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Influence of tillage and weed control methods on growth, productivity and quality of maize (*Zea mays* L.)

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ABSTRACT

To find the effect of tillage and weed control methods on growth, productivity and quality of maize a field experiment was conducted at the Vishvavidyalaya farm during *kharif* 2002 and 2003. The experiment was conducted in a silty clay loam soil with 12 treatment combinations (3 tillage methods in main plot and 4 weed control methods in sub plot) in a split plot design replicated thrice. The study revealed that raised seed bed being statistically at par with conventional tillage resulted in significant increase in plant height, dry matter and grain yield of maize over zero tillage by causing significant reduction in population and dry matter of weeds. Raised seed bed and conventional tillage recorded an increase in the grain yield to the tune of 13.2 and 17.2 % during first year and 14.2 and 16.6 during second year, respectively over zero tillage. However, there was no significant effect of tillage methods on quality components of the grains. Among weed control methods atrazine 1.5 kg ha^{-1} behaved statistically alike to acetachlor 1.25 kg ha^{-1} in significantly reducing the population and dry matter of weeds, thereby, producing significantly taller maize plants with higher dry matter content and 72.2 and 78.2 % higher grain yield over unweeded check during 2002 and 2003, respectively with significantly higher starch and protein content in grains. The corresponding values for acetachlor 1.25 kg ha^{-1} were 71.9 and 71.4 %.

***Key Words**:* Tillage, Weed control methods, Productivity and Quality of Maize

Weed infestation is one of the major constraints of low productivity of maize. The average yield loss due to weed in maize in India is 29.5-74.0 %. The uncontrolled weeds at critical period of crop weed competition reduced the growth and development and subsequently yield of maize by 30-95% depending upon type and intensity of weed infestation (Pandey *et al*., 2001). The faster growth of weeds offered greater crop-weed competition for nutrients, water, light and space and resulted in poor grain quality (Shashinkis, 2001). High rainfall coupled with high temperature during *kharif* season, unavailability and costly human labour coupled with unfavorable weather conditions for intercultural operations makes the chemical control of weeds a suitable option to farmers. But the prohibitive costs, unavailability of herbicides, environmental hazards of their residues and development of resistant weed species or biotypes are major constraints in the adoption of chemical herbicides alone as regular practice. These facts necessitate the use of herbicide in conjunction with other production practices like tillage methods to manage the weeds effectively, economically and ecologically viable basis. The present study was, therefore, undertaken to study the effect of tillage and weed control methods on crop weed competition, growth, productivity and quality of maize.

MATERIALS AND METHODS

The field experiment was conducted at the experimental farm of Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur during *kharif* 2002 and 2003. The soil of the experimental field was silty clay loam in texture, acidic in reaction (pH 5.5 and 5.6), medium in available nitrogen (302.8 and 296.6 kg ha^{-1}), phosphorus (17.8 and 18.6 kg ha^{-1}) and potassium (316.7 and 321.9 kg ha^{-1}) during first and second year, respectively. The experiment consisted twelve treatment combinations of three tillage methods *viz*. zero tillage, conventional tillage and raised seed bed in main plots and four weed control methods *viz*. unweeded check, acetachlor 0.75 kg ha^{-1}, acetachlor 1.25 kg ha^{-1} and atrazine 1.5 kg ha^{-1} in sub plots. The treatments were laid out in split plot design with 3 replications. The crop maize cv. PSCL-3438 was sown on 11 November during both the years by using seed rate @ 20 kg ha^{-1}. The spacing was 60 cm apart in rows with plant to plant distance of 20 cm following different tillage treatments. The sowing in zero tilled and raised seed bed plots was done with zero till maize drill and raised seed bed planter, respectively. A basal dose of nitrogen, phosphorus and potassium @ 40, 60 and 40 kg ha^{-1}, respectively through urea, single superphosphate and muriate of potash was drilled at the time of sowing and rest 80 kg N $ha^{-1}$was applied in two equal splits at knee height and pre-tasseling stages. All herbicides were applied as pre-emergence within 48 hours of sowing with the help of Maruyama power sprayer fitted with flat fan nozzle using 600 l of water ha^{-1}. Zero tilled plots were sprayed with paraquat dichloride 0.6 kg ha^{-1} at 15 days before sowing to kill the existing

