Research Article

Influence of *Kharif* Crops and Weed Control Measures on Nutrient Uptake by Weeds, Soil Properties and Residual Effect on Wheat

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Abstract

A field experiment was conducted during two consecutive *rabi* and *kharif* seasons of 2010-11 and 2011-12 at Bikaner to evaluate the effect of *kharif* crops and weed control measures on weeds, soil properties and residual effect on succeeding wheat during its pot study. Experiment was laid out in Factorial Randomized Block Design with three replications comprising different treatment combinations *i.e.,* three *Kharif* crops as pearl millet, cluster bean, ground nut and three weed control measures- weedy check, mechanical method (Two hand weeding) and chemical methods. Based on the two years of study results revealed that pearl millet reduced the nutrient (N, P and K) uptake of individual as well as total weed species as compared to groundnut, but it remained statistically at par with cluster bean. It was too reduced by two hand weeding as compared to chemical method and weedy check at harvest. In residual pot study of wheat, chemical method (applied in *kharif* crops) significantly reduced the germination, fresh and dry weight of wheat compared to weedy check and two hand weeding during both the years and on pooled mean basis. Soil properties revealed that significantly highest available nitrogen and phosphorus in soil was recorded after harvesting of cluster bean and pearl millet, respectively as compared to other crops. Organic carbon and potassium content of soil was not influenced significantly by different *kharif* crops. A non-significant effect of weed control measures applied in *kharif* crops was found in available N, P, K and organic carbon.

Keywords: *kharif* crops, Nutrient uptake, Pot study, Soil properties and Weed control.

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Introduction

The prosperity and well-being of a nation depends directly or indirectly on the agricultural production of that country. Steady and unavoidable increase in population is leading to pressure on arable land that is limited, therefore, higher production per unit area, time and input is the real solution for the self-sufficiency in food, feed, fodder, fiber and oilseeds for the daily needs of living- beings. The higher production of these commodities is possible with crop production by growing two or more crops within a year with ample supply of nutrients. As there is no scope for horizontal expansion of our agricultural land, additional amount of food grains has to be harnessed vertically through enhancing productivity of individual crops.

Pearl millet, ground nut and cluster bean are traditional rainy season crops cultivated in arid zone of Rajasthan. Wherever irrigation facility is accessible, these crops are followed by wheat, barley, cumin and mustard in winter season. In North- Western Rajasthan, particularly in IGNP (Indira Gandhi Nahar Pariyojana) command area these crops are taken in place of high-water demanding crops like cotton due to limited irrigations.

Effect of preceding crops on succeeding crop varies significantly depending upon the nature of the crop, its fertilization and soil type. Therefore, residual effect of *kharif* crops is to be investigated. Cropping sequence particularly those that include legumes, improves nitrogen status of soil and help in increasing the yield of succeeding cereal crops [1]. Therefore, production technology or management practices should be developed keeping in opinion all the crops grown in a year.

Wheat [*Triticum aestivum* (L.).] is the most essential staple food crop of the world and appeared as the backbone of India's food security [2]. It is one of the most important and remunerative *rabi* cereal crop of India not only in terms of acreage, but also in terms of its flexibility for adoption under wide range of agro climatic conditions and crop growing conditions.

Weeds compete with crop plants for moisture, nutrients, light and space. Potential losses due to weeds can be as high as 65% depending on crop, rate of weed infestation, weed species and management practices [3]. So weed control is important for plants using chemicals or conventional methods. Chemical weed control is an excellent addition to conventional methods and forms an important part of modern crop production. Recently, the use of herbicides has become more common than mechanical, due to the concomitant increase in crop yields. Pendimethalin

and atrazine are herbicides commonly used to control weeds in kharif crops but these herbicides may persist for a long time under low soil moisture and poor organic matter. The work on residual effect of herbicides (pendimethalin in cluster bean/ground nut and atrazine in pearl millet) applied in *kharif* crops on succeeding crop of wheat in wheat-based cropping system is meager. It is therefore, needed to find out the residual influence on succeeding wheat crop.

