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Weed management in winter maize + potato intercropping system

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ABSTRACT

A field experiment was conducted to study the effect of weed management practices on weed control and yield of maize + potato intercropping system. The highest maize equivalent yield (152.79 q/ha) was recorded with two hand weedings at 25 and 50 days after sowing (DAS) closely followed by atrazine 0.5 kg/ha followed by hand weeding at 50 DAS (149.69 q/ha). The lowest maize equivalent yield (91.85 q/ha) was recorded in weedy check. All the weed management practices significantly reduced the density and biomass of grasses, sedges and broad leaf weeds over weedy check. The highest weed control efficiency (76.44%) was recorded with hand weeding (twice) followed by atrazine 0.5 kg/ha *fb* hand weeding at 50 DAS (66.25%). Maximum net monetary returns (Rs 61155/ha) was recorded under hand weeding (twice), which was at par with atrazine 0.5 kg/ha followed by one hand weeding at 50 DAS (Rs 59877/ha).

Key words : Benefit-cost ratio, Herbicides, Weed control efficiency, Winter maize+potato intercropping

Winter maize is one of the highest yielding cereals by virtue of the climatic condition it experiences during its crop growth period. High yield is realized from winter maize in Bihar. A very congenial weather is experienced for growth and development of weeds after sowing of maize. Weed control is not only a ticklish problem, but also a costly one. Generally in widely spaced crops, the growth rate of the main crop is very slow in the early stages and the inter row spaces remain completely unutilized for pretty long period. Such situation is most congenial for the emergence and growth of weeds, which grow fast in absence of any competition from the crop plants. Thus, the weeds take away major share of inherent and applied nutrients and pose severe competition to crop plants for space, solar radiation, carbon dioxide, moisture *etc*. When the main crop enters into its grand growth period, by that time the weeds cover the entire inter row spaces and dominate as the major dominating crop unless and until weeds are removed regularly manually or through use of herbicides. Taking an inter crop is the best approach disallowing fast growth of weeds. It is essential to select an intercrop having quick growth habit right from the seedling stage and maturing early, so that it is harvested before the grand growth period of the main crop. In this way the inter crop gives almost zero competition to the main crop and is referred to as a parallel crop. When the growth of maize almost ceases, the weeds grow unabated. Under this circumstances, the winter maize is ideally suited for adopting an inter crop system. Potato is considered to be the most remunerative crop in space and time. Planting potato as intercrop in between main rows not only helps in the maximum utilization of natural resources but also contributes higher yield of crops. (Prasad and Prasad 1988). Therefore, an investigation was carried out to study the effect of different weed management practices on weed control and yield of winter maize + potato intercropping system under agro climatic conditions of north Bihar.

MATERIALS AND METHODS

The field experiment was conducted at the research farm of Rajendra Agricultural University, Pusa, Bihar, during winter (*rabi*) season of 2004-05 and 2005-06. The soil of the experimental field was sandy loam in texture having 0.47% organic carbon, alkaline in reaction (pH 8.2) with normal electrical conductively (0.50 µS/m) and analysing medium in available nitrogen (287 kgN/ha), phosphorus (22.5 kgP/ha) and potassium (149 kgK/ha). The experiment was laid out in randomized block design with 10 treatments replicated thrice. Weed control treatments consisted of weedy check, hand weeding twice at 25 and 50 DAS, atrazine 0.5 kg/ha, atrazine 0.5 kg/ha + earthing up at 25 DAS, atrazine 0.5 kg/ha + hand weeding at 50 DAS, alachlor 1.5 kg/ha, alachlor 1.5 kg/ha + earthing up at 25 DAS, alachlor 1.5 kg/ha + hand weeding at 50 DAS, isoproturon 1.0 kg/ha, and isoproturon 1.0 kg/ha + earthing up at 25 DAS. The maize variety 'Deoki' and the potato variety 'Kufri chandramukhi' were sown in lines at a row distance of 60 cm apart on November 16 and 20 in 2004 and 2005, respectively. The population of both the crops was kept same in both the years. At first potato was sown on ridges and the maize sowing was done on the upper side of furrow with the help of hand tools. Both the crops were sown at a plant to plant spacing of 30 cm. Basal dose of 60, 80 and 60 kg N, P_2O_5 and K_2O,

respectively was applied at the time of sowing. Remaining dose of N was applied in 2 equal splits i.e. 40 kg N/ha each, at 30 DAS and after harvest of potato, respectively. Herbicides were sprayed using spray volume of 600 litres/ ha with the help of Knapsack sprayer fitted with flat fan nozzle. Pre-emergence application of atrazine, alachlor and isoproturon was done immediately after sowing. Five irrigations were applied to winter maize + potato intercropping system. Weed count and weed dry biomass were recorded at 60 DAS by using a 0.25 m^2 sized quadrate randomly at 2 places in each plot. Data on weed population and weed dry biomass subjected to square root transformation as $\sqrt{x+0.5}$ because of wide variations, where x is actual weed population recorded on the field. Weed control efficiency (WCE) has been calculated with the following formula :

$$WCE = \frac{(x - y)}{x} \times 100$$

Where x = weed dry weight in weedy check and y = weed dry weight in other treated plots. Benefit-cost ratio was determined by dividing net monetary returns by cost of cultivation.

