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Research Paper

Effects of weed-management on weeds and baby corn (*Zea mays*) under north-western Indian Himalayas

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ABSTRACT

A field experiment for evaluating indices of weed management and economics of baby corn (*Zea mays* L.) was conducted at the research farms of Mountain Livestock Research Institute, Kashmir, Jammu and Kashmir during the rainy (*kharif*) season of 2014 and 2015. The experiment comprising 11 treatments [Farmers practice (W_1); earthing-up and weeding at 30 and 45 DAS (W_2); atrazine @ 1.5 kg a.i./ha pre-emergence at 1 DAS (W_3); atrazine @ 1.5 kg a.i./ha early post-emergence at 10 DAS (W_4); straw mulch (@ 1 kg/m^2 paddy straw) at 1 DAS (W_5); straw mulch (@ 1 kg/m^2 brown sarson) at 1 DAS (W_6); polyethylene mulch (90 mm black) at 1 DAS (W_7); polyethylene mulch (90 mm white) at 1 DAS (W_8); saw mulch (1.5 cm depth) at 1 DAS (W_9); weedy check (W_{10}) and weed-free (W_{11})] was laid out in a randomized complete-block design 3 replications. Treatment W_{11} recorded significantly lowest weed density (2.03) and dry-matter accumulation, but the highest cob yield among all the treatments, whereas the highest values of weed density and dry-matter accumulation were recorded in the W_{10} treatment. The highest cob yield with and without husk was recorded in weed-free plot followed by the black and white polythene mulched plots, respectively. The husked and unhusked cob yield in black polythene-mulched treatments was higher than the weedy check and farmers' practice by 32 and 41% and 7 and 11%, respectively. The highest net profit (₹91,760 and ₹94,994) and benefit: cost ratio (1.54 and 1.58) for 2014 and 2015, respectively, was recorded for earthing-up and weeding at 30 and 45 DAS treatment. However, white polyethylene recorded the lowest values of net returns (₹45,802 and ₹48,128) and benefit: cost ratio (0.45 and 0.47) for 2014 and 2015, respectively.

Key words: Baby corn, Economics, Weed-control efficiency, Weed index,

In India, maize is grown on an area of 9.43 million ha, with production and productivity of 24.35 million tonnes and 2,583 kg/ha respectively (GoI, 2017). Maize has been classified in different types according to its use and/or starch content, viz., flour corn (*Zea mays* var. *amylacea*), popcorn (*Zea mays everta*), Dent corn (*Zea mays* var. *indentata*), flint corn (*Zea mays* var. *indurata*), sweet corn (*Zea mays* var. *saccharata*), waxy corn (*Zea mays* var. *ceratina*), pod corn (*Zea mays* var. *tunicate*) and baby corn (*Zea mays* L.) (Dar *et al*., 2017).

Baby corn (*Zea mays* L.) refers to the whole, entirely edible cobs of immature corn harvested just before fertilization at 2–3-cm-long silk-emergence stage (Dar *et al*., 2014a). Baby corn is a delicious and nutritive vegetable and is consumed as a natural food. It is very tasty, sweet and easy to consume because of its tenderness and sweetness with good nutritive value. Due to changing food preferences in Indian life-style, the urban population is switching over to new food items; the 'Baby corn' is a new addition to Indian foods. Being a short-duration crop, it easily fits in an intensive cropping system and in addition to baby cob it provides delicious green fodder to cattle (Dar *et al*., 2014b).

Weeds are perceived by the farming community as being the greatest cause of yield loss in maize crop. They create a severe crop-weed competition and are competing for light, water, nutrients, space, carbon dioxide etc. and increasing the cost of production. Yield losses in the range of 50–60% occur due to absence of appropriateness, and untimely and uncontrolled weed growth in maize fields, needing immediate attention. Manual weeding though very effective in controlling weeds, very often is cumbersome,

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labour-intensive, expensive and time-consuming (Warade *et al*., 2006). The use of atrazine herbicide has yielded encouraging results in maize at national and international level. How the herbicide behaviour with respect to weed growth and crop growth when applied at different stages of this crop needs to be studied. Different mulches can be exploited for weed control in maize and the different resources lying with the farming community can be put to use depending on their availability and suitability. Keeping in view the above facts, the study was undertaken for evaluating weed-management effects on weeds and baby corn under the temperate conditions of Kashmir valley.

