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EFFECT OF WEED COMPETITION AT DIFFERENT GROWTH STAGES ON THE YIELD OF POTATO (*SOLANUM TUBEROSUM* L.)

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Abstract

In a field experiment weeds were allowed to compete for 3, 5, 7, 9, and 10 weeks after planting potato crop and then all plots were kept free of weeds until harvest. In an other set plots were kept free of weeds for 3, 5, 7, 9, and 10 weeks after potato planting then weeds were allowed to compete with potato crop for rest of its growth. Weedy check and weed free plots till harvest were also included. Results revealed that weed competition during first 3 to 5 weeks reduced potato yield considerably. This appears to be the stage when weeds must be controlled to ensure good harvest. Highest yield of 34 t. ha-1 (82% higher than weed infested plots) was obtained when the crop was grown in a weed-free environment.

Introduction

Potato is and important food crop grown abundantly in Pakistan. It covers and area of *80* thousand hectares with an annual production of *83* thousand tonnes. Its per hectare yield (*10.5* t ha-1) is very low (Anonymous, 1991). High fertilizer dose with frequent irrigations tremendously increases weed growth. The weeds successfully compete with the potato crop for water, nutrients and light and thus reduce the yield and quality of tubers (Singh, 1986). The degree of losses in yield vary with the stage duration and degree of competition. It is, therefore, important to identify, the critical period of weed-crop competition for effective weed control programme. Mathingly and Widdavosn (1958) found that the rate of crop growth affect absorption of phosphorus. When crop growth is low, less phosphorus is taken up. Shahota and Gkovindakrishnan (1979) found that if the start of a weed-free period in potatoes was delayed for 60 days, weed dry weight increased from 2.5 to 17.1 t ha-1 compared with 20.4 t ha-1 in the control, while tuber yield was reduced from 7.80 to 3.76 t ha-1 (3.56 t ha-1 in weedy check). Schepps and Ashely (1985) reported that weeds decreased the rate of photosynthesis by shading the crop plants and ultimately translocation of photosynthates towards tuber decreased which resulted in small tuber size. According to Singh *et al.* (1986) maximum tuber yield (10.02 to ha-1) was obtained in plots kept weed free till harvest followed by those kept weed free till 45 days after sowing (9.88 t ha-1) and was significantly greater than all other treatments i.e. weed free till o, 15, 30, 60 and 75 days after sowing.

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As the potato emergence is very slow, therefore, the emerging shoots are liable to have serious competition with weeds from germination until the plant begins to proliferate and cover the rows. Determination of the most critical period of weed-potato-competition is therefore highly desirable for effective weed management.

The present study was, therefore, planned to find out the critical periods of weed infestation limiting the potato crop yield under Faisalabad (Pakistan) conditions.

Materials and Methods

An experiment to study the effect of weed competition at different growth stages on the yield of potato (*Solanum tuberosum* L.) was conducted on sandy loam soil with pH 6.7. The experiment was laid out using randomized complete block design with four replications and a plot size measuring 2.5 x 6m. Potato cultivar "Desire" was sown @ 2.5 t ha-1 in 62.5 cm apart rows with plant to plant distance of 15 cm. Twenty cart loads of farm yard manure were added before the crop was sown. 50 kg N + p205 ha-1 was applied at sowing and 50 kg N was added with first earthing up. There were three sets of treatments.

Ist set included:

T1 Weedy check
T2 Weed-crop competition for 3 weeks after planting
T3 Weed-crop competition for 5 weeks after planting
T4 Weed-crop competition for 7 weeks after planting
T5 Weed-crop competition for 8 weeks after planting
T6 Weed-crop competition for 9 weeks after planting
T7 Weed-crop competition for 10 weeks after planting

After prescribed period of weed-crop competition, crop was kept free of weeds until harvest.