weeds and stubbles of wheat crop. 914.2 mm and 1820.0 mm total rainfall were received during crop seasons of 2002 and 2003, respectively. Data related to density and dry weight of weeds recorded at 30, 60, 90 and at harvest stage of the crop, were analyzed after $\sqrt{x+1}$ transformation. Plant height and dry matter accumulation of maize plant was recorded at these respective stages from the average of five randomly sampled crop plants. For determining the protein content in grains, the nitrogen content that determined by Micro-Kjeldahl's method (A.O.A.C., 1970), was multiplied with 6.25 factor. The starch content was estimated according to the method given by Dubois *et al.* (1956).

RESULTS AND DISCUSSION

The weeds recorded in the experimental field were *Digitaria sanguinalis* (38.08%), *Echinochloa colona* (25.37%), *Panicum dichotomiflorum* (13.84%), *Commelina benghalensis* (11.54%), *Cyperus iria* (4.96%), *Brachiaria ramosa* (3.56%) *and others* (5.70%) *including Oxalis latifolia, Ageratum conyzoides, Cynodon dactylon, Ipomoea purpurea* and *Polygonum alatum*.

Effect on weeds

Among various tillage methods, raised seed bed resulted in significantly lowest density and dry matter accumulation of weeds at all the stages of observations. The conventional tillage was the next best in significantly reducing the weed population and dry matter of weeds at 60 DAS. Among weed control methods, atrazine 1.5 kg ha^{-1} being statistically at par with acetachlor 1.25 kg ha^{-1} resulted in significantly lower density and dry matter accumulation of weeds at all the stages of observations. Pandey *et al.* (2001) and Miklos (1981) also proved the superiority of atrazine and acetachlor, respectively to control weeds in maize crop. Lower dose of acetachlor @ 0.75 kg ha^{-1} was also significantly superior to unweeded check to reduce the weed population and their dry matter accumulation significantly at all the stages of observation (Table-1).

Effect on Growth

The mean data on progressive plant height and dry matter accumulation of maize (Table 2) revealed that both were increased at an increasing rate up to 60 DAS and there after increased at a decreasing rate upto the harvest of the crop.

Raised seed bed being statistically at par with conventional tillage resulted significantly taller plants with significantly higher dry matter accumulation of maize at all the stages of observations. However, in respect of plant height, conventional tillage was statistically at par with zero tillage at 30 DAS. On mean basis, 7.2 and 14.4 % increase in plant height and dry matter accumulation, respectively was recorded with conventional tillage over zero tillage. The corresponding figures for raised seed bed were 5.5 and 13.6 %. This increase in height and dry matter by these methods could be ascribed to reduced crop weed competition in conventional tillage at 60 DAS and by raised seed bed during both stages of observation. In addition the better aeration, soil moisture, nutrient availability and root growth resulted significantly higher values of all the parameters of crop growth.

Among weed control methods, atrazine 1.5 kg ha^{-1} being statistically at par with acetachlor 1.25 kg ha^{-1} produced significantly taller plants with significantly higher dry matter accumulation during all the stages of observation. Acetachlor 0.75 kg ha^{-1} behaved statistically alike to acetachlor 1.25 kg ha^{-1} in producing significantly taller plants at all the stages of observation and to atrazine 1.5 kg ha^{-1} at harvest stage of the crop. At harvest stage of the crop, atrazine 1.5 kg ha^{-1} and acetachlor 1.25 kg ha^{-1} resulted in an increase of 44.7cm and 42.3 cm in plant height and 51.3 and 45.5 % increase in dry matter accumulation of maize, respectively over unweeded check. The superior performance of both these herbicides could be ascribed to decrease crop-weed competition by decreasing the population and dry matter of weeds and nutrient uptake by them at all the stages of observation. Chassot *et al.* (2001) and Cox *et al.* (1990) also reported increase in growth and development of maize with conventional tillage and ridge tillage, respectively.

