

Weeds Competition in Pearl Millet in Arid Zone as Influenced by Varieties, Doses of Nitrogen and Methods of Weed Control.

VIJAY KUMAR AND P. C. RAHEJA*

In the past, the mechanical and cultural practices have been adopted for control of weeds. Due to the increasing cost of labour, the severity of weed competition and the limitation of such weed control practices in various crops, the use of herbicides by the cultivators is likely to increase. The application of 2, 4-D exhibit high degree of selective herbicidal properties. In cereal crops it controls most of the broad-leaved weeds and checks growth of many others. The crop-weeds competition in arid zone is critical and the information on control of common weeds in *bajra* in relation to various cropping, mechanical and chemical control methods is lacking.

Khan and Mathur (1961) comparing the various cultural practices for weed control in *bajra* crop reported that presence of weeds significantly reduced the grain yield. Weeding by hand hoe proved significantly better than interculture with bullock drawn hoe. Mathur (1962) stated that pre and post emergence of 2, 4-D at 1.5 lb per acre showed effective weed control in *bajra*. It was indicated that hand weeding, when included in the trial, was found to be most effective in controlling weeds. Burnside and Wicks (1964) compared in dry land sorghum infested mainly with *Amaranthus* and *Setaria* spp, the treatments of various herbicides, 0, 1, 2 and 3 cultivations, hand weeding and control. Weed control with pre emergence was feasible and more effective than cultivation. Comparing hand weeding, hand pulling and spraying of 2, 4-D at different times on wheat, Mukhopadhyay (1965) reported that spraying of 2, 4-D at 4 and 6 weeks stages at the rate of 6 oz a. i. per acre gave effective control of weeds. There was some regeneration of weeds under hand weeded and hand pulling treatments. Misra and Vijay Kumar (1962 and 1965) and Misra and Mathur (1966) has reported effective control of weeds with post emergence application of 2, 4-D at 1.5 to 2 kg a. i. per hectare in arid zone.

MATERIALS AND METHODS

Investigations were conducted at Central Research Farm, Central Arid Zone

* Asstt. Prof. of Agronomy, P. A. U., Ludhiana and Project Manager, Lake Nasser, Aswan, U. A. R., respectively.

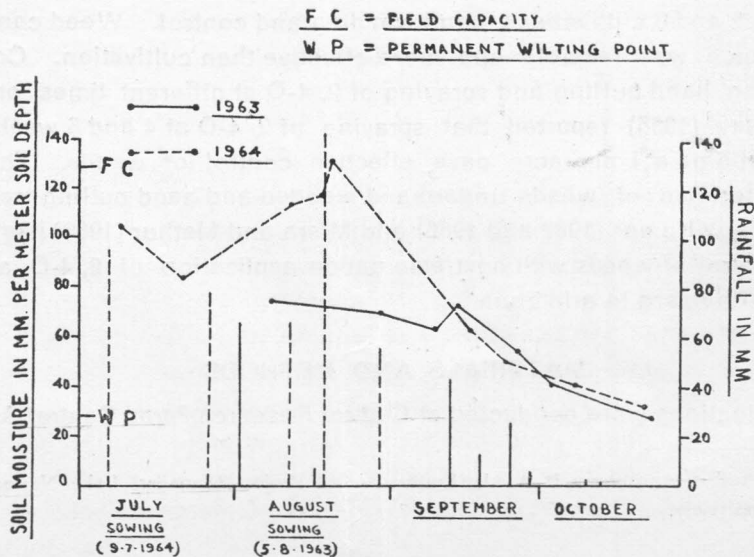
Research Institute, Jodhpur during *Kharif*, 1963 and 1964. The farm soil is desert sandy type containing 86 per cent sand, 8 per cent silt and 6 per cent clay. The soil was poor in the available N, P & K. The rainfall at the farm was 135 and 450 mm during the first and the second growing season respectively. As such weeds infestation was low in the first year while, 3-4 wetting-drying cycles (Fig. 1) in the second year resulted heavy weeds competition to the crop.

