained when planted at 100 cm row spacing. The highest number of pods (38.94) and branches $plant^{-1}$ (2.61) were produced in 100 cm row spacing. It was concluded from the experiment that pods yield linearly decreased with increase in row spacing and the least row spacing of 40 cm resulted in higher yield and least weed infestation. Dual gold 960 EC and Stomp 330 EC were equally superior in terms of higher pods yield and yield components by reducing weeds density and weed biomass.

Key words: Growth, herbicides, pea, row spacing, yield components.

INTRODUCTION

Pea (*Pisum sativum* L.) is an important source of food in Pakistan and is an important component of our daily dishes i.e. consumed in several ways either eaten as vegetable or in soup. The total area under pea cultivation in Pakistan was 11.689 thousand hectares with total production of 83.603 thousand tons in year 2008-

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09. Khyber Pakhtunkhwa shares an area of 1.781 thousand hectare with production of 12.239 thousand tons with an average yield of 6.7 tones ha^{-1} (MINFA, 2009). Non availability of promising varieties, poor production package and lack of sensitive market are major bottlenecks in the production of pea. But the biggest problem in the way of increasing the production ha^{-1} is the weed competition (Ullah *et al.*, 2008). Weeds use the nutrients, moisture, and space etc. needed for crop plants, hence resulting in yield reduction (Jilani *et al.*, 2003). Weeds also deteriorate the quality of farm produce, hence reduce the market value. Season long crop-weed competition reduces the green pod yield by 44.6-55.6% (Prakash *et al*., 2000).

Gurcharan *et al.* (1994) found that the application of different herbicides significantly enhanced the grain yield of pea (79.6-85.1%) as compared to control treatment. Townley and Wright (1994) found that herbicide application reduced weed dry matter production, with largest effect at low field pea populations. Jensen *et al.* (1996) found temporary herbicide damage in all treatments, but were most serious in treatments with high rates of MCPA. Auskalnis (1997) noted decrease in number of weeds by 36-52%, and increase in grain yield of peas by 0.35 t ha^{-1} (8.5%), with application of Stomp 330 EC applied at 3 litres ha^{-1}. Singh and Wright (1999) found decrease in germination, nodulation, total nitrogenase activity, net photosynthesis, leaf area, and root-shoot dry weight, nitrogen content and seed yield of peas with application of pre emergence herbicides. Sharma (2002a) found maximum plant height, pod length, number of seeds pod^{-1} and seed yield ha^{-1} in 20 cm row spacing and maximum number of pods $plant^{-1}$ and 100 seed weight at higher plant spacing (40 cm). Sharma (2002b) found better seed yield in row spacing of 30 x 10 cm over 22.5 x 10 cm spacing. The grain yield was not affected by any of the cultivars. Rops (1997) got highest yields in close row spacing and yield declined by 6-17% as the spacing increased. Miller and Libbey (1999) observed that herbicides treatments for weed control did not affect pea plant density and no of pods $plant^{-1}$. Being high nutritional value of pea and its different types of culinary use, it is imperative to improve the quality and production of crop. The use of herbicides has become indispensable for the control of weed, resulting in the diversion of nutrient and moisture to the major crop plant. Row spacing on the other hand provides efficient space for plant canopy, which has direct relation with space, light aeration, so this experiment was carried out in order to study the impact of row spacing and herbicides on growth and yield components of pea production.

MATERIALS AND METHODS

In order to investigate interactive effect of herbicides and row spacing on growth and yield of pea (*Pisum sativum* L.), cv. Climax, a field experiment was conducted at Horticulture Research Farm, Agricultural University Peshawar during 2005-06. The layout of the experiment was in a Randomized Complete Block Design with spilt plot arrangement having three replications. Different herbicides viz. Dual gold 960 EC, Stomp 330 EC, Sencor 70 WP, Isoproturon 50 WP and weedy check was kept in main plot and row spacing of 40, 60, 80 and 100 cm in sub-plots. There were 20 sub-plots in each replication. Total experimental area was 542 m^2. Plant to plant distance was 10 cm. There were 10, 6, 5, 4 rows in 40, 60, 80 and 100 cm row spacing, respectively. All herbicides were applied as pre-emergence with the help of knapsack sprayers. To apply herbicides wisely, all precautionary measures were used. Nitrogen @ 15 kg and phosphorus @ 20 kg ha^{-1} as urea and single super phosphate, respectively were applied at the time of sowing.