Effect on quality

Tillage methods did not significantly influence the protein and starch content in maize grains, while, weed control methods influenced both the quality parameters significantly during both the years (Table 3). Atrazine 1.5 kg ha^{-1} being statistically at par with the both doses of acetachlor during both the years, resulted in significantly higher protein and starch content in maize grains excepting lower dose of acetachlor 0.75 kg ha^{-1} in respect of protein content during 2003. The higher protein content could be ascribed to the reduced crop-weed competition by these treatments, which helped the crop to grow better and absorb and assimilate more nitrogen in grains and synthesize more starch.

Effect on grain yield

Both tillage and weed control methods influenced the 1000-grain weight, grain and stover yield of maize significantly excepting on harvest index during both the years. Raised seed bed and conventional tillage being statistically at par with each other increased the 1000-grain weight, grain and stover yield significantly over zero tillage during

both the years (Table 3). The increase in grain yield due to these tillage practices could be ascribed to improved physical conditions of the soil which enhanced the uptake of nutrients by crop and reduced the state of crop weed competition by lowering the weed population and dry biomass. On average basis conventional and raised seed bed registered an increase of 15.2 and 14.1% for grain and stover yield, respectively during the first year, while, the corresponding figures during the second year were 15.4 and 17.1 %. Barry and Miller (1986) also reported significant increase in grain yield of maize with conventional tillage over zero-tillage and with ridge tillage over zero tillage (Fausey, 1990).

Weed control treatments significantly increased the 1000-grain weight, grain and stover yield of maize over weedy check (Table 3). Atrazine 1.5 kg ha^{-1} being statistically at par with acetachlor 1.25 kg ha^{-1} produced significantly higher maize grain and stover yield during both the years. It is evident from the mean data of two years for grain yield that atrazine 1.5 kg ha^{-1} and acetachlor 1.25 kg ha^{-1} registered an increase of 75.4 and 72.1 %, respectively over unweeded check during 2002, while, during the second year this increase was 77.8 and 74.8 %, respectively. This increase in yield might be due to effective weed control by these treatments leading to reduce crop weed competition. These findings are in line with the results of Sharma *et al.* (1998) for atrazine and with Tomordi (1987) for aceatachlor.

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Table 1 : Effect of tillage and weed control treatments on population and dry matter of weeds at different stages of observation (mean of 2002 and 2003)

Treatments	Total weed population m^{-2}				Total dry matter (g m^{-2})			
	Days after sowing			At	Days after sowing			At
	30	60	90	Harvest	30	60	90	Harvest
Tillage methods								
Zero	9.4	15.2	12.4	10.5	6.6	10.7	8.7	7.8
	(91.9)	(244.7)	(161.4)	(115.7)	(45.0)	(126.0)	(81.1)	(64.6)
Conventional	9.1	14.6	11.9	10.0	6.4	10.2	8.6	7.5
	(85.4)	(228.0)	(149.0)	(105.0)	(43.4)	(113.0)	(77.9)	(59.3)
Raised seed bed	8.2	13.9	11.0	9.3	5.6	9.0	7.5	6.7
	(70.6)	(202.7)	(127.4)	(90.4)	(33.3)	(90.5)	(61.2)	(48.7)
CD (P=0.05)	0.7	0.6	1.0	0.2	0.4	0.4	0.6	0.4
Weed control methods								
Unweeded	12.3	20.3	16.2	13.9	9.4	15.6	12.4	10.8
	(149.4)	(412.2)	(262.4)	(190.7)	(86.9)	(242.2)	(153.0)	(117.0)
Acetachlor	9.3	14.6	12.2	10.4	6.4	9.8	8.1	7.4
0.75 kg ha^{-1}	(85.4)	(212.9)	(148.0)	(105.8)	(39.5)	(95.7)	(65.3)	(53.2)
Acetachlor	7.1	11.9	9.3	7.7	4.6	7.5	6.1	5.6
1.25 kg ha^{-1}	(48.7)	(142.9)	(85.2)	(57.6)	(19.2)	(53.3)	(36.0)	(30.5)
Atrazine	7.0	11.5	9.4	7.9	4.3	7.0	6.3	5.5
1.50 kg ha^{-1}	(46.9)	(132.5)	(88.1)	(60.7)	(16.6)	(45.1)	(39.3)	(29.2)
CD (P=0.05)	0.7	0.6	0.6	0.6	0.5	0.4	0.5	0.5

