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Chemical Weed Control in Maize - Wheat Rotation in Semi - Arid Tropics

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Results of a five year field trial in a permanent layout showed that no more than 100 per cent replenishment of nitrogen removed by weeds was necessary to reduce weed competition. Increasing rates of simazine significantly increased maize yield but since it tended to decrease wheat yields, half a kilogram of simazine as pre-emergence treatment was the best treatment vis-a-vis freedom from harmful residual effect of higher rates on wheat. Pre + post-emergence application providing 0.5 kg 2,4-D/ha along with replenishment of 100 per cent N removed by weeds was the most beneficial treatment. Increase in maize yield and reduction in weed dry matter production with the use of simazine at half a kg/ha rate were 4.2 and 13.2 q/ha, respectively without harmful effect on wheat.

In areas where maize precedes wheat, recommendations for chemical control in maize with triazines should take into account the residual effect on wheat since the latter has been reported to be highly susceptible to residues of triazine (Saroha and Singh, 1971). An adverse residual effect of triazines on wheat in the first few years may not be decernible with one kg/ha chemical, but over a period of several years adverse effects are noted. Since income and yield potential from wheat are more, it is necessary to adjust the time and application rate of triazines to maize so that it has no residual effect on wheat. Weeds cause reduction in crop yields by mainly competing for nitrogen; it is likely that replenishment of N removed by weeds may reduce the severity of competition and thus may affect the application rate of herbicide to maize. Thus to ascertain how far the replenishment of N in maize and wheat crops in rotation and how a variation in time of application of herbicides can increase maize yield without affecting wheat yield, an experiment was conducted.

MATERIALS AND METHODS

The treatments for the experiment comprised combinations of nitrogen replenishment levels (100, 125, 150, 175 and 200 per cent of N removed by weeds) and three levels of herbicides (0.5, 1.0 and 1.5 kg/ha) applied as pre + post, and post-emergence. The removal of nitrogen by weeds is estimated as 40 and 30 kg N/ha in the *Kharif* and *Rabi* season respectively. Replenishment of N was calculated on these basis. Simazine was applied as a pre-emergence treatment and atrazine as a post-emergence treatment as the former is not water soluble. In combined pre + post-emergence half of the dose of herbicide was applied as pre-

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emergence through simazine and the half as post-emergence through atrazine. In case of wheat, 2, 4-D sodium salt was applied as pre-emergence and 2, 4-D amine salt as post-emergence. In pre + post-emergence treatment half of the dose of 2, 4-D sodium salt was given as pre-emergence treatment and the other half as post-emergence treatment through amine salt. The experiment was laid out in a randomized block design with three replications. This design was used for experimentation as the field is very uniform and the coefficient of variation in earlier experiments have not exceeded more than 20 per cent. The experiment was conducted for a period of five years on the same site. Maize Ganga 5 and wheat S 227 were used as test crops. The 100, 125. 150, 175 and 200 per cent N replenishment levels were applied to both crops and corresponded to 40, 50, 60, 70 and 80 kg/ha in case, of maize and 30 37.5, 45.0, 52. 5 and 60 kg/ha respectively, in case of wheat. In addition, maize and wheat each received 70 kg N and 40 kg P_2O_5/ha per year. The soil of the experimental field was a clay loam of pH 8.5 and contained 0.86 per cent organic carbon, 0.05 per cent total N, 36 kg/ha available P_2O_5, 180 kg/ha available K and 3.4 per cent free calcium carbonate.

RESULTS AND DISCUSSION

Table I shows that no more replenishment of nitrogen than that removed by weeds was necessary for reducing weed competition. Pre-emergence application of simazine increased maize grain production by 2.2 q/ha (11.5 per cent) in comparison with post-emergence treatment of atrazine with a concomitant decrease in weed dry matter production by 4.2 q/ha (26.4 per cent). Pre-emergence application of simazine increased the uptake of nitrogen by maize and reduced its uptake by weeds in all years. The increase and decrease in the uptake by maize and weeds were 4.0 and 5.7 kg/ha respectively on an average. Combined pre and post-emergence treatment was as good as pre-emergence treatment of simazine. Effective weed control and higher yield of maize with pre-emergence application of simazine or atrazine were also reported by Mani *et al.* (1970).