For weed density, number of weeds m^{-2} in three randomly selected places in each plot was counted after 30 days of herbicides application using a 0.33 x 0.33 m^2 quadrate. The data was converted to weed density m^{-2}. For weed biomass, weeds within the 0.33 x 0.33 m^2 in three randomly selected places were harvested after final picking of pea, and data was converted into g m^{-2}. Pods on middle rows plants in each treatment were counted and average pods $plant^{-1}$ was calculated. Ten pods were randomly selected from harvested pods of selected plants in each treatment and their length was measured in centimetre. Pea plant was observed in each plot and damage plants were counted. The phytotoxic levels were 100, 75, 50, 25 and 0%. When all the plants were killed in a treatment that amounted to 100% phytotocicity, 75% stand for pale coloured and brown spotted leaves. About 50% phytotocicity mean yellow coloured leaves and visual weakness of a plant, and 25% phytotocicity was indicated by few yellowish spots on pea leaves, which ultimately recovered. Seeds in 10 selected pods were counted and subsequently mean numbers of seed pod^{-1} were calculated. After final picking plant height of 10 randomly selected plants were measured with measuring rod and mean was computed from the sum. Branches on 10 randomly selected plants in each treatment were counted and then average was calculated. The harvested pod from selected plant was weighed in each picking in tons and the cumulative data was converted to pods yield in t ha^{-1}.

The recorded data on all parameters was subjected to ANOVA technique by using MSTATC computer software and the significant means were separated by using Fishers protected LSD test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Germination of pea

Different herbicides had significant while row spacing and their interaction had non-significant effect on germination percentage (Table-1). Herbicides application reduced the germination percentage. The highest germination (83.2%) was recorded in weedy check and the lowest (70.7%) with Dual gold. It is clear from the results that when herbicides were applied to the plots, the germination was slightly low as compared to the plots where no herbicides were applied. As all the herbicides were applied as pre-emergence so it may be attributed to their adverse effect on pea germination. Singh and Wright (1999) found that all pre-emergence herbicides decreased germination.

Weeds density

Weeds density (m^{-2}) was significantly affected by herbicides, row spacing and their interaction (Table-1). Weeds density ranged from 60.33-241.00 m^{-2}. The highest weeds density (241.0 m^{-2}) was recorded in weedy check; while, the lowest weeds density (60.33 m^{-2}) was noticed with application of Dual gold. The experiment was infested with broad leaf weeds as well as grassy weeds, however the weeds which were in abundance in the field were *Anagallis arvensis* L., *Chenopodium album* L., *C. muale, Coronopus didymus* L., *Vicia sativa* L., *Fumera indica* L. and *Cyprus rotendus*. Gurcharan *et al.* (1994) suggested that all weeds controlling treatments resulted in 79.6-85.1% control of weed. In various row spacing, the highest weed density (152.6 m^{-2}) was recorded in 100 cm spacing which decreased with decrease in row spacing and minimum weed density m^{-2} (96.87) was found in 40 cm row spacing. The maximum weeds density in wider row spacing may be due to more nutrient, moisture and space availability for the weeds to grow while less moisture, nutrient and space are available for the weeds in case of closer row spacing. Row spacing x herbicides interaction indicated that maximum weed density (279.0 m^{-2}) was observed in weedy check x 100 cm row spacing, whereas the minimum weed density (44.3 m^{-2}) was noticed in Dual gold x 40 cm row spacing (Fig.1).

Weeds biomass

Herbicides, row spacing and herbicides x row spacing had significant effect on weeds biomass (Table-1). The highest weeds biomass (1082 g m^{-2}) was recorded in weedy check, whereas, the lowest weeds biomass (526 g m^{-2}) was observed with application of Dual gold. The herbicides Isoproturon failed to give good results in case of weeds control. The Dual gold gave very good control of weeds and hence reduced the weeds biomass. Anyszka *et al*. (1998) stated that mixture of herbicide (Propisochlor @ 2.16 kg ha^{-1} and Prometryne @ 1.80 kg ha^{-1}) gave best results with 99.5-100 % reduction in weed biomass. Weed biomass increased with increase in row spacing. The highest weeds biomass (797.1 g m^{-2}) was found in 100 cm row spacing, whereas, the lowest weed biomass (748.2 g m^{-2}) was found in 40 cm row spacing. The maximum weed biomass in wider row spacing may be due to more space, moisture, nutrient and light availability to the weeds. With decreasing row spacing the weeds growth also decreased and hence weeds biomass decreased. The interaction (herbicide x row spacing) indicated that weeds biomass (1114.3 g m^{-2}) was higher in weedy check x 100 cm row spacing and lowest weeds biomass (493.3 g m^{-2}) was found in plots of Dual gold x 40 cm row spacing (Fig. 2).