Second set included:

T8 Weed-crop competition through out growth period
T9 Weed-free plots until 3 weeks after planting
T10 Weed-free plots until 5 weeks after planting
T11 Weed-free plots until 7 weeks after planting
T12 Weed-free plots until 8 weeks after planting
T13 Weed-free plots until 9 weeks after planting
T14 Weed-free plots until 10 weeks after planting

Third set included:

T15 two hoeings at 3 and 7 weeks after planting
T16 Two hoeings at 5 and 9 weeks after planting

In treatments T8 to T14 where weeds were not allowed to grow for first four weeks Gramaxone was applied as pre-emergence to check weed growth. For subsequent weedy check (three WAP) in such plots hand weeding was done every fortnight.

Fresh above ground weed biomass was recorded from an area of one meter square at each weeding date. Broadleaf and grassy weeds were weighed separately and then added together to work out total weed biomass per hectare.

The potatoes were sorted out into different categories i.e. small, medium and large visually and their relative contribution to total yield was worked out in percentage.

Soil samples were collected from the upper 22.5 cm of soil to determine relative uptake of NP from different weed control treatments. At harvest two central rows from each plot were harvested and yield was recorded and converted to hectare basis.

The data collected were analyzed statistically using f=Fisher's analysis of variance technique. Duncan's New Multiple Range Test at 5 percent probability level was applied to test the differences among treatment means (Steel and Torrie, 1980).

Results and Discussion

Weed flora of experimental field comprised of *Amaranthus viridis* L.(Pigweed), *Anagallis arvensis* L. (Pimpernal), *Chenopodium album* L. (goose foot), *Convolvulus arvensis* L. (bindweed), *Digera arvensis* Forsk (torsok), *Medicago denticulata* L. (medic), *Melilotus parviflora* L. (Sweet clover), *Portulacca oleracea* L. (Purselane), *Rumex dentatus* L. (dock), *Senebiera didyama* L. (Swinecress), *Trianthema monomgyna* L. (Horse purselane), *Cyperus rotundus* L. (purple nutsedge) and *Cynodon dectylon* L. (bermuda grass). Broad leaved weeds were 71 percent of the total weed biomass of 35.99 t ha-1 (Tabled 1-a). In a treatment where the weeds were allowed to grow until harvest a total weed biomass of 35.99 t ha-1 (Fresh wt.) was recorded followed by 31.66 and 33.99 t ha-1 in treatments where weeds were allowed to grow for first 9 and 10 weeks after planting, respectively (Table 1-a). Weedy check and weed-crop competition for 10 WAP produced statistically same weed biomass. Weed crop competition for only 3 WAP produced the lowest weed biomass. Similarly in treatments where the weeds were not allowed to grow for first 3-5 weeks there was treatments amount of biomass. Again where the weeds were removed at 3 and 7, 5 and 9 weeks after planting there was considerable increase in weed biomass.

On the other hand lowest weed biomass was produced where plots were kept weed free until 9 and 10 WAP. However weed-free environment until 8, 9 and 10 WAP produced similar weed biomass. Hoeing at 3 and 7 WAP was more effective in decreasing weed biomass production than hoeing at 5 and 9 WAP. However, these were not as effective as the weed control by the herbicide used. These results are in agreement with the finding of Sahota and Govindakrishnan (1979).

The data (Table 2) revealed that in weedy check the percentage of smaller tubers was very high than in the plots which wee kept weed free throughout the growth period and until 10

WAP. The percentage of small and large tubers was 16.0 and 25.0, respectively in potato plots left weed infested for the first 10 WAP, while the percentage of smaller and larger size tubers were 8.0 and 38 percent, respectively in weed free plots. Plots kept weed free for the first 3 week when compared with weed infested plots upto 9 WAP had statistically same results. Plots kept free upto 9 WAP were also having similar results to plots kept weed free upto 10 WAP and to plots kept weed free for the whole season. Weeds in weedy plots suppressed the crop canopy by their dominating characteristic mainly by the shading effect (Schepps and Ashely, 1985).