The experiment was laid out in 3^3 confounding design with two replications. The treatments included were :—

1. *Varieties* :— V_1 —R. S. K., V_2 —Chadi & V_3 —Local (Jodhpur).
2. *Nitrogen doses* :— N_0 —Control, N_1 —20 kg/ha & N_2 —40 kg/ha.
3. *Methods of weed control* :— W_0 —No weeding, W_1 —three weedings by *Khurpi* at 3, 6 and 9 weeks after sowing and W_2 —two sprayings of 2, 4-D @ 150 kg a.i./ha at 5 and 7 weeks after sowing

The crop was sown on 5th of August and 9th July in 1963 and 1964 respectively. The number and dry weight of weeds was studied at about 20 days interval by one square metre quadrat at two places randomly. The last observation on weeds was taken at the time of the harvesting. The weed competition Index was calculated as suggested by Gill and Vijay Kumar (1965).

FIG.1. SOIL MOISTURE (—) AND RAINFALL (!!) IN THE CROP GROWING PERIODS



RESULTS

The data relating to number and dry weight of weeds are given in table 1 and 2.

It is apparent that weeds population was maximum at 34 and 45th day during 1963 and 1964 respectively. There was a marked reduction in weeds population at harvest

Weeds population in relation to various treatments :— Differences in population and dry matter accumulation of weeds in plots of various varieties were not significant, and not consistent.

Nitrogen application showed adverse effect on weeds population. N_2 plots showed significantly less number of weeds than N_0 plots at 58th day in the first year and at harvest in the second year respectively. Differences between N_0 and N_1 were not significant.

Effect of weeding by *Khurpi* and spraying of 2, 4-D on reducing the number of weeds was clearly seen in both the years after the weeding treatments were started. Both the weeded treatments showed highly significant difference over no weeding. At all the stages weeding by *Khurpi* showed minimum weeds population. Number of weeds in W_1 plots were significantly less than W_2 at 58th day in 1963 and at 85, 93rd and at harvest in 1964

Dry matter accumulation in weeds in relation to various treatments :

There was no consistency in the dry matter accumulation of weeds in plots of various varieties at different stages of growth. The differences were statistically not significant at any stage.

The application of nitrogen at two levels showed slight reduction in dry matter of weeds in the first year. Reverse was true in the second year. Differences were not consistent and statistically not significant, except at initial stage (20th day) in the second year when N_2 showed significantly higher dry weight of weeds than N_0 .

Dry matter accumulation in weeds showed a very high increase with time in unweeded plots (W_0) upto 52 and 89th day during the two years respectively which was reduced to practically half at the harvest. Effect of weed control measures (W_1 and W_2) on reducing the weeds yield was apparent as soon as weedings were started and this effect was accumulated with time. Hand weeding and spraying of 2, 4-D without differing significantly between themselves, except at 89th day in 1964, showed highly significant reduction in weeds yield than no weeding at all the stages in both the years. Dry matter accumulation of weeds in W_1 plots was practically nil during the reproductive stages of the crops and was significantly less than W_2 at 89th day in 1964. Differences between W_2 and

Table 1:-- Average number of weeds per square metre as affected by different treatments.

Treatments	Days after sowing								
	34	58	71	20	45	75	85	92	105
	1963			1964					

Varieties:

V ₁	17.6	10.1	4.31	5.77	41.25	15.54	13.0	19.0	14.8
V ₂	13.7	13.5	5.11	7.66	46.44	20.72	20.3	11.5	19.8
V ₃	16.6	12.1	5.55	7.44	28.98	20.1F	13.3	16.6	12.3
'F' test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
SE (+)	2.18	1.37	0.93	1.90	5.91	2.94	2.36	2.62	1.83

Nitrogen-Doses:

N ₀	13.1	14.9	5.83	5.33	44.71	20.88	19.1	20.0	1.71
N ₁	15.0	12.3	4.77	10.11	39.78	16.32	15.8	15.0	12.9
N ₂	20.0	8.5	4.44	5.44	30.96	19.32	11.7	12.0	9.9
'F' test	N.S.	Sig.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	Sig.
SE (+)	2.18	1.37	3.93	1.90	5.91	2.94	2.36	2.62	1.83
C. Dat 5%	—	4.07	—	—	—	—	—	—	5.43

Methods of weed control:

W ₀	15.4	25.1	11.05	9.55	61.30	40.88	29.2	30.4	21.2
W ₁	17.4	3.2	1.72	6.00	27.33	5.50	3.3	4.3	5.4
W ₂	15.2	7.4	2.27	5.33	82.00	10.54	14.1	12.0	13.2
'F' test	N.S.	Sig.	Sig.	N.S.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (+)	2.18	1.37	0.93	1.90	5.91	2.94	2.36	2.62	1.83
C. D. at 5%	—	4.07	2.76	—	17.56	8.72	7.01	7.78	5.43
C. D. at 1%	—	5.06	3.78	—	—	11.96	9.67	10.66	7.44

Table 2 :— Dry weight of weeds per square metre in relation to different treatments.