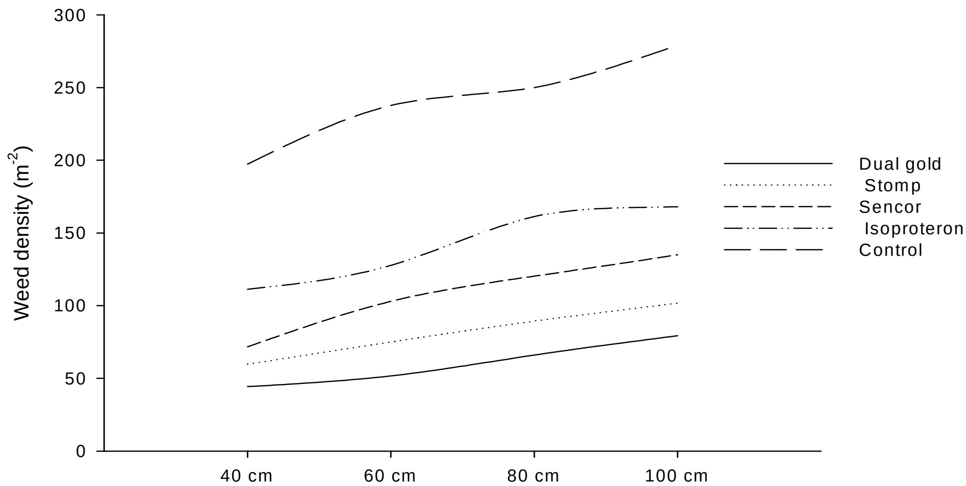

Figure 1. Interaction between herbicides and row spacing for weed density m^{-2}.

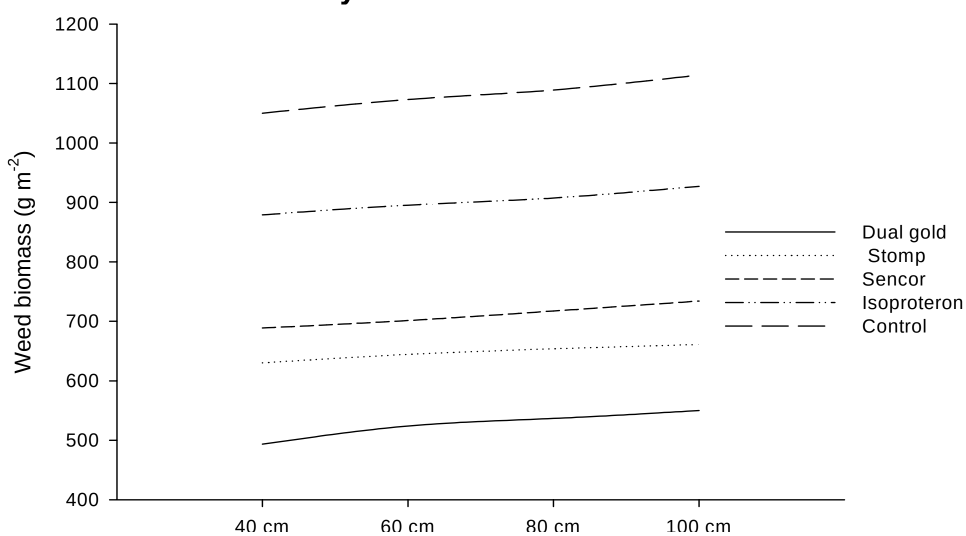

Figure 2. Interaction between herbicides and row spacing for weed biomass (g m^{-2}).

Plant height

Herbicides, row spacing, and herbicide x row spacing interaction had significant effects on plant height (Table-1). In case of various herbicides, taller plants (100.1 cm) were observed in weedy check, and shorter plants of 89.25 cm were produced in plots sprayed with Dual gold. Taller plants in weedy check plots may be due to the competition of pea plants with weeds for sunlight, water and nutrients uptake that resulted in leggy, weaker and taller plants. The dwarf plants in plots applied with Dual gold may be due to its phytotoxic effect on pea plant and so the plants do not recovers quickly and remained dwarfed. Singh and Wright (1999) found that decrease in growth of herbicides treated plots may be due to the direct effect of herbicides on pea. In case of different row spacing, tallest (100.1 cm) and shortest plants (90.33 cm) were recorded in 40 and 100 cm row spacing, respectively. In close row spacing, the space for plant spreading was less and hence plant height increased significantly. Sharma (2002a) found the tallest plant from closer row spacing. In case of interactive effects of herbicides x row spacing, application of Isoproturon gave taller plants (106.0 cm) in 40 cm row spacing, whereas, Dual gold resulted in shorter plants (85.33 cm) in 100 cm row spacing (Fig. 3).