Maize grain production went on increasing with the increasing levels of triazine herbicides with a concomitant decrease in weed dry matter production except in the year 1970-'71. When compared with 0.5 kg/ha, an application rate of 1.5 kg/ha increased grain yield by 2.7 q/ha (14.1 per cent) and reduced weed dry matter production by 7.9 q/ha (45.1 per cent). Even an application of 0.5 kg of herbicide increased grain production by 4.2 q/ha and reduced weed dry matter production by 13.2 q/ha in comparison with control. The overall effect of triazines, except in 1970-71, was also found significant in increasing grain yield and decreasing weed dry matter production over control by 5.6 and 17.4 q/ha respectively. These findings are in conformity with those of Mani *et al.* (1970).

Data in Table II show that replenishment of N removed by weeds had no

TABLE I. Effect of weed removed nitrogen replenishment and time and rate of application of herbicides on maize grain and weed dry matter production and uptake of N by grain and weeds

Treatments	Maize grain (q/ha)						N uptake by maize (kg/ha)					Weed dry matter production (q/ha)						N uptake by weeds (kg/ha)				
	1968-69	1969-70	1970-71	1971-72	1972-73	Mean	1968-69	1969-70	1970-71	1971-72	Mean	1968-69	1969-70	1970-71	1971-72	1972-73	Mean	1968-69	1969-70	1970-71	1971-72	Mean
N replenishment level (%)																						
100	23.9	25.5	14.9	19.8	12.2	19.3	33.8	33.4	31.0	34.0	33.0	5.2	11.8	8.0	9.2	33.8	13.6	8.1	16.6	12.1	14.6	12.8
125	28.3	25.2	13.3	17.4	11.8	19.2	45.4	36.5	27.5	30 8	35.0	4.6	9.3	9.2	8.6	32·2	12.8	7.5	13.3	13.1	13.2	11 8
150	31.6	28.5	15.0	18.3	13.0	21.3	47.8	38.6	30.8	32.9	37.5	3.9	12.0	8.4	9.7	32.9	13.4	7.2	16 5	14.7	14.6	12.2
175	32.5	28.7	14.5	19.0	12.6	21.5	51.3	39.0	28.7	34.3	38.3	3.9	11.0	8.0	9.1	33.6	13.1	7.3	15.3	12.8	13.6	12.2
200	30.4	27.3	14.6	19.8	12.2	20.9	48.8	36.8	29.9	35.5	37.8	3.6	11.3	8.3	8.6	33.0	13.0	6.7	15.8	13.1	13.5	12.3
C.D. at 5%	1.5	NS	NS	NS	NS	—	6.0	3 4	NS	NS	—	1.1	NS	NS	NS	NS	—	NS	NS	NS	NS	—
Timing of herbicide application																						
Pree-emergence	27.2	29.5	16.2	19.9	13.7	21.3	43.1	38.5	32.3	36.4	37.6	5.0	9.5	4.9	6.8	33.2	11.7	9.1	13.6	7.6	10.4	10.2
Pre+Post emergence	31.4	28.5	14,2	18.9	12.7	21.1	48.0	39.9	30.6	32.0	37.6	3.5	10.3	8.5	6.6	31.1	12.0	5.8	14,5	12,4	10,3	10.8
Post-emergence	29.6	24.3	13.0	17.7	10.7	19.1	44.6	32.2	25.8	32.0	33.6	4.2	13.8	11.7	13.7	35.9	15.9	7,0	18.4	17.1	21.0	15.9
C.D. at 5%	1.1	2.0	1.3	1.4	1.9	—	4,7	2,6	3.3	2.9	—	0.8	1.4	1.1	1.8	2.8	—	1.5	2,8	2.4	3.3	—
Rate of herbicide application (kg/ha)																						
0.5	26.6	26.5	14.2	17.4	10.7	19.1	40,5	35,3	30.1	31.3	34.3	5.5	14.3	12.1	12.2	43.5	17.5	9.7	19.5	18.0	18.1	16.5
1.0	29.5	27.2	14.8	19.0	13.0	20.7	46.5	36.9	29,4	33.1	36.5	4.2	10.8	7.8	8.4	31.2	15.5	7.2	15.1	11.0	12.8	11.5
1.5	32.0	28.8	14.5	20.2	13.3	21.8	49.0	38.4	29.2	36.1	38.2	3.0	8.5	5.3	6.5	24 6	9.6	5.2	12.0	8.1	10.1	8.9
C.D. at 5%	1.1	2.0	NS	1.4	1.9	—	4.7	NS	NS	2.9	—	0.8	1.4	1.1	1.8	2.8	—	1.5	2.6	2 4	3.3	—
Control	21.3	18.3	14.0	12.5	8.3	14.9	31.4	23.2	29.1	20.7	26.1	12.4	23.3	25.9	32.5	59.4	30.7	19.1	30.4	32.1	53.6	33.8
Treated	29.4	27.5	14.5	18.9	12.4	20.5	45.3	36.8	29.6	33.5	36.3	4.2	11.0	8.4	9.0	33.1	13.3	7.4	15.5	12.4	13.9	12.3
C.D. at 5%	1.5	2.5	NS	1.9	2.3	—	6.0	3.4	NS	3.8	—	1.1	1.8	1.4	2.4	3.7	—	1.9	3.6	3.1	4·3	—