Treatments	Days after sowing							
	34	52	67	20	41	71	89	105
	1963				1964			
<i>Varieties :</i>								
V ₁	5.71	10.36	4.51	2.92	5.28	15.29	30.10	26.80
V ₂	6.08	13.96	5.12	6.68	9.15	15.90	29.45	20.95
V ₃	7.45	12.15	8.22	3.14	6.57	22.93	45.17	20.31
Mean	6.41	12.16	5.95	2.91	7.00	17.71	34.91	22.69
'F' test	N.S.	N. S.	N. S.	N.S.	N.S.	N.S.	N.S.	N. S.
<i>N. Doses :</i>								
N ₀	5.59	14.08	7.80	1.98	5.37	14.76	32.76	21.26
N ₁	5.83	12.71	7.26	2.50	8.28	16.16	32.63	27.21
N ₂	7.81	9.67	5.79	4.27	7.41	22.20	39.33	19.58
Mean	6.41	12.16	5.95	2.91	7.00	17.71	34.91	22.69
'F' test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C. D at 5%	—	—	—	1.76	—	—	—	—
<i>Methods of weed control :</i>								
W ₀	9.73	25.22	13.03	3.83	13.55	46.08	75.54	48.08
W ₁	3.43	3.42	0.70	2.77	2.48	0.98	1.07	3.24
W ₂	6.02	7.82	3.05	2.14	5.02	6.00	28.11	16.72
Mean	6.41	12.16	5.95	2.91	7.00	17.71	34.91	22.69
'F' test	Sig.	Sig.	Sig.	N.S.	Sig.	Sig.	Sig.	Sig.
C. D. at 5%	2.73	5.05	5.55	—	5.30	11.65	17.93	16.87
C. D. at 1%	3.73	6.90	7.61	—	—	13.67	25.02	23.12

W_0 were also at par of significance at various stages in the first year.

Correlation between dry weight of weeds per square metre and grain yield of *bajra* per plant was calculated. The relationship was found to be negative. The regression equation is given as under.

$$Y = 9.8763 - 0.0886 x \text{ (Fig. 2).}$$

It indicated that increase in every gram of dry weight in weeds per square metre reduced the grain yield by 0.09 gm per plant.

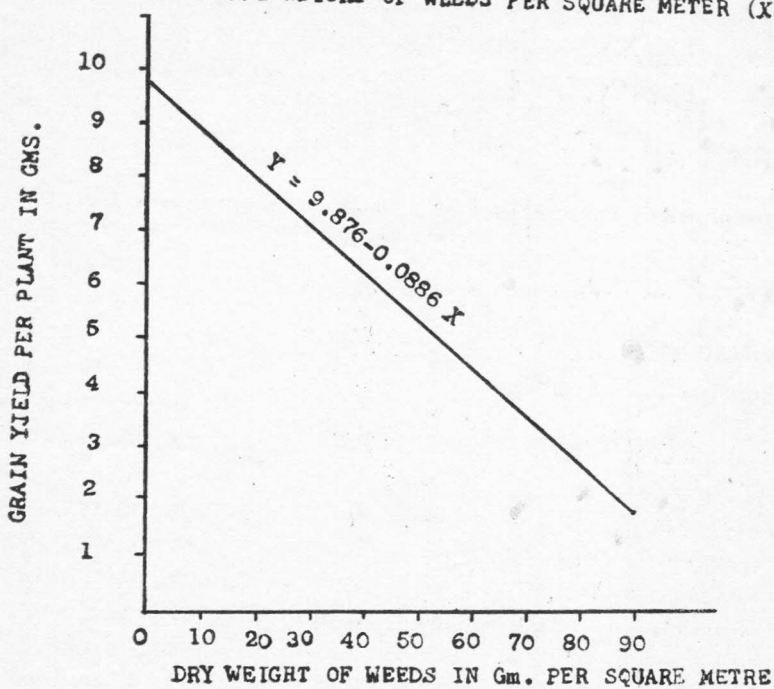
Susceptibility of various weeds to spraying of 2, 4-D :