RESULTS AND DISCUSSION

Weed flora

The most dominating weed species found in weedy check throughout the crop growth period were *Cynodon dactylon* L. and *Polypogon monspeliensis* L. among the grasses; *Cyperus rotundus* L. as sedges and *Chenopodium album* L., *Cannabis sativa* L., *Anagallis arvensis* L. *Melilotus indica* L., *Nicotiana plumbeginifolia* L. and *Fumaria parviflora* L. as broad leaf weeds at 25 days after sowing (DAS) of crops.

Effect on weeds

All the weed control treatments significantly reduced the density and dry weight of weeds over weedy check. Among the weed control measures, two hand weedings at 25 and 50 DAS recorded the lowest weed count and weed dry weight followed by atrazine 0.5 kg/ ha *fb* hand weeding (50 DAS) and atrazine 0.5 kg/ha *fb* earthing up at 25 DAS. Application of atrazine 0.5 kg/ha, alachlor 1.5 kg/ha and isoproturon 1.0 kg/ha resulted into weed free conditions for long period which produced lower weed dry biomass. These results are in conformity with the findings of Pandey *et al.* (1996). But Singh *et al.* (2002) recorded the lowest weed biomass with two hand weedings done at 20 and 40 DAS. Therefore, cumulative effect of herbicide alongwith hand weeding further reduced the weed biomass significantly. The weed control efficiency was maximum (76.44%) with two hand weedings closely followed by atrazine 0.5 kg/ha *fb* hand weeding at 50 DAS (66.25%) and atrazine 0.5 kg/ha *fb* eathing up at 25 DAS (62.08%). The integrated weed control with application of herbicides at lower rate along with hand weeding found to prevent the weed shifts and herbicide resistance in weeds (Singh *et al.* 1999) (Table 1).

Effect on yield attributes and yield

All the weed control treatments significantly out numbered and out weighed the weedy check in respect to yield attributes, *viz.* length of cobs (cm), number of cobs/ plant, test weight of maize and number of tubers/plant and weight of tubers/plant of potato. Among the weed control measures, hand weeding twice at 25 and 50 DAS led to record maximum length of cobs, number of cobs/ plant and test weight of maize and the highest number of tubers/plant, weight of tubers/plant closely followed by integrated use of atrazine 0.5 kg/ha *fb* hand weeding at 50 DAS. Application of atrazine 0.5 kg/ha *fb* earthing up at 25 DAS was next to them with regard to above characters and proved at par to latter. Higher value of all the yield attributes with 2 hand weedings and chemical weeding

Table 1. Effect of Weed management practices on weed density, weed dry weight and weed control efficiency (%) in winter maize + potato intercropping (mean data of two years)

Treatment	Weed density (No./m^2)				Dry weight of weeds (g/m^2)	WCE (%)
	Grasses	Sedges	BLWs	Total		
Weedy check	3.88 (14.6)	9.83(96.2)	8.22 (67.2)	13.36 (178.0)	8.15 (66.0)	-
2 Hand weedings at 25 and 50 DAS	1.61 (2.1)	2.09 (5.5)	2.58 (6.2)	3.71 (13.8)	2.29 (5.2)	76.44
Atrazine 0.5 kg/ha	1.73 (2.5)	4.08(16.2)	2.96 (8.3)	5.24 (27.0)	3.54 (12.1)	56.56
Atrazine 0.5 kg/ha *fb* earthling up at 25 DAS	1.64 (2.2)	3.47(11.6)	2.38 (5.2)	4.41 (19.0)	3.09 (9.1)	62.08
Atrazine 0.5 kg/ha *fb* HW at 50 DAS	2.04 (3.7)	2.94 (8.2)	2.02 (3.6)	4.0 (15.5)	2.75 (7.1)	66.25
Alachlor 1.5 kg/ha	1.81 (2.8)	2.09 (5.5)	2.38 (5.2)	5.83 (33.5)	3.98 (15.3)	51.16
Alachlor 1.5 kg/ha *fb* earthling up at 25 DAS	1.48 (1.7)	4.08(16.2)	2.25 (4.6)	4.79 (22.5)	3.67 (13.0)	54.96
Alachlor 1.5 kg/ha *fb* HW at 50 DAS	1.61 (2.1)	3.86(14.4)	2.0 (3.5)	14.27 (17.8)	3.56 (12.2)	56.31
Isoproturon 1.0 kg/ha	1.84 (2.9)	5.18(26.4)	2.58 (6.2)	6.0 (35.5)	4.75 (22.1)	41.71
Isoproturon 1.0 kg/ha *fb* earthing up at 25 DAS	0.4 (0.94)	4.32(18.2)	2.42 (5.4)	4.94 (24.0)	3.83 (14.2)	53.00
LSD (P=0.05)	0.05	0.060	0.07	0.02	0.03	-