NS = Not significant

effect on grain yield, weed dry matter production and uptake of N by wheat or weeds. In general pre + post-emergence application of 2, 4-D increased grain production. Pre + post and post emergence treatments reduced weed dry matter production by 9.1 (74 per-cent) and 9.6 q/ha (78 per cent) and reduction by in the weed uptake by 16.7 (66 per cent) and 18.8 kg/ha (75 per cent) respectively in comparison with pre-emergence treatment. Higher wheat yields with pre + post or post-emergence application of 2, 4-D were also reported by Singh (1967). Though weed dry matter production under post-emergence treatment was the least i. e. 2.7 q/ha only as against 12.3 q/ha under pre-emergence treatment, the reduction in the weed dry matter production as a result of post-emergence treatment was not found associated with increased production of wheat. This might be due to an increased area affected in wheat because of greater herbicide residues left under post-emergence treatment in maize and partially due to off-setting of any weed control advantage with post-emergence of 2, 4-D by bringing in deformitive effect on wheat.

The combined pre + post-emergence application appeared to have diluted the concentration effect. Harmful effects of post-emergence of 2, 4-D on wheat were also reported by Nel and Hammes (1968). Reduction in the yield of wheat due to higher rates of simazine or atrazine applied to maize were also reported by Milojic and Misovic (1969) and Bagdanuski (1968). Decreased weed dry matter production could not make up the loss due to residual effect of triazines on wheat as exhibited by a greater per cent area affected and the highest grain yield in wheat (39.1 q/ha) was obtained when only half a kilogram simazine was applied to previous maize crop.

An application of no more than 0.5 kg/ha herbicide was required to control weeds in wheat field as rates higher than this tended to significantly reduce grain production. When compared with 1.0 kg of 2, 4-D per hectare, an application of 0.5 kg/ha increased wheat grain production by 1.6, 3.1, 3.0, 1.8 and 0.8 q/ha, respectively in 1968 69 to 1972-73. Corresponding increases over 1.5 kg/ha application rate were 3.7, 3.4, 7.0, 6.8 and 2.1 q/ha, respectively. Data also show that decreases in wheat grain production by an increase in the application rate of 2, 4-D from 0 5 kg/ha over 1.0 kg/ha were less than those accuring from an application rate of 1.5 kg/ha over 1.5 kg/ha. Averaged over five years, increases from an application rate of 0.5 kg/ha in comparison with 1.0 and 1.5 kg ha were 2.1 (5.6 per cent) and 4.6 q/ha (13.3 per cent) respectively.