For such studies, the observations were recorded from the four marked places in 9 plots of 1st replication from which the number of weeds were counted on alternate days after the spraying of 2, 4-D. This study was continued for 15 days after both the sprayings of 2, 4-D. Different weeds were assigned the marks ranging from 1-4 depending upon the harmful effect of 2, 4-D. The details of the average data are given in table 3.

Table 3—Comparative toxic effect of 2, 4-D on common weeds in *Bajra* crop.

Weeds	Marks			Remarks.
	1963	1964	Average	
1. <i>Amarantus viridis</i>	2.50	2.75	2.62	Marks 1.0 = Practically no harmful effect was visible.
2. <i>Aerva persica</i>	1.00	1.05	1.00	1.0-2.0 = Weeds were green but growth was checked.
3. <i>Berrerea</i> spp.	3.25	3.30	3.28	2.0-3.0 = Apical bud died, growth was reduced, harmful effect was marked by twisting of leaves and bending of stem and weeds were partly died.
4. <i>Cyperus rotundus</i>	2.75	2.62	2.68	3.0-4.0 = More than 90 percent plant portion died within 15 days after spraying.
5. <i>Cenchrus catharticus</i>	1.25	1.00	1.12	
6. <i>Crotalaria burhia</i>	1.00	1.00	1.00	
7. <i>Corcherus anticorus</i>	3.75	3.80	3.75	
8. <i>Convolvulus pluricaulis</i>	1.50	.75	1.67	
9. <i>Digera muricata</i>	3.00	3.80	3.40	
10. <i>Euphorbia thymifolia</i>	2.25	2.50	2.37	
11. <i>Giesekia pharnaceoides</i>	3.00	2.95	2.93	
12. <i>Gynodropsis gynandra</i>	3.50	3.60	3.55	
13. <i>Helietropium subulatum</i>	2.25	2.75	2.50	
14. <i>Indigofera</i> spp.	1.00	1.00	1.00	
15. <i>Mollugo nudicaulis</i>	3.85	3.80	3.82	
16. <i>Phyllanthus niruri</i>	2.50	2.40	2.45	
17. <i>Pulicaria wightiana</i>	2.75	3.00	2.83	
18. <i>Tephrosia purpurea</i>	3.00	3.30	3.15	
19. <i>Tribulus terrestris</i>	3.00	3.00	3.00	
20. <i>Volutarella ramosa</i>	2.00	2.25	2.12	

FIG. 2-REGRESSION BETWEEN GRAIN YIELD PER PLANT (Y)
ON DRY WEIGHT OF WEEDS PER SQUARE METER (X)



In general, the effect of 2, 4-D in killing the various weeds was similar in both the years. However, the effect of 2, 4-D was more marked during 1964 than 1963. Weeds with 2.75 marks and above were susceptible and can be effectively controlled by 2, 4-D sodium salt application at the rate of 1.5 kg acid equivalent per hectare. Out of the common weeds, the most susceptible weeds to 2, 4-D application were *Mollugo naudicaulis*, *Digera muricata*, *Corchorus* spp., *Borerrea* spp., *Tephrosia purpurea*, *Tribulus terrestris* and *Giesekia pharnaceoides*.

Weeds which were partially affected were *Cyperus rotundus*, *Pulicaria wightiana*, *Euphorbia thymifolia*, *Phyllanthus niruri* and *Volutarella ramosa*, while *Convolvulus pluricaulis* was occasionally affected.

The weeds resistant to 2, 4-D application at the above rate, while growing in the Bajra crop, were *Crotalaria burhia*, *Cenchrus catharticus*, *Aerva persica* and *Indegifera* spp.