Table-1. Germination, weed density, weed biomass and plant height of pea as affected by pre-emergence herbicides (H) and row spacing (RS).

Treatments	Germination (%)	Weed density m^{-2}	Weed biomass ($g\ m^{-2}$)	Plant height (cm)
Herbicides				
Dual gold 960 SC	70.7 e	60.33 e	526.0 e	89.25 d
Stomp 330 EC	72.4 d	81.42 d	647.0 d	92.56 cd
Sencor 70 WP	75.3 c	107.5 c	710.3 c	95.83 bc
Isoproturon 50 W	78.5 b	142.1 b	902.2 b	98.83 ab
Weedy check	83.2 a	241.0 a	1082. a	100.1 a
LSD	1.666	5.86	10.17	3.569
Row Spacing (cm)				
40	76.3	96.87 d	748.2 d	100.1 a
60	75.8	119.0 c	767.5 c	96.93 b
80	76.1	137.4 b	780.8 b	93.80 c
100	75.9	152.6 a	797.1a	90.33 d
LSD	NS	3.32	4.395	1.001
Interaction				
H x RS	NS	*Fig. 1	*Fig. 2	*Fig. 3

Means of the same category followed by different letters are significantly different at 1% probability and NS = Non-significant.

Number of branches plant^{-1}

Analysis of the data indicated that herbicides, row spacing, and herbicide x row spacing interaction had significant effects branches plant^{-1} (Table-2). More branches plant^{-1} (2.4) was noticed in plots applied with Dual gold and less number of branches plant^{-1} (1.4) in weedy check. The higher number of branches plant^{-1} in Dual gold applied plots may be due to fewer weeds in these plots which provide more space, nutrient and moisture for the plant to grow. The competition of the crop with weeds was less which helped in the growth of the plant and hence produced more branches plant^{-1}. The less number of branches in weedy check plots may be result of more weeds in these plots and more competition between the crop and the weeds for the space, nutrient and moisture. In case of row spacing, more number of branches plant^{-1} (2.6) were recorded in 100 cm row spacing where as less number of branches plant^{-1} (1.4) were observed in 40 cm row spacing. The increase in number of branches plant^{-1} in wider row spacing may be due to more space availability to plants to spread rather to grow straight. This was the main reason that the plant height in wider row spacing was less and hence produces more branches; on the other hand, plant height in closer row spacing was more and gave less number of branches plants^{-1}. Similarly, Sharma (2002a) found more number of branches plant^{-1} in wider row spacing. In case of interaction, maximum branches plant^{-1}(3.36) were recorded with Dual gold applied in plots maintained at 100 cm row spacing, whereas less number of branches plant^{-1} (1.10) was observed in weedy check plots having 40 cm row spacing (Fig.4).

Pod length

Pod length was significantly affected by various herbicides, row spacing and their interaction (Table-2). In case of herbicides, longer pods (7.99 cm) were noted with Dual gold, whereas the smaller pods (7.1 cm) were recorded in weedy check plots. The minimum pods length in weedy check plots may be due to the competition of weeds with crops plants for light, space and nutrients, while maximum pods length in plots where Dual gold was applied can be attributed to the fact that the weeds were controlled throughout the cropping season as compared to other herbicides and the pea plant did not faced any competition with weeds. Prakash *et al.* (2000) suggested that pea crop produced longer pods when the numbers of weeds decreased. In row spacing, longer pods (7.98 cm) were noticed in 40 cm row spacing and smaller pods (7.3 cm) in 100 cm row spacing. This may be due to the fact that less space was available for the weeds to grow in closer row spacing and the competition of the crop with weeds was less resulted in comparatively longer pods. Interaction between herbicides x row spacing indicated that pod length (8.3 cm) in 40 cm row spacing was higher when treated with Stomp and Dual gold, whereas in weedy check plots produced shorter pods (6.9 cm) planted at 80 and 100 cm row spacing (Fig. 5)