Data (Table II) also show that application of 2. 4-D is necessary for weed control in wheat and withholding its application, severely increased weed competition and decreased crop yields. These data further show the severity of residual effect on wheat of triazines applied to maize. It, therefore, appears that lower yields in plots receiving more than 0.5 kg ha of 2, 4-D. When 2, 4-D partly due to an adverse effect of tria-

TABLE II. Effect of weed removed nitrogen replenishment and time and rate of application of herbicides on wheat grain yield and weed dry matter production, uptake of N by grain and weeds and per cent area affected in wheat

Treatments	Grain yield (q/ha)						N uptake by wheat (kg/ha)						% area affected in wheat	Weed dry matter production (q/ha)						N uptake by wheat (q/ha)				
	1968-69	1969-70	1970-71	1971-72	1972-73	Mean	1968-69	1969-70	1970-71	1971-72	Mean	Grain without 2, 4-D		1968-69	1969-70	1970-71	1971-72	1972-73	Mean	1968-69	1969-70	1970-71	1971-72	Mean
N replenishment level (%)																								
100	42.5	42.6	37.0	37.2	31.9	38.2	81	98	91	91	90	35.0	9.8	5.3	3.9	4.9	7.2	6.9	5.6	8.7	9.1	12.8	21.0	12.9
125	36.6	40.5	35.7	31.1	30.3	34.8	74	99	85	78	84	32.1	7.7	5.9	4.4	5.5	7.8	8.6	6.4	10.4	10.0	11.5	20.8	13.2
150	39.8	42.5	38.5	34.3	34.0	37.8	78	102	99	87	91	36.0	8.2	4.6	3.7	4.6	6.8	8.0	5.5	8.2	9.5	11.0	19.7	12.1
175	40.3	41.3	37.7	32.1	33.3	36.9	80	101	97	83	90	34.0	8.3	4.8	4.4	6.5	8.3	7.8	6.4	8.4	9.4	14.8	21.3	13.5
200	37.5	39.4	38.5	34.0	33.3	36.5	74	100	10	87	92	33.1	10.0	5.5	3.4	5.5	8.0	9.3	6.3	9.4	9.0	13.6	26.0	14.5
C.D at 5%	4.5	NS	NS	NS	NS	—	NS	NS	NS	NS	—	NS	NS	NS	NS	NS	NS	NS	—	NS	NS	NS	NS	—
Timing of 2, 4-D application																								
Pre-emergence	37.0	38.5	34 5	33.2	35.0	35.6	73	91	85	80	82	32.0	3.3	11.9	7.8	11.9	14.4	15.7	12.3	19.6	18.3	27.6	35.3	25.2
Pre+Post emergence	40.8	42.0	39.7	36.7	33.2	35.5	80	101	106	88	94	34.8	8.3	1.9	2.0	2.5	5.4	4.1	3.2	3.7	5.0	6.0	17.5	8.5
Post-emergence	40.6	43.2	38.2	31.3	29.4	36.5	81	107	97	88	93	35.6	14.8	1.8	2.0	1.9	3.1	4.5	2.7	3.4	5.0	4.5	12.7	6.4
C.D. at 5%	2.7	2.9	3.6	NS	4.2	—	5.8	9.1	139	NS	—	NS	2.1	1.1	0.9	1.2	1.9	1.8	—	2.0	2.5	4.2	4.8	—
Rate of 2,4-D application (kg/ha)																								
0.5	41.2	43.4	40.7	36.6	33.5	39.1	80	104	105	90	95	35.1	2.8	6.2	5.4	7.6	10.9	10.1	8.0	10.8	13.0	17.5	28.2	17.4
1.0	39.6	40.3	37.7	34.8	32.7	37.0	78	96	95	90	90	35.2	6.7	5.0	3.6	5.3	7 2	8.2	5.9	8.9	8.4	12.9	20.0	12.6
1.5	37.5	40.0	33.7	29.8	31.4	34.5	75	99	88	76	84	32.0	16.8	4.4	2.8	3.4	48	6.0	4.3	7.3	6.8	7.7	17.3	5.5
C.D. at 5%	2.7	2.9	3.6	4.9	NS	—	NS	NS	NS	11.9	—	NS	2.1	1.1	0.9	1.2	1.9	1.8	—	2.0	2.5	4.2	4.8	—
Control	39.8	40.2	36.7	32.7	37.3	37.3	76	91	89	83	85	36.0	0.5	13.2	13.1	17.5	22.6	25.9	18.5	20.8	25.3	37.8	47.5	32.9
Treated	36.3	39.5	41.2	37.5	33.7	36.9	77	100	96	85	90	34.0	8.8	5.2	3.9	5.4	7.6	8.1	6.0	9.0	9.4	12.7	21.8	13.2
C.D at 5%	NS	NS	NS	NS	NS	—	NS	NS	NS	NS	—	NS	2.8	1.5	2.4	1.5	2.5	2.3	—	2.6	3.3	5.4	6 3	—

