Effect of weed management on wheat performance and profitability ~~weeds, growth, yield and economics of wheat~~ in transitional plain of L~~l~~uni basin

Abstract~~:~~

An experiment was conducted at Agricultural Research Station, Keshwana, Jalore under arid climatice condition~~s~~ in R~~r~~abi season during 2018-19 with the aim~~object~~ of suppressing weeds with~~effect of~~ herbicides ~~on weed~~for ~~,~~ profitable wheat production~~growth, yield and economics~~. Result ~~The data~~ showed~~s~~ that~~t the treatment~~ 2,4-~~–~~D at~~@~~ 0.5 kg ai ha^{-1} at 35 DAS+ hand hoeing 45 DAS recorded lower ~~dry~~ dry matter of weed~~s~~s at harvest (18.33 g/?), with maximum plant growth, spike length (8.53 cm), n~~N~~umber~~o.~~ of spikelets (17/16.89), n~~N~~umber~~o.~~ of seeds/ ~~per~~ spike (54.67), seed yield (40.09 q) and Straw yield (59.13 q) of wheat, and at par with the treatment Metsulfuron 4 g ha^{-1} 35 DAS + hand hoeing 45 DAS. The treatment 2,4-~~–~~D at~~@~~ 0.5 kg ai ha^{-1} at 35 DAS+ hand hoeing 45 DAS also produced the maximum gross return (₹117763), net return (₹70886) and B:C ratio (2.51).

Key words: Wheat; weed management, growth, yield, economics

1. Introduction

India stands in second position next to china in the world with regard to area and production of wheat. In India wheat is grown on 34.5 million hectares with total production of 108.75 million tonnes with average productivity of 3152 kg ha^{-1} (Anon.~~ymous~~, 2020; Anon., 20-21). In Rajasthan, it is cultivated on 3.09 million hectares area with total production of 12.02 million tonnes and average productivity of 3885 kg ha^{-1} (Anonymous, 2020-21?). The productivity of the crop in the western Rajasthan is lower than the potential yield (Ref.). In Jalore district, it is grown on 0.05 million ha~~,~~ w~~W~~ith ~~the~~ total production 0.12 MT and average productivity is 2339 kg ~~kg~~ ha^{-1} is very low as compared to state productivity (~~Anonymous, 2020-21).~~

Productivity of wheat is very low ~~in~~ due to stiff competition from weeds, variable climatic conditions, genotypes, seeding time and cultural practices; and other management practices (Kantwa *et al.* ~~,~~2015). In the wheat crop, initial high soil moisture and free space leads to severe infestation of grassy and broad-lea~~f~~ves weeds. Globally, yield reduction in wheat due to weed infestation~~s~~ is 13.1 %

Comment [A1]:

Comment [A2]: Improve on the abstract

Comment [A3]: Look for a conventional name

Comment [A4]: approximated to nearest whole number

Comment [A5]: used a universal unit e.g Kg, Tonnes/hectare

Comment [A6]: what si the unit here?

Formatted: Strikethrough

Formatted: Font: Not Italic

(Singh, T.) or more and also reported that selected wheat varieties incurred 60-65 % biomass loss due to weed infestation.

The insect and disease effect on crop is visible, but the damage done by weeds is often noticed. The total loss caused by various pests in agriculture, weeds account for 37 %, followed by insect (29%), disease (22%) and others including nematodes, rodents, mites, birds etc. (12 %) (Ref). ~~w~~Weed seeds germinate along with crop seeds or many a time before crop and start competing with crops for vital growth resources like solar radiation, nutrients and water resulting in serve yield loss. All together total actual economic loss due to weeds in 16 major crops was estimated as RS 78,591 crore/annum (Gharde *et al.*~~,~~ 2018). However, the total economic losses will be much higher, if all the crops, and indirect effects on weeds on human and animal health, loss of biodiversity, nutrient depletion, reduction in grain quality etc. are taken in to consideration.

Hand weeding is a common practice in Rajasthan but it is less efficient, labour intensive, costly and often not done at the~~on~~ right time. Hand weeding is generally done when weed infestation is quite visible in the field and at this stage weeds ~~have already done the~~ competition is critical to the crop~~. but without hoeing the soil remains compact.~~ There is need to identify right time for herbicide application and hoeing.