Highest tuber yield of 34 t ha-1 was obtained in weed-free plots which was 82 percent higher than weedy check (Table 3a). Weed-free or weed infested period upto 3 WAP did not show significant differences. Probably this is the time when weed crop competition is relatively low. If weed crop competition is allowed for 5 weeks after planting, or beyond there is considerable decrease in tuber yield. The difference in yield increased with increasing time intervals.

In situation where crop was kept free of weeds upto 3-5 WAP (Table 3b) or beyond was proportionate increase in yield ranging from 48-78 percent. Where the weeds allowed to compete for 3 and 7 WAP and 5-9 WAP, although the yield was higher compared with weedy check but considerably low compared with early control of weeds. These results are substantiated by the findings of Sahota and Govindakrishnan (1979) and Singh et al. (1986).

It may be concluded that crop weed competition upto 3 WAP is most critical. Early weed control tends to increase crop yield by minimizing crop weed competition whereas delayed weeding tends to decrease the crop yield by increasing weed crop competition.

The soil samples taken at harvest from different treatments (Table 4) show that there was no difference in N uptake in any of the treatments sampled. However weed-infested plots uptake of phosphorus was less because of poor potato tuber formation, hence there was more residual phosphorus. Residual phosphorus appears to be higher where the weeds were allowed to grow throughout the season while in all season weed-free plots, its level was lower indicating higher phosphorus uptake by the crop.

It appears that during early vegetative growth of the crop when weed-crop competition was less nutrients were taken up almost equally by the weed and crop plants. However, relatively higher level of phosphorus at harvest show that phosphorus absorption was less in weedy than in weed-free plots. Similar results were reported by Mathingly and widowson (1958). Economic analysis showed that maximum net benefit of Rs. 79222.5 ha-1 was obtained in treatment in which plots were kept weed free throughout the growth period of crop (Table 5). It was followed by the treatment where wed were removed uptill 10 WAP. Weed-free environment from 3 WAP onward gave the highest marginal role of return (MRR) (11900%), thereby suggesting its superiority over all other weed-crop competition stages. It was followed by plots where there was no weed-crop competition upto 8 WAP (MRR = 2008.33%).

Table 1. Above Ground Weed Biomass (t ha^{-1}) as Effected by Various Weed Control Durations

Treatments	Broad leaves	Grasses	TOTAL
Weedy Check	29.99 a	6.00 a	35.99 a
Weed-crop competition for 3WAP**	10.66 h	2.00 fg	12.66 h
Weed-crop competition for 5WAP	15.99 g	3.33 ef	19.32 g
Weed-crop competition for 7WAP	22.66 de	3.83 de	26.49 de
Weed-crop competition for 8WAP	24.66 abc	4.33 ed	28.99 cd
Weed-crop competition for 9WAP	26.66 abc	5.00 bc	31.66 bc
Weed-crop competition for 10WAP	28.66 ab	5.33 ab	33.99 ab
Noweed-crop competition	6.66 i	1.00 h	7.66 i*
Weed-free plots until 3 WAP	25.32 c	4.00 dc	29.32 cd
Weed-free plots until 5 WAP	21.33 e	3.33 ef	24.66 ef
Weed-free plots until 7 WAP	15.99 g	2.67 f	18.66 g
Weed-free plots until 8 WAP	9.33 h	2.67 f	12.00 hi
Weed-free plots until 9 WAP	8.66 hi	1.67 gh	10.33 hij
Weed-free plots until 10 WAP	7.33 i	1.00 h	8.33 ij
Hoeing at 3x7 WAP	18.66 f	3.33 ef	21.99 fg
Hoeing at 5x9 WAP	22.66 de	4.66 bed	27.32 de

* = Any two means in a column not sharing a letter in common differ significantly 5% probability level.