MATERIALS AND METHODS

The experiment was conducted at the Research Farm of Mountain Livestock Research Institute, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Jammu and Kashmir during the rainy season (*kharif*) of 2014 and 2015. The site is situated between (34.15°N and 74.40°E at an altitude of 1,650 m above mean sea-level). Climatically the experimental site falls in temperate zone of north-western Himalaya, characterized by hot summers and very cold winters. The average annual precipitation is 944.6 mm (average of past 30 years), most of which is received from December to April in the form of snow and rains. The data pooled across 2 years depicted the maximum and the minimum temperatures of 28.1°C and 12.9°C, respectively, and the total precipitation amounted to 389.50 mm. The total number of sunshine hours recorded during the crop-growth period was 144.4 hours and the mean maximum and minimum relative humidity were 79.30% and 53.00%, respectively, during the crop-growth period. The soil was clay loam, medium in organic carbon, low in available nitrogen (159 kg/ha), medium in available phosphorus (17.2 kg/ha) and high in available potassium (412 kg/ha) with neutral *p*H.

The experiment was laid out in a randomized complete-block design with 3 replications and consisted of 11 treatments, *viz.* Farmers practice (W_1), Earthing-up and weeding at days after sowing 30 (DAS) and 45 DAS (W_2), atrazine @ 1.5 kg a.i./ha, Pre-emergence at 1 DAS (W_3), atrazine @ 1.5 kg a.i./ha, early post-emergence at 10 DAS (W_4), straw mulch (1 kg/m^2 paddy straw) at 1 DAS (W_5), straw mulch (1 kg/m^2 brown sarson) at 1 DAS (W_6), polyethylene mulch (90 mm black) at 1 DAS (W_7), polyethylene mulch (90 mm white) at 1 DAS (W_8), saw mulch (1.5 cm depth) at 1 DAS (W_9), weedy check (W_{10}) and weed-free (W_{11}). The variety 'HM 4' was used for the experiment. The gross plot size was 6 m × 3 m and net plot size was 5.40 m × 1.50 m. The major weeds associated with the crop were identified according to species during the crop growth. A quadrant of 1 m^2 area was randomly thrown in each plot at knee-high (34-37 days after sowing), tasselling, and maturity stages. Weeds under the quadrant were carefully cut at ground level and total number of weeds/m^2 were counted. The weed samples from 1/m^2 quadrent in each plot were counted species-wise at different growth stages, *viz.* knee-high, tasselling, and maturity. These samples were oven-dried at 60°C temperature to a constant weight and total dry-matter accumulation of weeds/m^2 was recorded and expressed in q/ha. Economic analysis was done on the basis of prevailing market prices of inputs and output from each treatment.

RESULTS AND DISCUSSION

Weeds identified

The major weeds associated with the crop were: *Cynodon dactylon* (L.) Pers*., Sorghum halepense* (L.) Pers., *Poa annua* L.*, Portulaca oleracea* L.*, Convolvulus arvensis* L.*, Amaranthus* spp.*, Chenopodium album* L. and *Cyperus rotundus* L. (Table 1). These results are in confirmation with the findings of Bahar *et al*., (2009).

Weed density

Data presented in Table 2 showed that weed density was significantly affected by different weed-management practices. Weedy check treatment recorded the highest weed density at knee-high, tasseling and harvesting stages and was followed by atrazine @ 1.5 kg a.i./ha early post-emergence at knee-high, tasseling and harvesting stages), atrazine @ 1.5 kg a.i./ha pre-emergence, paddy straw mulch, farmers practice, brown sarson mulch, white polyethylene mulch, black polyethylene mulch, earthing up and weeding at 30 DAS and 45 DAS respectively. However, the lowest weed density was recorded by weed-free at knee-high, tasseling and harvesting stage. This might be due to the continuous removal of weeds under weed-free treatment that resulted in the lowest weed density. The lowest weed density resulted in reduced crop-weed competition, which helped the crop to grow better and resulted in less removal of nutrients by weeds. Among the different mulches, black polyethylene mulch recorded the lowest weed density. These findings are in close confirmation with those reported by Sinha *et al*. (2003), Nagalakshmi *et al.* (2006) and Malviya and Singh (2007).