Number of pods plant^{-1}

Number of pod plant^{-1} was significantly affected by herbicides, row spacing and their interaction (Table-2). In case of herbicides, maximum number of pods plant^{-1} (43.67) were recorded with Dual gold and minimum number of pods plant^{-1} (25.74) was observed in weedy check plots. The increase in number of pods plant^{-1} with application of herbicides especially with Dual gold may be due to the increase in number of branches plant^{-1} and less competition with weeds for space, light, nutrient and moisture uptake that increased number of pods plant^{-1}. Prakash *et al.* (2000) suggested that number of seeds pods^{-1} improved with decrease in number of weeds per unit area. In case of row spacing, higher number of pods plant^{-1} (38.94) was recorded in 100 cm row spacing as compared to minimum of 32.04 pods plant^{-1} in 40 cm row spacing. The increase in the number of pods plant^{-1} in wider row spacing may be due to vigorous plants as in wider spacing; plant grew vigorously and produced more branches which resulted in high number of pods plant^{-1}. On the other hand, in closer row spacing, the plant growth was decreased which resulted in less number of pods plant^{-1}. Sharma (2002a) found the highest number of pods number plant^{-1} in wider row spacing as compared to closer spacing. Fig 7 showed the interaction between herbicides x row spacing, greater number of pods plant^{-1} (48.80) was recorded with Dual gold in 100 cm apart rows, and the minimum number of pods plant^{-1} (24.77) noted in weedy check plots planted at 40 cm apart rows (Fig. 6).

Number of seed pod^{-1}

It is evident from Table-2 that herbicides, row spacing and their interaction had significant effects on number of seed pod^{-1}. In herbicide treatments, maximum number of seed pod^{-1} (7.8) were recorded with application of Dual gold, closely followed by Stomp 330 EC (7.7), while the minimum number of seed pod^{-1} (6.9) were obtained in weedy check plots. Size of pods was longer with application of Dual gold and hence resulted in maximum number of seeds pod^{-1} and visa versa. Prakash *et al.* (2000) suggested that number of seeds pods^{-1} increased with decrease in weeds density. In case row spacing, the highest numbers of seed pod^{-1} (7.8) were noted in 40 cm row spacing, whereas the lowest number of seed pod^{-1} (7.1) were recorded in 100 cm row spacing. It may be due to the fact that in closer row spacing the pods length was maximum resulting in maximum no seeds pod^{-1} in these plots and visa versa. Sharma (2002a) found maximum number of seeds pods^{-1} in wider row spacing than closer row spacing. The interaction between herbicides and row spacing is given in fig 6, the highest number of seed pod^{-1} (8.1) was observed with Dual gold when applied in 40 cm row spacing as compared to the lowest number of seed pod^{-1} (6.7) in weedy check plots planted in100 cm apart rows (Fig. 7).

Table-2. Branches per plant, pods length, pods per plant and pod yield of pea as affected by pre-emergence herbicides (H) and row spacing (H).

Treatments	Branches plant^{-1}	Pods plant^{-1}	Pods length (cm)	Seeds pod^{-1}	Pod yield (t ha^{-1})
Herbicides					
Dual gold 960 EC	2.4 a	43.67 a	7.99 a	7.8	4.577 a
Stomp 330 EC	2.2 b	39.48 b	7.9 a	7.7	4.262 ab
Sencor 70 WP	2.1 bc	35.79 c	7.7 b	7.5	3.560 bc
Isoproturon 50 WP	1.8 c	31.60 d	7.5 c	7.4	3.257 c
Weedy check	1.4 d	25.74 e	7.1 d	6.9 c	2.246 d
LSD	0.24	2.54	0.29	0.29	0.76
Row spacing (cm)					
40	1.4 d	32.04 d	7.98 a	7.8	3.957 a
60	1.7 c	34.03 c	7.8 b	7.6	3.745 b
80	2.2 b	36.02 b	7.5 c	7.3 c	3.455 c
100	2.6 a	38.94 a	7.3 d	7.1	3.165 d
LSD	0.15	0.53	0.04	0.04	0.18
Interaction					
H x RS	*Fig. 4	*Fig. 5	*Fig. 6	*Fig. 7	NS

Mean of the same category followed by different letter are significantly different at 1% probability and NS= Non-significant