2. Materials and methods

2.1 Field experiment site, detail and soil:-

A field experiment was conducted during rabi season 2018-19 at Agricultural Research Station, Keshwana, Jalore (Agriculture University, Jodhpur, Rajasthan) to study "Influence of integrated nutrient management on fodder pearl millet in transitional plain of luni basin" Randomized complete Block Design (RCBD) with three replications was used to design the field experiment. The treatments for this experiment were~~as~~, Weedy check, Weed free, o~~O~~ne hand hoeing at 35 DAS, 2,4-~~-~~D at~~@~~ 0.5 kg ai ha^{-1} at 35 DAS, Metsulfuron 4 g ha^{-1} 35 DAS, 2,4 D at~~@~~ 0.5 kg ai ha^{-1} at 35 DAS+ hand hoeing 45 DAS, Metsulfuron 4 g ha^{-1} 35 DAS + hand hoeing 45 DAS. Wheat variety RAJ3077 was sown on 6th December 2018. Sowing was done manually by using 100 kg ha^{-1} seed rate in a row spaced 22.5 cm.

Table 1: Physico-chemical characteristics of the soil (0-30 cm)

Comment [A7]: Is this a reference?

Comment [A8]: Use a conventional unit

Formatted: Font: Italic

Comment [A9]: Beef up the justification of the study. It is not only about timing of weed management intervention.

Formatted: Font color: Red

Comment [A10]: This is not the aim of the study

Comment [A11]: Review the table. Make it scientific

Soil parameters	Value
pH	8.02
EC ($dS\ m^{-1}$)	0.45
Organic carbon (%)	0.23
Bulk density (Mg m^{-3})	1.55
Available N (kg ha^{-1})	166
Available P_2O_5 (kg ha^{-1})	18
Available K_2O (kg ha^{-1})	280
Available S (mg kg^{-1})	13.44
DTPA extractable Zn (mg kg^{-1})	0.17
DTPA extractable Fe (mg kg^{-1})	2.70
Soil texture	Sandy loam

2.2 Analysis of weeds, plant growth and yield

Weed dry matter of each weed species was taken at initial and harvest from two random spots in each plot by counting the number of weeds per quadrate of 0.25 m^2 and then it was converted in to m^{-2}.The observations on plant height, spike length, number~~No.~~ of spikelet per spike, ~~-~~branch $plant^{-1}$, were recorded manually on five tagged sample~~selected representative~~ plants and number~~No.~~ of seeds per spike was measured~~recorded~~ manually on 10 spike from tagged~~selected~~ five plants. Harvesting was done 13th April 2019. The seed and straw yield were rmeasured~~ecorded~~ from the net plot area of each treatment. The test weight was measured~~recorded~~ by counting a ~~of~~ thousand seeds, then weighed~~ts it~~. Weed control efficiency (WCE) was calculated by using the following formula suggested by Das (2008) and expressed in percentage:

Comment [A12]: What is the size?

$$WCE = \frac{DMC - DMT}{DMC} \times 100$$

Where, DMC is the dry matter of weeds in control (unweeded) plot and DMT is the dry matter of weeds in treated plot.

2.3 Economics and statistical analysis:-

An economic analysis was done to compare the returns of various treatments of herbicides applications. Gross return determined from seed and straw yield and net return was determined by subtracting the costs of production from gross income. The data of experiment in different observations were statistically analyzed in accordance with the analysis of variance techniques as described by Panse and Sukhatme. The critical difference (CD), were calculated at 5 % level of probability. Thise elucidates the nature and magnitude of treatments effects., Ssummary table along with SEm± and CD (p=0.05) were prepared.