Material and Methods

A field experiment was conducted during the *rabi* and *kharif* seasons of 2010-11 and 2011-12 at College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner (28.01^0N, 73.22^0E, 234.7 m above mean sea level). Bikaner falls under Hot Arid Eco-region. The average annual rainfall of the tract is about 260 mm which is mostly received during the rainy season. Soils are loamy sand with 0.08% organic carbon [4], available N 133.7 kg/ha [5], P 16.2 kg/ha [6] and K 198.4 kg/ha [7]. Experiment was laid out in Factorial Randomized Block Design with three replications comprising different treatment *i.e.*, three *Kharif* crops as pearl millet (C_1), cluster bean (C_2), ground nut (C_3) and three weed control measures- weedy check (W_1), mechanical method (Two hand weeding) (W_2) and chemical methods (W_3) with gross plot size of 48 m^2/plot. Pearl millet 'HHB-67' @ 5kg/ha, cluster bean 'RGC-986' @20 kg/ha and ground nut 'HNG-10' @80 kg/ha were sown in 30 cm row spacing on 5 July 2010 and 8 July 2011 under irrigated condition. Recommended dose of phosphorus and potassium and half dose of nitrogen were applied at the time of sowing through urea, SSP and MOP, respectively in *kharif* crops. The remaining half dose of nitrogen was top dressed through urea in two equal splits at 25 and 40 DAS in pearl millet only. The herbicides atrazine @ 0.50 *a.i.*/ha sprayed one day after sowing as pre emergence in pearl millet and pendimathalin @1.0 *a.i.*/ha also sprayed one day after sowing as pre emergence in cluster bean and ground nut. These herbicides were sprayed with the help of knapsack sprayer using 500 liters of water per hectare. In hand weeding treatments hand weeding was performed at 25 and 45 DAS in all the *kharif* crops. Timely harvesting of all three crops in September and November were done during both the years. Different crop observations as seed, straw and biological yields of each net plot (inclusive of tagged plants) were recorded in kg/plot after cleaning the threshed produce were converted into t/ha. The weed samples collected at harvest were categorized in different species and kept in oven to dry. The samples were ground to pass through 40 mess sieve and used for nutrient content by the standard methods as N content by Kjeldahl's method [8], P content by Vanadomolybdo phosphoric acid [9] and K content by yellow colour method tri-acid digested material by using Flame photometer [9]. The nutrient uptake by weed was calculated by the formula.

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content (\%) x Weed dry matter (kg/ha)}}{100}$$

The data obtained from the study of two years were analyzed statistically using the F-test, as per the standard procedure. For residual pot study, Raj-3765 of wheat variety was grown in pot and growth parameters as plant height, germination %, fresh and dry weight of wheat were studied. The soil samples collected after harvest of *kharif* crops were analyzed for available organic carbon, nitrogen, phosphorus and potassium contents using the standard methods.

Results and Discussion

Nitrogen uptake by weeds

Effect of Kharif crops

Data presented in **Table 1** revealed that, pearl millet reduced the nitrogen uptake by *Digera arvensis* during both the years and in pooled mean as compared to ground nut and cluster bean. Pearl millet reduced the N uptake to the tune of 10.36 and 4.94 % over ground nut and cluster bean respectively. Pearl millet reduced the N uptake by *Tribulus terrestris* to the tune of 10.16 and 5.35 % over ground nut and cluster bean. Pearl millet reduced the N uptake by total weeds to the tune of 10.23 and 4.87 % over ground nut and cluster bean respectively, at harvest in pooled mean basis. It might be due to, made more nutrients available to crops but less to weeds and consequently encouraged higher concentration of nutrients and more yield and thereby higher uptake of nutrients as reported by Singh and Yadav [10].

Effect of weed control measures

Two hand weeding and chemical method significantly reduced the N uptake of *Digera arvensis* by 97.53 and 52.05 % over weedy check respectively, in pooled mean basis at harvest. Two hand weeding and chemical method significantly reduced the N uptake of *Tribulus terrestris* by 99.26 and 77.94 % over weedy check respectively. Two hand weeding and chemical method significantly reduced the N uptake of total weeds by 98.41 and 66.21 % over

weedy check respectively, in pooled mean basis at harvest (Table 1).