Values in parentheses are means of original values

Table 2 : Effect of tillage and weed control treatments on height and dry matter accumulation of maize plant at different stages of observation (mean of 2002 and 2003)

Treatments	Plant height (cm)					Dry matter (g m^{-2})				
	Days after sowing			At Harvest	Mean	Days after sowing			At Harvest	Mean
	30	60	90			30	60	90		
Tillage methods										
Zero	56.34	243.20	254.70	258.47	203.18	9.91	116.82	130.99	139.21	99.23
Conventional	57.10	263.23	276.18	279.63	219.03	12.71	135.38	149.26	156.89	113.56
Raised seed bed	53.36	257.99	270.61	275.12	214.27	11.59	133.57	149.73	156.03	112.73
CD (P=0.05)	1.44	8.76	8.00	8.64	6.71	0.93	9.01	11.06	8.52	7.38
Weed control methods										
Unweeded	50.55	214.79	228.71	232.16	181.55	8.07	96.24	109.43	118.45	83.05
Acetachlor 0.75 kg ha^{-1}	55.75	262.22	273.02	277.58	217.14	10.59	122.82	138.82	145.86	104.52
Acetachlor 1.25 kg ha^{-1}	57.69	268.98	282.29	286.57	223.88	13.08	144.41	159.40	166.36	120.81
Atrazine 1.50 kg ha^{-1}	59.07	273.23	284.61	288.14	226.26	13.85	150.88	165.66	172.16	125.63
CD (P=0.05)	2.69	7.45	9.59	11.36	7.77	1.28	6.28	7.54	9.71	6.20

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Table 3 : Effect of tillage and weed control methods on protein and starch content, 1000-grain weight, grain and stover yield and harvest index of maize

Treatments	Protein content (%)			Starch content (%)			1000-garin weight (gm)		Grain yield (kg ha^{-1})		Stover yield (kg ha^{-1})		Harvest Index	
	2002	2003	Mean	2002	2003	Mean	2002	2003	2002	2003	2002	2003	2002	2003
Tillage methods														
Zero	9.74	9.52	9.63	57.13	56.76	56.95	252.88	239.25	5862.30	5735.87	12633.56	11992.96	31.80	32.43
Conventional	9.86	9.74	9.80	58.75	58.15	58.45	266.05	250.67	6872.07	6686.67	14697.08	14152.34	31.89	32.13
Raised seed bed	9.90	9.64	9.77	59.32	58.93	59.13	263.87	248.35	6638.21	6551.86	14119.66	13926.89	32.01	32.00
CD (P=0.05)	NS	NS	NS	NS	NS	NS	9.06	8.51	236.45	446.30	1143.99	473.77	NS	NS
Weed control methods														
Unweeded	9.33	9.20	9.27	55.78	55.06	55.42	241.04	226.80	4379.10	4171.97	9258.67	8705.25	32.10	32.47
Acetachlor 0.75 kg ha^{-1}	9.84	9.57	9.71	58.00	57.59	57.80	259.51	243.80	6382.80	6542.27	13529.04	13774.74	32.09	32.23
Acetachlor 1.25 kg ha^{-1}	10.05	9.84	9.95	59.60	59.38	59.49	269.00	253.37	7527.37	7151.97	16132.73	15189.74	31.84	32.01
Atrazine 1.5 kg ha^{-1}	10.11	9.94	10.03	60.21	59.77	59.99	274.18	260.37	7540.85	7432.99	16346.63	15759.89	31.57	32.05
CD (P=0.05)	0.45	0.32	0.39	2.61	2.53	2.57	8.36	9.93	311.74	289.31	751.81	586.67	NS	NS