Cyperus rotundus generally resprouted within 25 days of spraying of 2, 4-D if enough moisture was present in the soil. *Pulicaria wightiana*, which was the dominating weed, appeared always little later i. e. 35-45 days after sowing. During 1963, a dry year, when the total number of weeds was comparatively low, it represented more than 50 per cent of the total weeds population in most of the treatments especially in control plots. It was susceptible to the 2, 4-D application hence was not seen often in W_2 plots. Similar observation was recorded during 1964. The population of this weed was not reduced during 1963 when the population of most of the other weeds i. e. *Tephrosia purpurea*, *Euphorbia thymifolia*, *Phyllanthus niruri* and *Borerrea* spp. was low due to lack of moisture. Another important weed, *Digera muricata*, which showed high competition to the crop plants due to its larger vegetative growth and shared good proportion of weed population during 1964. This weed was also found to be highly susceptible to 2, 4-D spraying. As such *Digera muricata* was a dominate weed in control plots (no weeding) during early growth stages. Later on at the time of maturity when soil moisture in upper one metre soil approached wilting point, as shown in Fig. 1, it was replaced by *Pulicaria wightiana*.

Tephrosia purpurea, a common weed, was found to be highly susceptible to the 2, 4-D application. It showed the typical toxic symptoms of 2, 4-D with the death of the apical bud. Growth of the plant was checked and it resulted in slow death of the weed. *Euphorbia thymifolia* another common weed, showed some resistance to the action of 2, 4-D.

WEED COMPETITION INDEX (WI)

The value of Weed Index alongwith the percentage increase over control are given in table 4. It was assumed that the weed competition in W_1 plots was practically nil as such its yield was used for the calculations as no-weed plot.

Table 4 : -- Weed Competition Index.

Treatments	1963			1964		
	Y	P ₁	W ₁	Y	P ₁	W ₁
W ₀ -N ₀ weeding	2.19	—	25.7	2.40	—	51.6
W ₂ —spraying of 2, 4-D.	3.23	11.8	6.9	3.33	38.7	32.8
W ₁ —weeding by Khurpi.	3.89	34.6	—	4.96	106.6	—
Percentage reduction in weed competition	—	—	34.2	—	—	36.0

Y—Grain yield in quintals per hectare.

P₁—Percentage increase in yield over no weeding.

W₁—Weed Index.

The increase by application of 2, 4-D during 1963 and 1964 was about 12 and 39 per cent over no weeding respectively. The value for Weed Index was 51.6 for 1964 and only 25.7 for 1963. Thus, maximum possible increase during 1963 could not be more than 25 per cent because that was the maximum competition given by the weeds. So effectiveness of the weedicide, which has been under-rated during 1963, if worked on percentage basis, has been clearly brought out by W₁. While, during 1964, very high increase of about 39 per cent showed that 2, 4-D was highly effective but it still left 52 per cent competition from the weeds. It further indicated that the reduction in weed competition was about the same (34 and 36 per cent) during 1963 and 1964 respectively but the procedure of percentage increase in yield indicated considerable variation during these two years. This indicated that W₁ gave more appropriate measure to describe the effect of the 2, 4-D than percentage increase in yield over control (no weeding), which fluctuates widely and hence does not reveal the real situation.

DISCUSSION

Weeds population and their dry yield was considerably more in 1963 than 1964. This variation may be explained on the basis of high rainfall and soil moisture in 1964 than 1963. Besides, there were 3-4 wetting and drying cycles in the latter year (Fig. 1). While, weeds growth and population was reduced considerably with the reduction in soil moisture (W. P.) as observed in the beginning of October in both the years (Fig. 1).

Both the weed control practices i.e., spraying 2, 4-D and weeding by *Khurpi* showed effective control of weeds as is evident from weed population and dry

weight of weeds per square metre. Differences were significant at one per cent level throughout the growing period. Effect of W_1 was also significantly superior over W_2 . This effect is more clearly visible in dry matter accumulation as the dry weight of the weeds in W_1 treatment was negligible as compared to W_2 and W_0 . It was further observed that there was a slight increase in dry matter accumulation of weeds in W_1 plots at harvest in both the years. A few common weeds i.e. *Cyperus rotundus*, *Convolvulus plicatus* (both perennial) and *Pulcaria wightiana* and *Digera muricata* (annual) appeared late in the season while, the latter (annual) weeds showed casual appearance in the W_2 plots. Inhibition of such weeds in 2, 4-D sprayed plots may be described due to residual effect of the 2, 4-D sprayings. 2, 4-D penetrates the cuticle and migrates across epidermis and mesophyll to phloem. It probably accumulates in meristems and brings about dramatic change in differentiation processes, and if present in sufficient amounts, caused ultimate death. 2, 4-D may also be metabolized in plants accompanied by an increase in energy-rich bonds. If these are dissipated in a wasteful oxidation of carbohydrate reserve without the synthetic process normally included in respiration cycle, than such a mechanism explains the lethal action of 2, 4-D on weeds (Crafts, 1957):