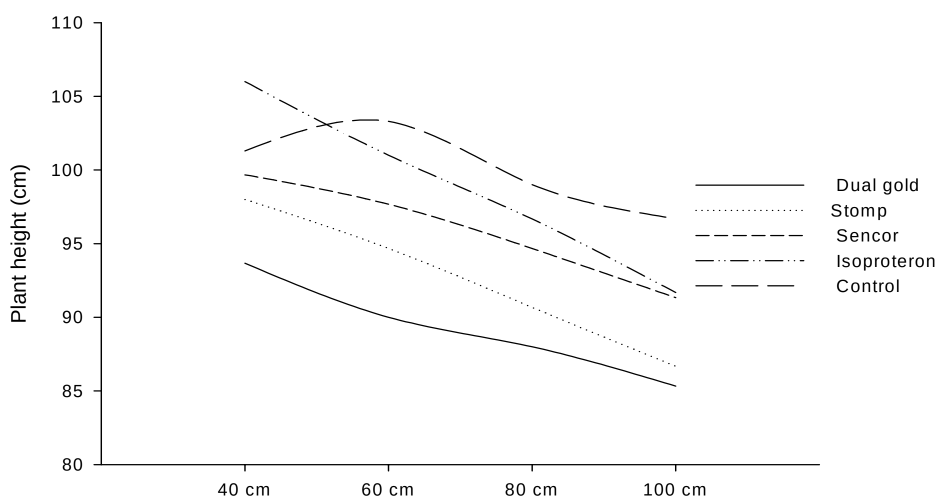

Figure 3. Interaction between herbicides and row spacing for plant height (cm).

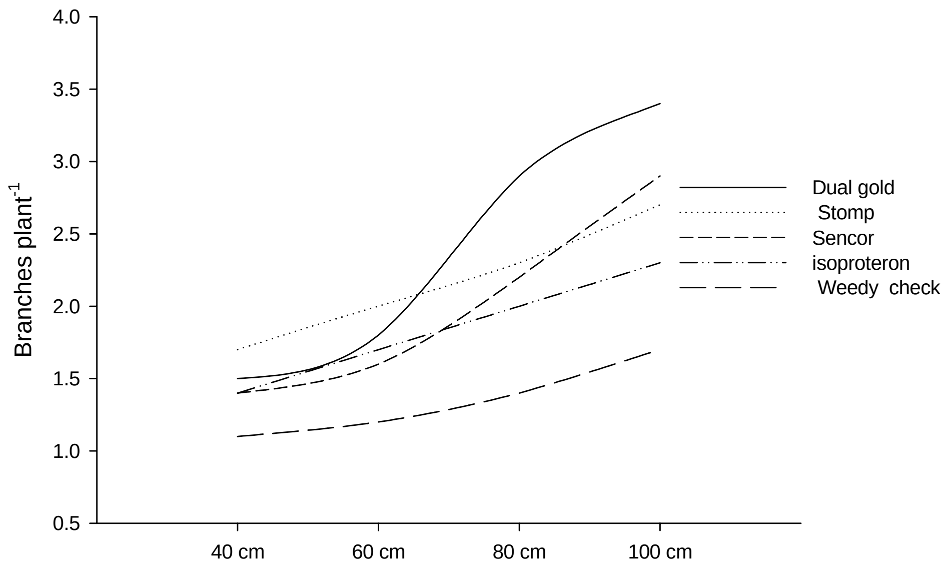

Figure 4. Interaction between herbicides and row spacing for branches plant^{-1}.

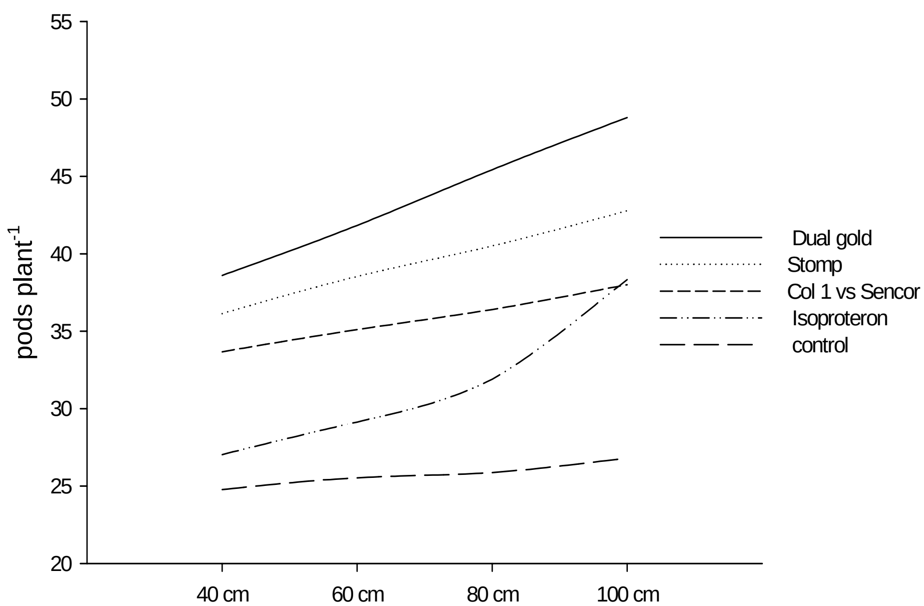

Figure 5. Interaction between herbicides and row spacing for pods plant^{-1}.

