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Effects of Different Soil Tillage Methods, Weed Control and Phosphorus Fertilizer Doses on Yield Components in Chickpea under Central Anatolian Conditions

[1]Nihal Kayan and [2]M. Sait Adak
[1]Department of Field Crops, Faculty of Agriculture, Osmangazi University, Eskişehir, Turkey
[2]Department of Field Crops, Faculty of Agriculture, Ankara University, Ankara, Turkey

Abstract: This research was carried out in Central Anatolian region (in Haymana, Turkey) throughout 2 years (2002-2003). The objective of this study was to determine the effects of different soil tillage methods, weed control and phosphorus fertilizer doses on yield and yield components of chickpea. The experimental design was split plot with three replications. In the research, two different soil tillage methods (moldboard plow and rotary tiller), two weed control methods (hand weeding and herbicide application) and three phosphorus doses (30, 60 and 90 kg P_2O_5 ha^{-1}) were used. According to the results, different soil tillage methods had effect on the number of plant at emergence. Tradational Tillage (TT) plots values had higher than Minimum Tillage (MT) values. Except harvest index, weed control methods had effect on all of the yield components. Hand weeding is the most effective method in weed control. When hand weeding isn't possible in wide areas, herbicide application may advice as an alternative solution. Phosphorus fertilization may provide high yield in chickpea.

Key words: Chickpea, soil tillage, weed control, phosphorus fertilization

INTRODUCTION

Chickpea is usually grown of marginal areas of the world[1]. It is also grown at marginal areas of the Turkey. The total growing area of this crop is 650,000 ha with a total production of 590,000 t in Turkey[2].

The grain yield of chickpea is reduced by weeds. Hand weeding methods is the most effective method in weed control. When hand weeding isn't possible in wide areas, herbicide application and cultural methods may advice as a alternative solutions. Usually lime level exceed 25% in dryfarming areas of Central Anatolia[3]. Therefore phosphorus fertilization is important in this area. However phosphorus fertilization of chickpea is little or none.

The objective of this study was to determine the effects of different soil tillage methods, (Tradational Tillage (TT)- Minimum Tillage (MT), weed control (hand weeding and herbicide) and phosphorus fertilizer doses (30, 60 and 90 kg P_2O_5 ha^{-1}) on yield and yield components of chickpea.

MATERIALS AND METHODS

This research was conducted for two years in the experimental field of Research and Application Farm, Faculty of Agriculture, University of Ankara (Haymana) during 2002 and 2003. Characteristics of soil at the experimental site are presented in Table 1. Climatic data related to the research location are shown in Table 2. Gökçe chickpea cultivar were used as research material. First year Gökçe was sown on March 18 and second year on April 16.

Soil tillage methods: Traditional Tillage (TT): moldboard plow (15-20 cm depth)
Minimum Tillage (MT): rotary tiller (8-10 cm depth)

Weed control methods
Hand weeding: weeding two times (in 1/3 of subplots) by hand

Herbicidal weed control: The treatment consisted 1250 cc aclonifen ha^{-1} post emergence during 2-3 leaves stage of weeds. The herbicide was applied in 300 L water ha^{-1} (in 1/3 of subplot).

Table 1: Soil characteristic of the experimental site

	2002	2003
Organic mater (%)	2.10	1.58
Clay (%)	37.80	26.00
Sand (%)	20.00	26.00
Silt (%)	42.00	48.00
pH	7.14	7.80
Ec (mmhos cm^{-1})	0.231	0.296
N (%)	0.14	0.18
P_2O_5 (ppm)	8.14	31.76
K_2O (ppm)	249.00	332.00

Corresponding Author: Dr. Nihal Kayan, Department of Field Crops, Faculty of Agriculture, Osmangazi University, Eskişehir, Turkey Tel: +90-222-3242991/16

Table 2: Climatic data of the research location

Years	Months	Temperature (°C)	Rainfall (mm)	Relative humidity (%)	Years	Months	Temperature (°C)	Rainfall (mm)	Relative humidity(%)
2002	March	6.5	47.0	77.8	2003				
	April	8.3	82.2	81.9		April	8.2	73.7	76.8
	May	13.8	25.8	70.6		May	16.4	60.0	68.5
	June	18.3	7.0	67.8		June	19.9	0.0	63.8
	July	22.6	66.7	64.4		July	21.3	5.5	60.8
Total Mean		13.9	228.7	72.5			16.4	139.2	67.47