Table 1 Effect of *kharif* crops and weed control measures on N, P and K uptake (kg/ha) by weeds at harvest (Pooled data of two years)

Treatments	N uptake			P uptake			K uptake		
	Digera arvensis	***Tribulus terrestris***	**Total weeds**	***Digera arvensis***	***Tribulus terrestris***	**Total weeds**	***Digera arvensis***	***Tribulus terrestris***	**Total weeds**
***Kharif* crop**									
Pearlmillet (C_1)	1.73	0.53	3.51	0.102	0.255	1.03	1.26	0.491	2.99
Clusterbean (C_2)	1.82	0.56	3.69	0.107	0.268	1.08	1.33	0.516	3.15
Groundnut (C_3)	1.93	0.59	3.91	0.114	0.285	1.14	1.41	0.550	3.33
SEm±	0.03	0.01	0.06	0.002	0.005	0.02	0.02	0.009	0.05
CD (P=0.05)	0.08	0.03	0.17	0.005	0.014	0.05	0.06	0.027	0.14
Weed control measures									
Weedy check (W_1)	3.65	1.36	8.20	0.215	0.655	2.59	2.66	1.262	7.10
Two hand weeding (W_2)	0.09	0.01	0.13	0.005	0.007	0.03	0.06	0.013	0.11
Chemical method (W_3)	1.75	0.30	2.77	0.103	0.146	0.63	1.28	0.281	2.27
SEm±	0.03	0.01	0.06	0.002	0.005	0.02	0.02	0.009	0.05
CD (P=0.05)	0.08	0.03	0.17	0.005	0.014	0.05	0.06	0.027	0.14

Phosphorous uptake by weeds

Effect of Kharif crops

Pearl millet reduced the P uptake of *Digera arvensis* to the tune of 10.52 and 4.67 % over ground nut and cluster bean respectively, at harvest in pooled mean basis. Pearl millet reduced the P uptake by *Tribulus terrestris* to the tune of 10.52 and 4.85 % over ground nut and cluster bean respectively. Pearl millet reduced the P uptake to an extent of 9.64 and 4.62 % over ground nut and cluster bean respectively, in pooled mean basis (Table 1).

Effect of weed control measures

Two hand weeding and chemical method significantly reduced the P uptake of *Digera arvensis* by 97.67 and 52.09 % over weedy check respectively. Two hand weeding and chemical method significantly reduced the P uptake of *Tribulus terrestris* by 98.93 and 77.70 % over weedy check respectively. Two hand weeding and chemical method significantly reduced the P uptake of total weeds by 98.84 and 75.67 % over weedy check respectively, in pooled mean basis at harvest (Table 1).

Potassium uptake by weeds

Effect of Kharif crops

Pearl millet reduced the K uptake of *Digera arvensis* to the tune of 10.63 and 5.26 % over ground nut and cluster bean, respectively. Pearl millet reduced the K uptake *Tribulus terrestris* to the tune of 10.72 and 4.84 % over ground nut and cluster bean respectively. Pearl millet reduced the K uptake to an extent of 10.21 and 5.07 % over ground nut and cluster bean respectively, at harvest in pooled mean basis (Table 1).

Effect of weed control measures

Two hand weeding and chemical method significantly reduced the K uptake of *Digera arvensis* by 97.74 and 51.87 % over weedy check respectively. Two hand weeding and chemical method significantly reduced the P uptake of *Tribulus terrestris* by 98.96 and 77.73 % over weedy check respectively. Two hand weeding and chemical method significantly reduced the K uptake of total weeds by 98.45 and 68.02 % over weedy check respectively, at harvest in pooled mean basis (Table 1).

The reduction in the depletion of N, P and K by weeds under weed control treatments may be attributed mainly to the corresponding reduction in the dry matter yield of weeds due to the effective suppression of weed growth compared to weedy check without influencing N, P and K content and resulted in reduced nutrient depletion by weeds. Results corroborate with findings of Srinivas and Satyanarayana [11]; Madhu *et al.* [12] and Gochar et al. [13].