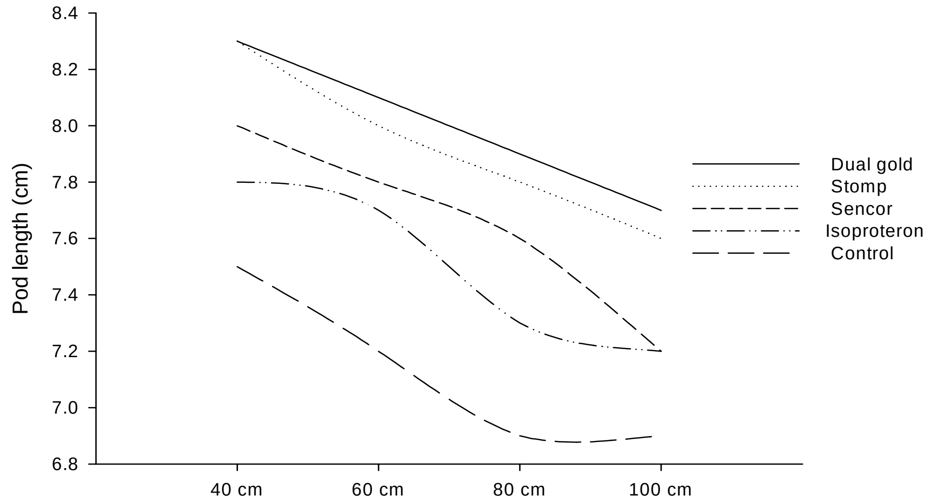

Figure 6. Interaction between herbicides and row spacing for pod length (cm).

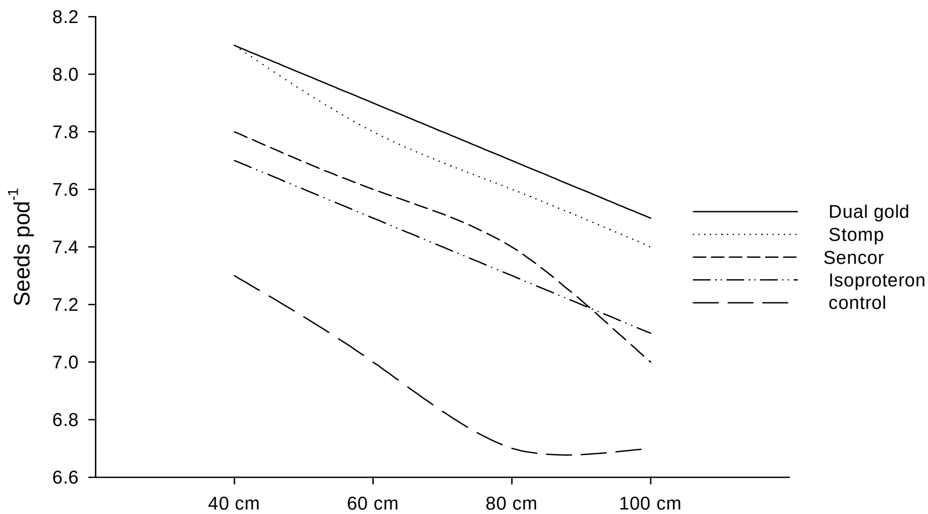

Figure 7. Interaction between herbicides and row spacing for number of seeds pod^{-1}

Pods yield (t ha^{-1})