Table 3: Effect of tillage, weed control and phosphorus fertilization on some traits of chickpea (*Cicer arietinum* L.) in 2002

Soil tillage systems	Weed control methods	Phosphorus fertilization	The number of plant at emergence (m^{-2})	The biological yield per plant (g)	The number of pod per plant	The number of seed per plant	The grain yield per plant (g)	Hundred kernal weight	Harvest index (%)	Grain yield (g m^{-2})
TT		30 kg $P_2O_5ha^{-1}$	59.33	7.78 II *I*	11.64	10.64 II *I*	4.43 II *I*	43.47 I *I*	55.65	141.60
TT		60 kg $P_2O_5ha^{-1}$	61.33	7.10 II *II*	10.96	9.89 II *II*	4.03 II *II*	42.93 I *I*	57.11	139.50
TT		90 kg $P_2O_5ha^{-1}$	57.33	9.20 I *I*	14.04	13.04 I *I*	5.35 I *I*	42.22 I *II*	57.84	138.00
MT		30 kg $P_2O_5ha^{-1}$	49.33	8.83 I *I*	13.00	11.29 I *I*	4.82 I *I*	43.48 I *I*	57.59	115.40
MT		60 kg $P_2O_5ha^{-1}$	52.66	9.43 I *I*	14.11	13.07 I *I*	5.33 I *I*	43.50 I II *I*	58.96	134.40
MT		90 kg $P_2O_5ha^{-1}$	52.00	9.22 I *I*	13.96	12.40 I *I*	5.22 I *I*	45.14 I *I*	55.99	130.30
Mean (TT)			59.33	8.03	12.21	11.19	4.60	42.87	56.87	139.72
Mean (MT)			51.33	9.16	13.69	12.25	5.12	44.04	57.51	126.68
	Mean (Weed check)		-	7.73B	11.87B	10.84b	4.43b	42.52	56.61	119.02b
	Mean (Hand weeding)		-	9.94A	14.66A	13.45a	5.63a	44.13	58.46	155.82a
	Mean (Herbicide)		-	8.12B	12.32B	10.87b	4.52b	43.72	56.51	124.76b
		Mean (30 kg $P_2O_5ha^{-1}$)	54.33	8.31	12.32b	10.97	4.62	43.47	56.62	128.46
		Mean (60 kg $P_2O_5ha^{-1}$)	57.00	8.27	12.53b	11.48	4.68	43.21	58.04	136.95
		Mean (90 kg $P_2O_5ha^{-1}$)	54.66	9.27	14.00a	12.72	5.29	43.68	56.92	134.19
Soil tillage (A)			NS	NS	NS	NS	NS	NS	NS	NS
Weed control (B)			-	25.003**	40.632**	40.562*	7.999*	NS	NS	7058.7*
A x B			-	NS	NS	NS	NS	NS	NS	NS
Phosphorus fertilization (C)			NS	NS	15.032*	14.676*	2.430*	NS	NS	NS
A x C			NS	6.017*	NS	17.016*	2.395*	10.681*	NS	NS
B x C			-	NS	NS	NS	NS	NS	NS	NS
A x B x C			-	NS	NS	NS	NS	NS	NS	NS

*: significant at the 0.05 probability level, **: significant at the 0.01 probability level, - Romen figures are used that as the different soil tillage systems are comparisoned phosphorus fertilization mean, - İtalic romen figures are used that as the different phosphorus fertilization are comparisoned soil tillage systems means

Phosphorus fertilization: 30, 60 and 90 kg P_2O_5 ha^{-1} were applied as Triple Super Phosphate at sowing time with sowing machine.

The experimental design was split plot with three replications. Experiment was conducted as tillage systems main plots, weed control methods sub-plots and phosphorus fertilizations sub-subplots. Each sub-subplots was 12.5 m^2 in size. Chickpea seeds were sown by sowing machine with 30 cm row spacing in 5 cm depth. Nitrogen fertilization was done at sowing time (20 kg ha^{-1} N).