NS = Not Significant

zinesapplied to maize and partly due to deformitive effect of 2, 4-D was not applied wheat grain yield was 35.1, 35.2 and 32.0 q ha under 0.5, 1.0 and 1.5 kg ha of triazines applied to maize as against 39.1, 37.0 and 34.5 q ha of grain yields respectly when 2, 4-D was applied at the rate of 0.5, 1.0 and 1 5 kg ha.

Poste-mergence application of 2,4-D had a significantly better effect on uptake of nitrogen by grain and there was not much difference between the uptake of N under pre + post and post-emergence treatments but the differences were significant over pre-emergence treatment in all years except in 1971–'72. Post-emergence treatment resulted in a significantly decreased uptake of N by the weeds in all years. On an average post - emergence or pre+plus post – emergence treatments increased the uptake of N by 11.0 (13.4 per cent) and 12.0 kg/ha (14.6 per cent), respectively. The corresponding decrease in N uptake by weeds were 16.7 (66.2 per cent) and 18.8 kg/ha (74.6 per cent) respectively over pre - emergence.

Uptake of nitrogen by wheat grain though tended to decrease with an increase in the appllcation rate of 2, 4-D but the differences were significant in one out of four years. There was, however, a significant reduction every year in the N uptake by weeds due to an increase in the herbicide application rates. On an average, application of herbicides increased the uptake of N by grain by 5.0 (5.6 per cent) and decreased the uptake of N by weeds by 19.7 kg ha (59.9 per cent) over control.

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REFERENCES

BAGDANAUSKI, A. F. 1968. The residual effect of simazine and atrazine in the crop rotation. *Vestsi Akad. Navuk. BSSR Sel. Sel-Skagaspad Navak* 1: 78-82.

MANI, V. S., S. N. TRIPATHI, A. I. BHAGWANI, and B. P. MATHUR. 1970. Chemical weed control in maize crop. *Indian Fmg.* 19: 19-20.

MILOJIC, B. and M. MISOVIC.1969 The effect of herbicide residues in the soil on the yield of winter wheat. *Zoborn Rod Pol. Opriv. Fak. Univ. Beogrt.* 15: 13.

NEL, P. C. and P. S. HAMMES. 1968. Effects on Punjab Wheat of preemergence application of 2, 4-D ester. *S. Afr. J. Agric. Sci.* 11: 219-25.

SAROHA, M. S. and H. G. SINGH, 1971. Effect of increasing levels of triazine herbicides on weed control in maize and residual effect on wheat. *Indian J. Weed Sci.* 2: 97-104.

SINGH, H. G. 1967. Effect of 2, 4-D on crop-weed competition in wheat. *Indian J. Agron.* 12: 25-30.