As expected 2, 4-D showed great promise in killing most of the broad-leave weeds. The common weeds of arid zone i. e., *Digera muricata*, *Corchorus antichorus*, *Tribulus terrestris* and *Gisekia pharnaciodes* were most susceptible to 2, 4-D at 1.5 kg acid equivalent per hectare. In general, *Gisekia pharnaciodes*, *Digera muricata*, *Pulcaria wightiana* and *Cyperus rotundus* were the most common weeds. The first appeared with the crop and was the dominating weed in the early growth stages of the crop but disappeared after the monsoon. The second came slightly late and practically died with the harvesting of the crop. The third appeared during the grand growth period of the crop and gave maximum competition to the crop during maturity. It was profusely growing even after harvesting of the crop. It may be mentioned here that the first three weeds were susceptible to 2, 4-D spraying. *Cyperus rotundus*, however, resprouted within 25 days of 2, 4-D spraying. The action of 2, 4-D consists in the destruction of meristems that normally account for growth and development of the plants. Mature leaves, stems and roots may be killed, but without destruction of buds, and in consequence perennial weeds viz. *Cyperus rotundus* & *Convolvulus* spp. recovered.

SUMMARY

Number and dry weight of weeds was not significantly affected by various varieties. Nitrogen fertilization showed adverse effect on weed population. Harmful effect of nitrogen doses was, however, not marked on dry matter of

weeds. Weed competition, as evident from weeds population and their dry weight was practically nil in W_1 (hand weeded) plots. Superiority of 2, 4-D was also significant over control (No Weeding). The reduction in weed competition by 2, 4-D was about the same (34 and 36 per cent) during 1963 and 1964 respectively. Increase in every gram of dry weight in weed per square metre reduce the grain yield by 0.09 gram per plant. Most of the broad leaved weeds were susceptible to the 2, 4-D sprayings.

REFERENCES

- Burnside, O. C. and Wicks, G. A. Cultivation and herbicide treatments on dry land sorghum. *Weeds*. 12 (4) : 307-310, (1964).
- Crafts, A. S. The Chemistry and mode of action of herbicides. *Adv. Pest Control* 1 : 39-80, (1957).
- Gill, G. S. and Vijay Kumar. Weed Index—a new method for reporting weedicide trials. *Proc. II Ind weed control seminar held at PAU Hissar* 14-17 Feb. (1966).
- Khan, A. R. and Mathur, B. Effect of cultivation with alternative tillage implements with and without interculture on the yield of *bajra* under rainfed conditions. *Indian J. Agric. Sci.* 31 (3) : 156-59, (1961).
- Mathur, R. L. A brief review of the work done on weed control in Rajasthan during 1858-59 to 1960-61. *Proc. Ist weed control seminar, I.C.A.R. sub. (2)*, (1961).
- Mathur, M. K., and Jain, M. B. L. D. 50 of 2, 4-D for *Tephrosia purpurea*. *Proc. II Weed Control Seminar held at P. A. U. Hissar* : 41, (1966).
- Misra, D. K. *Tribulus terrestris* weed in arid zone farming. *Indian J. Agron.* 7 (2) : 136-41, (1962).
- Misra, D. K. and Vijay Kumar. Response of *Pennisetum typhodes* to weeding in Arid Zone farming. *Indian J. Agron.* 6 (4) : 260-269, (1962).
- *Tephrosia Purpurea*—weed in arid Zone farming. *Indian J. Agron* 10 (4) : 371-374, (1965).
- and Mathur, M. K. Effect of herbicides on *bajra* yield. *Proc II Weed Control Seminar held at P. A. U. Hissar, Feb.* : 14-17, (1966).
- Mukhopadhyay, S. K. Control of weeds in Wheat and Rice for increasing crop production. *Indian J. Agron.* 10 (1) : 72-82 (1965).