Perusal of the data indicated that herbicides and row spacing had significant and their interaction had non significant effects on pods yield (Table-2). The highest pods yield (4.577 t ha^{-1}) was recorded with Dual gold and the lowest yield (2.246 t ha^{-1}) produced in the weedy check. The low pods yield in weedy check plots may be the results of weeds competition with pea crop for light, moisture and nutrients. Prakash *et al*. (2000) found that long season crop weeds competition reduces the green pods yield by 44.6 to 55.6 %. The high pods yield in plots applied with Dual gold was attributed to the better weeds control which made the better utilization of the resources like nutrients, solar radiation, water and space by pea crop that resulted in higher pods yield. Townley and Wright (1994) stated that good weeds control is critical in order to obtain high pods yield from pea. In row case spacing, the highest pods yield (3.957 t ha^{-1}) was recorded in 40 cm row spacing and decreased significantly with increase in row spacing i.e. the lowest pods yield of 3.165 t ha^{-1} was obtained from the plots planted in 100 cm row spacing. In closer row spacing, the number of pods $plant^{-1}$ were less as compared to wider row spacing but the number of plants per unit area was more that resulted in higher pods. Rops (1997) found that yield increased in closer row spacing and declined by 6-17 % as the spacing is increased.

CONCLUSION

Pods yield linearly decreased with increase in row spacing. The herbicide, Dual gold 960 EC was superior in terms of high pods yield by improving growth and yield component of pea crop. The findings suggested that application of herbicide Dual gold in pea crop, when planted at 40 cm apart rows produced the optimum yield and yield components in the study area.

REFERENCES CITED

Anyszka, Z., A. Dobrzanski, and J. Palczynski. 1998. Usefulness of propisochlor in controlling weeds in green peas *(Pisum sativum* L.). Veg. Crops Res. Bull. 49(3): 63-69.

Auskalnis, A. 1997. Effectiveness of the herbicides Stomp, Harness and Topogard on pea yield and weediness. In: Scientific Conference devoted to the 70th anniversary of plant protection science held in Lithuania, Dotnuva Akademija, Lithuania on 7-9 September, 1997. pp. 175-178.

Gurcharan, S.H., C. Kundra, L.S. Brar, R.P. Gupta and G. Singh. 1994. Effect of herbicides on soil micro-organism dynamics, Rhizobium-legume symbiosis and grain yield of pea (*Pisum sativum*). Ind. Ann. Agric. Res. 15(1): 22-26.

Jensen, P.K., P.F. Hansen, H. Brown (ed.), G.W. Cussans (ed.) and M. D. Devine. 1996. Tolerance of climbing peas to phenmedipham, desmedipham and ethofumesate containing herbicides used separately or in mixture. In: Proceedings of the second international weed control congress, Copenhagen, Denmark, 25-28 June 1996.

Jilani, M.S., A. Ghaffoor and S. Rehman. 2003. Conventional and chemical control of weeds in five cultivars of transplanted onion (*Allium cepa* L.). Pak. J. Weed Sci. Res. 9(3-4): 215-224.

Miller, T.W. and C.R. Libbey. 1999. Herbicides for weed control in green peas. Res. Prog. Report Western Soc. of Weed Sci. pp: 68-70.

MINFA. 2009. Agriculture Statistic of Pakistan. Ministry of Food and Agriculture, Govt. of Pakistan, Islamabad.

Prakash, V., A. K. Pandey, R. B. Singh and V. P. Mani. 2000. Integrated weed management in garden pea under mid-hills of north-west Himalayas. Ind. J. Weed Sci. 32(1-2): 7-11.

Rops, A.H.J. 1997. Effect of wider row spacing and date of sowing on the yield of anning peas. Publicatie Proefstation voor de Akkerbouw en de Groenteteelt in de Vollegrond, Lelystad. No. 81A, 215-216. (CAB Abst).

Sharma, S.K. 2002a. Effect of sowing time and spacing levels on seed production of pea cultivar Arkel. Seed Res. 30(1): 88-91.

Sharma, K.C. 2002b. Effect of dates of sowing and row spacing on chick pea genotypes under late sown conditions. Adv. Plant Sci. 15(2): 517-523.

Singh, G. and D. Wright. 1999. Effect of herbicides on nodulation, symbiotic nitrogen fixation, growth and yield of pea (*Pisum sativum* L). J. Agric. Sci. 133(1): 21-30.

Steel, R.G.D. and J.H. Torrie. 1980. Principles and procedure of statistics. 2nd Ed. McGraw-Hill, New York.

Townley, S.L., and A.T. Wright. 1994. Field pea cultivars and weed response to crop seed rate in western Canada. Canad J. Plant Sci. 74(2): 387-393.

Ullah W., M.A. Khan, S. Arifullah and M. Sadiq. 2008. Evaluation of Integrated weed management practices for maize (*Zea mays* L.). Pak. J. Weed Sci. Res. 14(1-2): 19-32.