Dry-matter accumulation of weeds

Dry-matter accumulation of weeds was significantly affected by different weed-management practices as depicted in Table 3. Weedy check treatment recorded the highest dry-matter accumulation at knee-high, tasseling and harvesting stages and was followed by atrazine @ 1.5 kg a.i./ha early post-emergence, atrazine @ 1.5 kg a.i./ha pre-emergence, paddy straw mulch, farmers practice, brown sarson mulch, white polyethylene mulch, black polyethylene mulch, earthing-up and weeding at 30 DAS and 45 DAS, whereas the lowest dry-matter accumulation was recorded by weed-free at knee-high, tasseling and harvesting stage (Table 3). This might be attributed to the effective control of weeds under these treatments, which reflected in less number of weeds and ultimately lower weed biomass. These findings are in close confirmation with those reported by Sinha *et al*. (2003), Nagalakshmi *et al.* (2006) and Malviya and Singh (2007).

Yield

The cob yield, with and without husk, was significantly influenced by the weed-management practices as reveled in Table 4. The highest cob yield, with and without husk, was obtained from the weed free plot, followed by the black and white polythene-mulched plots, respectively. The husked and unhusked cob yield in black polythene-mulched treatments was higher than the weedy check and farmers practice by 32 and 41% and 7 and 11%, respectively. The higher yield in mulched treatments may be attributed to effective weed control, lower weed density (Table 2) and lower dry-matter accumulation (Table 3) of weeds. These findings are in close confirmation with those reported by Sinha *et al*. (2003), Nagalakshmi *et al.* (2006) and Malviya and Singh (2007).

Economics

Economics in terms of gross profit, net profit and benefit: cost ratio with respect to baby corn and green fodder yield was worked out for various treatments. The highest net profit (₹91,760 and ₹94,994) and benefit: cost ratio (1.54 and 1.58) for 2014 and 2015, respectively were obtained from treatments earthing-up and weeding at 30 and 45 DAS. White polyethylene recorded the lowest values of net returns (₹45,802 and ₹48,128) and benefit: cost ratio (0.45 and 0.47) for 2014 and 2015, respectively (Table 5). The higher returns from the earthing-up and weeding at 30 and 45 DAS treatments because of enhanced yield, whereas low returns in polythene-mulched treatments was due to the higher cost of cultivation. The benefit: cost ratio was almost similar for the highest-yielding treatment

Table 1. Weed flora identified during the crop growth of baby corn

	Common name	Scientific name	Family
Grassy weeds	Bermuda grass	*Cynodon dactylon*	Gramineae
	Johnson's grass	*Sorghum halepense*	
	Annual blue grass	*Poa annua*	
Broad leaf weeds	Common purslane	*Portulaca oleracea*	Portulacaceae
	Field bind weed	*Convolvulus arvensis*	Convolvulaceae
	Pig weed	*Amaranthus* spp.	Amaranthaceae
	Common lambsquarter	*Chenopodium album*	Chenopodiaceae
Sedges	Nut sedge	*Cyperus rotundus*	Cyperaceae

Table 2. Weed density (m^2) in baby corn at different stages of crop growth as influenced by different weed-management practices (pooled data of 2 years)

Treatment	Growth stages: Knee-high stage	Tasseling stage	Harvesting stage
Farmers practice	7.74(59)	8.83(77)	9.64(92)
Earthing up and weeding	4.89 (23)	5.91 (34)	7.27 (52)
Atrazine @ 1.5 kg a.i/ha PE	8.36 (69)	9.43 (88)	9.89 (97)
Atrazine @1.5 kg a.i/ha Early PoE	8.65 (74)	9.69 (93)	10.14 (102)
Paddy straw mulch	7.87 (61)	8.94 (79)	9.48(89)
Brown sarson mulch	7.54 (56)	8.65 (74)	9.32 (86)
Black polyethylene mulch	6.32 (39)	6.77 (45)	7.99 (63)
White polyethylene mulch	6.78 (45)	8.18 (66)	8.88 (78)
Saw mulch	7.27 (52)	8.42 (70)	9.10 (82)
Weedy check	8.77 (76)	9.99 (99)	10.62 (112)
Weed free	2.03 (0.00)	3.05 (0.00)	4.23 (0.00)
SEm±	0.03	0.02	0.02
CD (P=0.05)	0.11	0.08	0.06