** = WAP = Weeks after planting.

Table 2. Effect of Weed Control Durations on the Tuber Size (%age) as Small Medium Large Tubers Graded Visually

Treatments	Small	Medium	Large
Weedy Check	28.00 a	48 i	24 i
Weed-crop competition for 3WAP**	9.00 gh	56 efg	35 bc
Weed-crop competition for 5WAP	10.00 fg	57 def	33 cd
Weed-crop competition for 7WAP	12.00 de	58 cde	30 ef
Weed-crop competition for 8WAP	13.00 cd	60 bc	27 gh
Weed-crop competition for 9WAP	14.00 c	60 bc	26 ghi
Weed-crop competition for 10WAP	16.00 b	59 cd	25 hi
Noweed-crop competition	8.00 h	54 ghi	38 a*
Weed-free plots until 3 WAP	14.00 c	60 bc	26 ghi
Weed-free plots until 5 WAP	11.00 ef	60 bc	29 f
Weed-free plots until 7 WAP	10.00 fg	58 cde	32 de
Weed-free plots until 8 WAP	9.5 fgh	54.5 gh	36 ab
Weed-free plots until 9 WAP	9.00 gh	55 fgh	36 ab
Weed-free plots until 10 WAP	8.00 h	54 ghi	38 a
Hoeing at 3x7 WAP	10.00 fg	62 ab	28 fg
Hoeing at 5x9 WAP	11.00 ef	63 a	26 ghi

* = Any two means in a column not sharing a letter in common differ significantly 5% probability level.

** = WAP = Weeks after planting.

Table 3. Effect of Weed Control Durations on Yield of Tubers (t/ha)

Treatments	Yield (t/ha)	% increase over weedy check
Weedy Check	18.67 g	-
Weed-crop competition for 3WAP**	26.70 ed	43.0
Weed-crop competition for 5WAP	22.70 ef	21.6
Weed-crop competition for 7WAP	20.67 efg	10.7
Weed-crop competition for 8WAP	20.00 fg	7.1
Weed-crop competition for 9WAP	20.00 fg	7.1
Weed-crop competition for 10WAP	19.34 fg	3.6
Noweed-crop competition	34.00 a	82.1
Weed-free plots until 3 WAP	27.67 c	48.2
Weed-free plots until 5 WAP	29.34 bc	57.2
Weed-free plots until 7 WAP	31.33 ab	67.8
Weed-free plots until 8 WAP	32.00 ab	71.4
Weed-free plots until 9 WAP	32.67 ab	75.0
Weed-free plots until 10 WAP	33.33 a	78.5
Hoeing at 3x7 WAP	24.00 de	28.5
Hoeing at 5x9 WAP	20.67 efg	10.7

* = Any two means in a column not sharing a letter in common diff significantly 5% probability level.

** = WAP = Weeks after planting.

Table 4. Effects of Weed Control Durations on Nitrogen and Phosphorus Levels in Soil at Crop Harvest

Treatments	N(Kg ha^{-1})	P(Kg ha^{-1})
Weeks after planing	N.S.	
Weed free	11.4	13 e*
Weedy check	11.3	18 a
Unweeded 8	11	15 cd
Unweeded 10	11.1	17 ab
Hand weeded 8	11.1	14 de
Hand weeded 10	11.3	13 e
Hand weeded 3+7	10.98	14 de
Hand weeded 5+9	11	16 bc

N.S. = Non Significant

* = Any two means in a column, not sharing a letter in common different significantly 5% probability level.

Table 5. Marginal Analysis of the Undominated Herbicides Response Data (ha^{-1})

Treatments	Net benefit (Rs.)	Variable cost (Rs.)	M.Increase in Net Benefit (Rs.)	M.Increase in variable cost (Rs.)	Marginal rate of return
0 week (weed-free)	97222.5	1527.5	1300	300	433.33
10 WAP (no weeds)	77922.5	1227.5	2850	300	950
8 WAP (no weeds)	75072.5	927.5	6025	300	2008.33
5 WAP (weed free)	69047.5	627.5	3675	300	1225.0
3 WAP (weed free)	65372.5	327.5	18172.5	27.5	11900.0
9 WAP weed infested)	47200.0	300.0	2850	300	100
0 WAP (weeds through out the season	44350.0	0	-	-	-

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