Result and Discussion:-

The experiment field was infested with *Chenopodium album, Chenopodium murale, Rumex dentatus, Asphodelus tenuifolius, Melilotus indica, Cyprus rotuendus, cCenchrus sSpecies and Fumaria parviflora*. The effect of different -management practices on different weeds were significant (Table 1). All the weed control treatments statistically reduced the dry matter of weeds over weedy--check at 60 DAS and harvest. The treatment 2,4--D at@ 0.5 kg ai ha^{-1} at 35 DAS+ hand hoeing 45 DAS significantly reduced the density of bBroad-leafaves weeds as well as grassy weeds at 60 DAS and harvest. The weed control efficiency showsed that 2,4-–D @ 0.5 kg ha^{-1} at 35 DAS+ hand hoeing 45 DAS and 2,4 D @ 0.5 kg ha^{-1} at 35 DAS control the weeds 73.09% and 72.08% respectively over weedy check. Regeneration of *R. dentatus* was noticed in 2,4-D at 0.5 kg ai/ha applied plots and thus increased the dry matter of the weed as compared to metsulfuron treated plots. These findings were in conformity with those reported by Singh and Ali (2004) and Pisal *et al*. (2013). Shivran *et al*. (2020) also observed that rRegeneration of R. dentatus was noticed in 2,4-D applied plots and thus increased the dry matter. Thoughe herbicide 2,4 D is used on a wide variety of terrestrial and aquatic broadleaf weeds (Anonymous, (2005)., iIt has little effect on grasses (ref). It appears to work by causing uncontrolled cell division in vascular tissue. Abnormal increase in cell wall plasticity, biosynthesis of proteins and production of ethylene occurs in plant tissues following exposure, and these processes are responsible for uncontrolled cell division (Anonymous, (2002).

The metsulfuron-methyl 4 g ai/ha PoE was next best after 2,4-–D in minimising weed biomass. A significant reduction in weed biomass 68.37 and 68.53 % with Metsulfuron 4 g ha^{-1} + hand hoeing 45 DAS and Metsulfuron 4 g ai ha^{-1} 35 DAS, respectively. Metsulfuron-methyl is generally absorbed by

Comment [A13]: The initial weed flora composition and weed flora composition at harvest should be presented in a table for comparison

Comment [A14]: Active ingredient

Formatted: Font: Italic

Formatted: Font: Italic

Formatted: Font: Italic

Formatted: Font: Italic

Comment [A15]: Add the reference

Comment [A16]: Stick to a pattern pls

Comment [A17]: Stick to a pattern of unit

leaves and translocated to growing points of the plant where it stops cell division and inhibiting the photosynthesis resulting into yellowing of plants.

Table:-2 Effect of weed management on weed dry matter (g m^{-2}) at 60 DAS and harvest of wheat

Sl. No.	Treatments	Dry matter of grassy weeds at 60 DAS	Dry matter of BL weeds at 60 DAS	Dry matter of total weeds at 60 DAS	Dry matter of grassy weeds at harvest	Dry matter of BL weeds at harvest	Dry matter of total weeds at harvest	Weed control efficiency at harvest (%)
1	Weedy check	6.80	26.67	33.47	8.80	56.87	65.67	0
2	Weed free	0.00	0.00	0	0.00	0.00	0	100
3	One hand hoeing at 35 DAS	4.50	19.18	23.68	5.20	36.47	41.67	36.55
4	2,4 D @ 0.5 kg ha^{-1} at 35 DAS	2.00	11.40	13.4	2.53	15.14	17.67	73.09
5	Metsulfuron 4 g ha^{-1} 35 DAS	2.20	14.03	16.23	2.93	17.74	20.67	68.53
6	2,4 D @ 0.5 kg ha^{-1} at 35 DAS+ hand hoeing 45 DAS	1.70	7.60	9.30	2.63	15.70	18.33	72.08
7	Metsulfuron 4 g ha^{-1} 35 DAS + hand hoeing 45 DAS	1.75	8.88	10.63	2.85	17.92	20.76	68.37
	SEm±	0.33	0.76	2.89	0.28	8.48	10.77	-
	CD (P=0.05)	1.03	2.37	0.93	0.88	2.72	3.457	-

Effect of herbicides on wheat growth, yield attributes and yields

Comment [A18]: Mode of action is not necessary here

Comment [A19]: Redo the table. No grid lines are expected.

Comment [A20]: State the weight unit/sqm

Comment [A21]: WCE 80% is considered to be acceptable. Pls check?