* Original values are in parenthesis

** data subjected to square-root transformation; PoE, post-emergence; PE, pre-emergence

Table 3. Dry-matter accumulation of weeds (t/ha) in baby corn at different stages of crop growth as influenced by different weed management practices (pooled data of 2 years)

Treatment	Growth stages		
	Knee high stage	Tasseling stage	Harvesting stage
Farmers practice	1.46	1.76	2.18
Earthing up and weeding	1.03	1.44	1.70
Atrazine @ 1.5 kg a.i/ha PE	1.54	1.89	2.27
Atrazine @1.5 kg a.i/ha Early PoE	1.64	1.92	2.38
Paddy straw mulch	1.22	1.59	1.99
Brown sarson mulch	1.14	1.53	1.86
Black polyethylene mulch	1.11	1.49	1.79
White polyethylene mulch	1.11	1.57	1.79
Saw mulch	1.38	1.64	2.08
Weedy check	2.00	2.44	2.79
Weed-free	0.00	0.00	0.00
SEm±	0.011	0.011	0.016
CD (P=0.05)	0.033	0.033	0.049

PE, pre-emergence; PoE, post-emergence;

Table 4. Effect of weed-management practices on cob yield with and without husk (t/ha) of baby corn (pooled data of 2 years)

Treatment	Cob yield with husk (t/ha)	Cob yield without husk (t/ha)
Farmers practice	9.14	1.73
Earthingup and weeding	9.86	1.95
Atrazine @ 1.5 kg a.i/ha PE	8.80	1.66
Atrazine @1.5 kg a.i/ha Early PoE	8.75	1.54
Paddy straw mulch	9.66	1.80
Brown sarson mulch	9.68	1.82
Black polyethylene mulch	9.78	1.92
White polyethylene mulch	9.71	1.90
Saw mulch	9.22	1.74
Weedy check	7.39	1.36
Weed free	10.26	2.01
SEm±	0.09	0.03
CD (P=0.05)	0.26	0.08

Table 5. Effect of weed-management practices on economics of baby corn

Treatment	Total cost of cultivation (× 10^3₹/ha)		Gross profit (× 10^3₹/ha)				Net profit (× 10^3₹/ha)		Benefit: cost ratio	
			Baby corn		Green fodder					
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Farmers practice	55.0	55.7	103.5	106.2	32.3	33.7	80.8	84.3	1.47	1.51
Earthing up and weeding	59.5	60.2	116.7	119.1	34.5	36.0	91.7	94.9	1.54	1.58
Atrazine @ 1.5 kg a.i/ha PE	52.2	52.9	99.7	103.3	31.9	32.5	79.4	82.9	1.52	1.57
Atrazine @1.5 kg a.i/ha Early PoE	52.2	52.9	92.1	96.3	31.1	32.9	71.0	76.3	1.36	1.44
Paddy straw mulch	61.9	62.6	108.2	110.0	32.9	35.8	79.3	83.1	1.28	1.33
Brown sarson mulch	61.9	62.6	109.1	111.5	33.0	35.8	80.2	84.6	1.30	1.35
Black polyethylene mulch	82.0	82.7	116.0	120.2	33.8	35.8	67.7	73.2	0.83	0.89
White polyethylene mulch	102.0	102.8	114.1	115.3	33.6	35.5	45.8	48.1	0.45	0.47
Saw mulch	56.1	56.6	104.4	105.0	32.8	34.0	81.0	82.4	1.44	1.45
Weedy check	50.5	51.2	81.6	84.0	26.0	27.5	57.1	60.3	1.13	1.18
Weed-free	68.5	69.3	120.5	121.7	35.5	37.5	87.4	89.9	1.28	1.30

Input cost : Seed, ₹40/kg; labour, ₹150/day for 2014 and ₹160/day for 2015; urea, ₹6/kg; DAP, ₹28/kg; MoP, ₹17/kg; black polyethylene, ₹3/m^2; white polyethylene, ₹5/m^2; straw, 1/kg; saw dust, ₹0.5/kg; atrazine, ₹300/kg; phorate, ₹75/kg.
Output cost: Baby corn, ₹60/kg; green fodder, ₹1/kg for 2014 and 1.10/kg for 2015