Residue study

In residual pot study of wheat, it was observed (**Table 2**) that *kharif* crops significantly increased the fresh and dry weight of wheat grown after groundnut as well as cluster bean, but plant height and germination % of wheat in bioassay study was not significantly affected by *kharif* crops (Table 2). *Kharif* crops like ground nut and cluster bean are known to fix atmospheric nitrogen in their root zone which is made available to succeeding crop favouring better plant growth in terms of increased plant fresh and dry weight of wheat. Balyan [14] also reported that wheat produced significantly higher dry matter and taller plant in pots preceded by legumes compared with pearl millet.

Chemical method (Table 2) significantly reduced the germination %, plant height, fresh and dry weight of wheat compared to weedy check and two hand weeding in pot study. The total weed density in wheat was also significantly reduced in chemical method. This reduction was due to the residues left by herbicides applied to preceding *kharif* crops [15].

Table 2 Residual effect of *kharif* crops and weed control measures on germination%, fresh weight, dry weight (g) at 30 DAS of wheat in pot study

Treatments	Germination (%)			Fresh weight (g)			Dry weight (g)		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
***Kharif* crop**									
Pearlmillet (C_1)	73.33	67.46	70.40	4.27	3.98	4.13	1.83	1.73	1.78
Clusterbean (C_2)	78.33	73.80	76.07	4.49	4.18	4.33	1.84	1.74	1.79
Groundnut (C_3)	80.00	73.60	76.80	4.95	4.60	4.77	1.95	1.84	1.90
SEm±	2.72	3.58	2.25	0.16	0.15	0.11	0.02	0.02	0.01
CD (P=0.05)	NS	NS	NS	0.49	0.45	0.32	0.05	0.05	0.03
Weed control measures									
Weedy check (W_1)	80.00	73.60	76.80	4.83	4.50	4.67	1.87	1.77	1.82
Two hand weeding (W_2)	81.66	76.87	79.27	5.09	4.73	4.91	1.96	1.86	1.91
Chemical method (W_3)	70.00	64.40	67.20	3.78	3.53	3.66	1.78	1.68	1.73
SEm±	2.72	3.58	2.25	0.16	0.15	0.11	0.02	0.02	0.01
CD (P=0.05)	8.15	10.74	6.48	0.49	0.45	0.32	0.05	0.05	0.03

NS – Non Significant

Interactive effect of kharif crops & weed control measures on fresh weight of wheat at 30 DAS

The interaction effect (**Table 3**) in residue pot study on pooled basis revealed that fresh weight of wheat significantly reduced by atrazine applied in pearl millet compared to pendimethalin applied in cluster bean and ground nut. Application of pendimethalin applied in cluster bean reduced the fresh weight of wheat significantly compared to pendimethalin applied in groundnut. It means that there was more residual effect of pendimethalin applied in cluster bean than applied in ground nut. However, in the field, there was no significant effect of these herbicides on succeeding wheat. The reason being groundnut had more water requirement and therefore applied more number of irrigation that may help in decomposing pendimethalin molecules faster than molecules of pendimethalin applied in cluster bean in which only two irrigations were given. The results are in close conformity with those of Peyvastegan and Farahabakhsh [16] and Arora and Tomar [17].

Table 3 Interactive effect of *kharif* crops and weed control measures on fresh weight of wheat at 30 DAS by residue pot study

Kharif Crops	Weed control measures								
	2010-11			2011-12			Pooled		
	W_1	W_2	W_3	W_1	W_2	W_3	W_1	W_2	W_3
Pearl millet (C_1)	4.96	5.03	3.76	4.61	4.68	2.65	4.79	4.85	2.74
Cluster bean (C_2)	4.81	4.89	2.83	4.48	4.55	3.51	4.64	4.72	3.63
Ground nut (C_3)	4.73	5.35	4.76	4.40	4.97	4.43	4.57	5.16	4.59
SEm ±	0.28			0.26			0.19		
C.D (P=0.05)	0.84			0.77			0.55		

W_1: Weedy check, W_2: Two hand weeding, W_3: Chemical methods

Soil studies

Effect of kharif crops

Available nitrogen status of soil influenced significantly from initial soil status. After harvesting of *kharif* crops, significantly highest available nitrogen in soil cluster bean and ground nut was recorded as compared to pearl millet during both the years of experimentation. While, pearl millet marginally reduced the available nitrogen in soil from initial status. On the basis of pooled mean, after cluster bean, there was 143.83 kg N/ha available in soil in cluster bean plots, which was 2.73 and 8.97 % higher as compared to ground nut and pearl millet plots, respectively (**Table 4**).