The number of plant at emergence per m^2 and harvest index were determined at each sub-subplot in the 0.25 m^{-2} area. Afterwards each sub-subplot was harvested, blended and grain yield (g m^{-2}) was measured. The biological yield per plant, the number of pod per plant, the number of seed per plant and the grain yield per plant were measured on 5 plants which were taken randomly from each sub-subplot.

The data were statistically analysed to determine the significance of the treatments with MİNİTAB program. Duncan test was applied on all measured parameters.

RESULTS

Significant differences were observed among weed control methods for the biological yield per plant, the number of pod per plant, the number of seed per plant, the grain yield per plant and grain yield in the first year. Phosphorus fertilization methods were shown differences for the number of pod per plant, the number of seed per plant, the grain yield per plant (0.05). Interactions between soil tillage systems and phosphorus fertilization methods were significant for the biological yield per plant, the number of seed per plant, the grain yield per plant and hundred kernel weights (Table 3). In second year, differences were observed among soil tillage systems for

Table 4: Effect of tillage, weed control and phosphorus fertilization on some traits of chickpea (*Cicer arietinum* L.) in 2003

Soil tillage systems	Weed control methods	Phosphorus fertilization	The number of plant at emergence (m^{-2})	The biological yield per plant (g)	The number of pod per plant	The number of seed per plant	The grain yield per plant (g)	Hundred kernel weight	Harvest index (%)	Grain yield ($g\ m^{-2}$)
TT		30 kg $P_2O_5 ha^{-1}$	59.66	10.77	15.33	13.80	5.70	42.58	53.48	239.50
TT		60 kg $P_2O_5 ha^{-1}$	56.00	11.16	15.84	14.58	5.94	42.02	51.80	242.30
TT		90 kg $P_2O_5 ha^{-1}$	60.00	11.04	15.31	13.84	5.93	42.89	53.59	236.60
MT		30 kg $P_2O_5 ha^{-1}$	42.00	11.24	16.40	14.96	6.11	42.73	55.50	165.00
MT		60 kg $P_2O_5 ha^{-1}$	47.66	12.60	18.04	16.60	6.98	42.01	57.35	177.50
MT		90 kg $P_2O_5 ha^{-1}$	47.33	13.57	19.44	18.07	7.47	41.93	57.11	171.10
Mean (TT)			58.55a	10.99	15.50	14.07	5.86	42.50	52.96	239.44
Mean (MT)			45.66b	12.47	17.96	16.54	6.85	42.22	56.65	171.18
	Mean (Weed check)		-	10.98	15.40	14.30	5.86	42.39	54.29	182.10
	Mean (Hand weeding)		-	12.06	17.51	15.84	6.56	42.50	54.95	226.31
	Mean (Herbicide)		-	12.15	17.28	15.78	6.64	42.20	55.18	207.50
		Mean (30 kg $P_2O_5 ha^{-1}$)	50.83	11.01	15.87	14.38	5.90b	42.65	54.49	202.20
		Mean (60 kg $P_2O_5 ha^{-1}$)	51.83	11.88	16.94	15.59	6.46ab	42.02	54.57	209.90
		Mean (90 kg $P_2O_5 ha^{-1}$)	53.66	12.31	17.38	15.96	6.70a	42.41	55.35	203.80
Soil tillage (A)			748.556*	NS	NS	NS	NS	NS	NS	NS
Weed control (B)			-	NS	NS	NS	NS	NS	NS	NS
A x B			-	NS	NS	NS	NS	NS	NS	NS
Phosphorus fertilization (C)			NS	NS	NS	NS	3.007*	NS	NS	NS
A x C			NS	NS	NS	NS	NS	NS	NS	NS
B x C			-	NS	NS	NS	NS	NS	NS	NS
A x B x C			-	NS	NS	NS	NS	NS	NS	NS

*: significant at the 0.05 probability level

the number of plant at emergence and phosphorus fertilization methods for the grain yield per plant (Table 4).

Phosphorus fertilization methods were shown significant differences for the grain yield per plant in both years.