The plant population and plant heights are important growth parameters influencing yields which are not only genotypic but also influenced byon environmental factorsal and management practices. The herbicide application of 2, 4-D and Metsulfuron alone and with hand hoeing did not show any significant effects on wheat at harvest stage.,

BGrain beingeing the most important economic component , grain yield of a crop reflects the resultant impact of yield attributes as influenced by herbicidal treatments and weed incursion. The maximum plant height (87.33 cm) was measured in plants sown inobserved with weed free plotstreatment, but the spike length, numbero. of spikelet per spike and No.number of seeds per spike were highest in plots treated maximum observed with the treatment 2,4 D @ 0.5 kg ai ha^{-1} at 35 DAS+ hand hoeing 45 DAS but which was at par with mMetsulfuron 4 g ai ha^{-1} 35 DAS + hand hoeing 45 DAS. However, Wweed control measures did not show significant effect on test1000-seed weight of wheat.

The Applied treatment 2,4 D @ 0.5 kg ha^{-1} at 35 DAS+ hand hoeing 45 DAS significantly increased the grain and straw yield over one hand hoeing at 35 DAS, 2,4 D @ 0.5 kg ha^{-1} at 35 DAS and Metsulfuron 4 g ha^{-1} 35 DAS but was statistically at par with Metsulfuron 4 g ha^{-1} 35 DAS + hand hoeing 45 DAS as well as weed free check. The treatment 2,4 D @ 0.5 kg ha^{-1} at 35 DAS+ hand hoeing 45 DAS and Metsulfuron 4 g ha^{-1} 35 DAS + hand hoeing 45 DAS was to extent of 76 and 72 % than the weedy check treatment. These results were in close conformity with the finding of Das (2008) and Singh *et al*. (2018).

The minimum value of growth, yield attributes and yield was found with weedy check treatment it might be due to competition by weeds for resources, which made the crop plant incompetent to take up more water and nutrients, consequently growth was adversely affected. Poor growth and less uptake of nutrients in weedy check might be due to less photosynthates, then less assimilates to numerous metabolic sink and ultimately poor development of yield components.

Table:-3 Effect of weed management on growth yield attributes and yield of wheat

Sl. No.	Treatments	Plant population (No.of plants/m^2)	Plant height at harvest (cCm)	Spike length (cCm)	Numbero. of spikelet per spike	No. of seeds per spike	1000-seedTest wt (g)	Seed yield (Q/ha)	Straw yield (Q/ha)

Comment [A22]: Stick to a pattern of paragraph

Comment [A23]: Redo the table as previously stated

Comment [A24]: What is Q?

1	Weedy check	20.49	70.67	8.17	12.00	37.67	39.32	22.76	34.80
2	Weed free	21.33	87.33	8.80	16.60	53.67	40.63	36.44	55.67
3	One hand hoeing at 35 DAS	20.87	77.33	8.53	14.17	49.50	41.74	33.33	50.60
4	2,4 D @ 0.5 kg ha^{-1} at 35 DAS	21.09	80.57	8.43	15.22	53.33	42.17	32.89	49.33
5	Metsulfuron 4 g ha^{-1} 35 DAS	20.56	74.83	7.60	14.44	51.00	41.12	27.02	40.53
6	2,4 D @ 0.5 kg ha^{-1} at 35 DAS+ hand hoeing 45 DAS	20.79	86.17	8.53	16.89	54.67	41.58	40.09	59.13
7	Metsulfuron 4 g ha^{-1} 35 DAS + hand hoeing 45 DAS	20.75	77.13	8.20	15.11	52.00	41.50	39.11	57.33
	SEm±	0.67	3.34	0.40	0.84	1.61	1.51	5.382	8.49
	CD (P=0.05)	NS	10.39	NS	2.62	5.00	NS	1.728	2.73

Economics

The mMaximum net returns and B:C ratio were recorded under aApplication of 2,4 D @ 0.5 kg ha^{-1} at 35 DAS+ hand hoeing 45 DAS over all the weed control treatments. This might be due to higher grain and straw yield and lower cost to control of weed. These results are in close agreement with results of Sshivran *et al*. (2020) who reported that highest net return was observed at metsulfuron 4.0 g ai/ha + 1 HW and 2,4-D 0.5 kg/ha + 1 HW.