Figures in parentheses are original values; BLWs-Broad leaf weeds; WCE-Weed Control Efficiency; DAS- Days after sowing.

along with cultural treatments might be due to enhancement in most of the growth parameters under most suitable environmental situation thereby resulting in better plant growth by confirming the views of Balyan and Bhan (1987). The highest maize grain yield (58.47 q/ha), potato tuber yield (158.72 q/ha) and maize equivalent yield (152.79 q/ha) was recorded with 2 hand weedings closely followed by application of atrazine 0.5 kg/ha *fb* one hand weeding at 50 DAS and atrazine 0.5 kg/ha *fb* earthing up at 25 DAS. All weed control receiving plots produced significantly higher maize grain and potato tuber yields and maize equivalent yields over unweeded check mainly due to superiority in yield attributes of crop components as a result of reduced crop-weed competition and increased water and nutrient availability (Tripathi and Singh 1987, Sinha *et al.* 1999) (Table 2).

Economics

The maximum net monetary returns (Rs 61155/ha) and benefit-cost ratio (1.34) were recorded with 2 hand weedings closely followed by application of atrazine 0.5 kg/ha *fb* hand weeding at 50 DAS (Rs 59877/ha). Application of atrazine 0.5 kg/ha *fb* earthing up at 25 DAS was next to them with regard to net monetary returns (Rs 58410/ha) being at par to application of atrazine 0.5 kg/ha only (Table 3). All treatments associated with control measurers were more remunerative than weedy check with regard to net monetary returns and benefit-cost ratio. Similar results were also reported by Prasad and Srivastava (1990).

Table 2. Effect of weed control measures on yield and yield attributes of maize and potato in winter maize+potato intercropping (mean data for two years)

Treatment	Maize yield attributes			Potato yield attributes		Maize grain yield (q/ha)	Potato tuber yield (q/ha)	Maize equivalent yield (q/ha)
	Length of cob (cm)	Cobs/ plant (No.)	Test weight (g)	Tubers/ plant (No.)	Weight of tubers / plant (g)			
Weedy check	9.6	0.80	155	5.35	133	35.63	94.61	91.85
2 Hand weedings at 25 and 50 DAS	19.4	1.62	201	10.21	241	58.47	158.72	152.79
Atrazine 0.5 kg/ha	17.2	1.52	191	8.89	231	53.62	152.32	144.14
Atrazine 0.5 kg/ha *fb* earthing up at 25 DAS	18.1	1.57	195	9.38	236	55.83	153.19	146.86
Atrazine 0.5 kg/ha *fb* HW at 50 DAS	18.8	1.60	199	9.69	239	57.64	154.89	149.69
Alachlor 1.5 kg/ha	15.3	1.38	165	7.61	194	50.42	151.45	140.42
Alachlor 1.5 kg/ha *fb* earthing up at 25 DAS	16.7	1.52	185	8.47	225	51.51	152.82	142.33
Alachlor 1.5 kg/ha *fb* HW at 50 DAS	16.2	1.48	176	8.11	218	52.94	153.54	144.19
Isoproturon 1.0 kg/ha	13.5	1.25	159	7.39	188	48.62	146.74	135.83
Isoproturon 1.0 kg/ha *fb* earthingup at 25 DAS	15.7	1.40	168	7.85	202	50.40	148.05	138.38
LSD (P = 0.05)	0.94	0.43	3.21	0.89	3.52	2.85	4.85	4.46

Table 3. Effect of weed control measures on monetary returns in winter maize + potato intercropping.

Treatments	Gross monetary returns (Rs/ha)	Net monetary returns (Rs./ha)	B:C ratio
Weedy check	64295	21547	0.50
2 Hand weedings at 25 and 50 DAS	106953	61155	1.34
Atrazine 0.5 kg/ha	100898	57517	1.33
Atrazine 0.5 kg/ha *fb* earthing up at 25 DAS	102808	58410	1.32
Atrazine 0.5 kg/ha *fb* HW at 50 DAS	104783	59877	1.33
Alachlor 1.5 kg/ha	98294	54544	1.25
Alachlor 1.5 kg/ha *fb* earthing up at 25 DAS	99631	54941	1.23
Alachlor 1.5 kg/ha *fb* HW at 50 DAS	100933	55660	1.23
Isoproturon 1.0 kg/ha	95081	51177	1.17
Isoproturon 1.0 kg/ha *fb* earthing up at 25 DAS	96866	52043	1.16
LSD (P = 0.05)	3628	2275	0.05

Market price of maize grain and potato tuber was Rs 700/- and 416/- per quintal, respectively.

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