In the first year, weed control methods were influenced the biological yield per plant, the number of pod per plant, the number of seed per plant, the grain yield per plant and grain yield similarly. The highest values were observed at hand weeding plots. They were followed by herbicidal weed control values. The lowest values were obtained at weedy check plots. The number of pod per plant was effected by phosphorus fertilization methods. In 90 kg P_2O_5 ha^{-1} treatment plots had the highest value for the number of pod per plant. The number of pod per plant value was close at 30 and 60 kg P_2O_5 ha^{-1} plots. The biological yield per plant, the number of seed per plant and the grain yield per plant values were not effected by phosphorus fertilization methods in MT plots, but the highest values were observed at 90 kg P_2O_5 ha^{-1} plots in TT plots. In 60 kg P_2O_5 ha^{-1} plots, the biological yield per plant, the number of seed per plant and the grain yield per plant values were higher in TT plots than MT plots (Table 3).

In the first year, hundred kernel weight values were not effected by different phosphorus fertilizer methods in TT plots and MT plots. In 90 kg P_2O_5 ha^{-1} plots, it was 42.22 g in TT plots and 45.14 g in MT plots (Table 3).

TT plots values were more higher than MT plots for the number of plant at emergence in second year. The grain yield per plant was influenced by different phosphorus fertilization methods, the highest values were obtained at 90 kg P_2O_5 ha^{-1} and the lowest values were obtained at 30 kg P_2O_5 ha^{-1} (Table 4).

DISCUSSION

TT plots values were higher than MT plots values for the number of plant at emergence in both year and significant differences were observed among soil tillage methods (0.05) in second year. Hayhoe *et al.*[4] reported that highest number of plant at emergence was observed in moldboard plow plots. Because of higher number of plant at emergence, TT plots values were higher than MT plots for grain yields. But statistically differences weren't observed among the soil tillage methods.

In the first year, weed control methods was influenced the biological yield per plant, the number of pod per plant, the number of seed per plant, the grain yield per plant and grain yield similarly. The highest values were observed in hand weeding plots. Herbicidal weed control plots values were followed it and the lowest values were observed in weedy check plots. This results were indicated that hand weeding method is the most effective method in weed control. When hand weeding isn't possible in wide areas, herbicide application may

advice as a alternative solution. Begna *et al.*[5] and Torresen *et al.*[6] were reported that herbicide use was increased grain yield in corn and cereals.

The number of pod per plant and the grain yield per plant were influenced by phosphorus fertilizer in first and second year respectively and the highest values were observed at 90 kg P_2O_5 ha^{-1} plots. Both first and second year, the biological yield per plant and the number of seed per plant were increased by phosphorus fertilization but statistically differences weren't found. Turk *et al.*[7], were reported that the number of pod per plant and the grain yield per plant were increased by phosphorus fertilization in lentil.

In the first year, the highest value was observed at 90 kg P_2O_5 ha^{-1} in TT plots for the biological yield per plant and the number of pod per plant. TT plots values were higher than MT plots for the biological yield per plant, the number of seed per plant and the grain yield per plant of 60 kg P_2O_5 ha^{-1} plots.

Soil tillage methods and phosphorus fertilization methods interactions were significant for hundred kernel weight in the first year. Different phosphorus fertilization methods weren't effected hundred kernel weight in TT and MT plots. In 90 kg P_2O_5 ha^{-1} plots, hundred kernel weights was observed as 42.22 and 45.14 g for TT plots and MT plots, respectively.

Second year values were higher than first year values by all of the yield components except harvest index and the number of plant at emergence. This reason might be related to effective rainfall as 108 mm (April + May) in first year. This value went up to 133.70 mm in second year (Table 2). Results of this research indicate that emergence was more abundant in TT plots. Weed control methods were effected all of the yield components except harvest index. The highest values were observed at hand weeding plots. This values were followed by herbicidal weed control values and the lowest values were observed at weedy check plots. Hand weeding method is the most effective method in weed control. When hand weeding isn't possible in wide areas, herbicide application may advice as a solution. According to obtained results, phosphorus fertilization may provide high yield in chickpea.

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