Table:-4 Effect of weed management on economics of wheat.

Sl. No.	Treatments	Gross Monitory (Rs/ha.)	Net Moneitory (Rs/ha.)	B:C Ratio
1	Weedy check	67472	26345	1.64
2	Weed free	108003	56876	2.11

Comment [A25]: explain

Comment [A26]: write in full

Comment [A27]: redo the table

Comment [A28]: ??

3	One hand hoeing at 35 DAS	98626	52499	2.14
4	2,4 D @ 0.5 kg ha^{-1} at 35 DAS	97023	55146	2.32
5	Metsulfuron 4 g ha^{-1} 35 DAS	79709	37882	1.91
6	2,4 D @ 0.5 kg ha^{-1} at 35 DAS+ hand hoeing 45 DAS	117763	70886	2.51
7	Metsulfuron 4 g ha^{-1} 35 DAS + hand hoeing 45 DAS	114707	67880	2.45

References

Anonymous, 2020-21 Government of Rajasthan, Department of Agriculture.

Anonymous (2002) Herbicide Handbook, 8th ed.; Vencil, W.K. Ed.; Weed science society of America: Lawrence, KS,2002: 113-115

Anonymous (2005) Reregistration Eligibility Decision (RED) 2,4-D: EPA738-R-05-002; U.S. Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances, Office of Pesticides Programs, U.S. Government Printing Office: Washington, DC, 2005

Das TK. 2008. *Weed Science: Basics and Application*. Jain Brothers Pub, New Delhi, 1st Ed. 655p.

~~Das TK. 2008. *Weed Science: Basics and Application*. Jain Brothers Pub, New Delhi, 1st Ed. 655p.~~

Gharde, Y., Singh, P.K., Dubey, R. P. and Gupta, P.K. 2018. ~~Assisment~~Assessments of yield and economic losses in agriculture due to weeds in India. Crop Protection 107: 12-18.

Panse, V. G. and Sukhatme, P.V. Statistical Methods for Agricultural Workers; Indian Council of Agricultural Research: New Delhi, India, 1985; pp. 87-89.

~~Pisal RR, Gopinath K and Pandey AK. 2013. Evaluation of sulfosulfuron and metribuzin for weed control in irrigated wheat. *Indian Journal of Agronomy* 51(31): 135–138.~~

Pisal RR, Gopinath K and Pandey AK. 2013. Evaluation of sulfosulfuron and metribuzin for weed control in irrigated wheat. *Indian Journal of Agronomy* **51**(31): 135–138.

Shivran H., Yadav, R.S., Singh, S.P., Godara, S.L., Bijarniya, A. L. and Samota, S. R. 2020. Tillage and weed management effect on productivity of wheat in North-West Rajasthan. Indian Journal of Weed Science 52 (2):127-131.

Comment [A29]: rewrite

Formatted: Font color: Red

Formatted: Font color: Red

Formatted: Font color: Red, Strikethrough

Formatted: Font color: Red, Strikethrough

~~Singh A, Jain KK and Upadhyaya SD. 2018. Effect of weed control methods on weeds and wheat under *Eucalyptus tereticornis* based agroforestry system. *International Journal Current Microbial and Applied Sciences* **7**(8): 2856–2867.~~

Formatted: Font color: Red, Strikethrough

Singh A, Jain KK and Upadhyaya SD. 2018. Effect of weed control methods on weeds and wheat under *Eucalyptus tereticornis* based agroforestry system. *International Journal Current Microbial and Applied Sciences* **7**(8): 2856–2867.

Singh P and Ali M. 2004. Efficacy of metsulfuron-methyl on weeds in wheat and its residual effects on succeeding soybean crop grown on vertisol of Rajasthan. *Indian Journal of Weed Science* 36(1-2): 34–37

~~Singh P and Ali M. 2004. Efficacy of metsulfuron-methyl on weeds in wheat and its residual effects on succeeding soybean crop grown on vertisol of Rajasthan. *Indian Journal of Weed Science* **36**(1-2): 34–37.~~

Formatted: Font color: Red, Strikethrough