Table 4 Effect of *kharif* crops and weed control measures on soil fertility after harvest of *kharif* crops

Treatments	Organic carbon (%)			Available nitrogen (kg/ha)			Available phosphorus (kg/ha)			Available potassium (kg/ha)		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
***Kharif* crop**												
Pearl millet (C_1)	0.088	0.093	0.091	127.78	136.17	131.98	19.17	22.13	20.65	231.1	247.6	239.3
Cluster bean (C_2)	0.089	0.094	0.092	139.34	148.31	143.83	17.85	20.74	19.29	236.6	253.4	245.0
Ground nut (C_3)	0.089	0.094	0.091	135.51	144.28	139.90	18.37	21.29	19.83	239.3	256.3	247.8
SEm±	0.005	0.005	0.004	2.77	2.90	2.00	0.18	0.19	0.13	3.64	3.82	2.64
CD (P=0.05)	NS	NS	NS	8.29	8.71	5.78	0.55	0.58	0.39	NS	NS	NS
Weed control measures												
Weedy check (W_1)	0.088	0.093	0.091	130.76	139.30	135.03	18.24	21.16	19.70	231.1	247.6	239.3
Two hand weeding (W_2)	0.089	0.094	0.092	135.22	143.98	139.60	18.52	21.44	19.98	236.7	253.5	245.1
Chemical method (W_3)	0.089	0.094	0.091	136.65	145.48	141.06	18.63	21.57	20.10	239.3	256.2	247.8
SEm±	0.005	0.005	0.004	2.77	2.90	2.00	0.18	0.19	0.13	3.64	3.82	2.64
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS =Non-significant

It was observed that available nitrogen status of soil was significantly higher in cluster bean grown plots. Available nitrogen status was rather depleted due to preceding crop of pearl millet as compared to initial soil status. The variation in soil nitrogen status due to *kharif* crops particularly of ground nut and cluster bean might be attributed possibly to the difference in residues left in the soil due to these crops. The results are in close conformity with Verma [18] and Shaktawat and Shekhawat [19]. Legumes play an important role in improving the fertility status of soil. They are known to enrich the soil with nitrogen through symbiotic nitrogen fixation. Legumes also make soil fertile due to better root penetration causing removal of nutrients from deeper soil layers and thus enriching the topsoil with such nutrients. Legumes (cluster bean) also add a sizable amount of roots exudates, leaf litter, root parts and other residues at maturity thereby improving the organic carbon and nitrogen content of soil after decomposition with eventual improvement in fertility and structure of the soil [20].

Available phosphorus of soil was not influenced significantly from initial soil status due to residual effect of *kharif* crops. Significantly highest available phosphorus content of soil was estimated after pearl millet as compared to other crops during both years of experimentation. On the basis of pooled analysis, after pearl millet, there was 20.65 kg/ha available phosphorus in soil, which was 7.05 and 4.13 % higher as compared to cluster bean and ground nut, respectively (Table 4), Kumpawat [21] observed similar findings. It was observed that *kharif* crops caused non-significant difference in organic carbon and available potassium content of soil.

Effect of weed control measures

A critical examination of data (Table 4) revealed that weed control measures did not have any significant influence on organic carbon, available nitrogen, phosphorous and potassium content of soil estimated after harvest of *kharif* crop.

Conclusion

Based on the two years of study it is recommended that pearl millet and two hand weeding significantly reduced the nutrient (N, P and K) uptake of individual as well as total weed species as compared to ground nut and other weed control measures, but it remained statistically at par with cluster bean. In residual pot study, fresh weight of wheat

significantly reduced by atrazine applied in pearl millet compared to pendimethalin applied in cluster bean and ground nut. In soil properties, significantly highest available nitrogen and phosphorus in soil was recorded after harvesting of cluster bean and pearl millet, respectively as compared to other crops. A non-significant effect of weed control measures was seen on soil properties.

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