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Satendra Lal Yadav
Holy Cross Krishi Vigyan Kendra, Hazaribag, Jharkhand, India

VP Chahal
Indian Council of Agricuture Research, KAB-1 Pusa New Delhi, India

Arti Yadav
Government of Uttar Pradesh, India

RK Singh
Holy Cross Krishi Vigyan Kendra, Hazaribag, Jharkhand, India

Dusyant Mishra
Indian Council of Agricuture Research, KAB-1 Pusa New Delhi, India

Praveen Kumar
Holy Cross Krishi Vigyan Kendra, Hazaribag, Jharkhand, India

Rahul Kumar
Department of Soil Science & Agricultural Chemisty, IGKV, Raipur, India

Correspondence
Satendra Lal Yadav
Holy Cross Krishi Vigyan Kendra, Hazaribag, Jharkhand, India

Response of phosphorus doses and weed control methods on nutrient uptake in chickpea (*Cicer arietinum*) under rainfed condition

Satendra Lal Yadav, VP Chahal, Arti Yadav, RK Singh, Dusyant Mishra, Praveen Kumar and Rahul Kumar

Abstract
A field experiment was conducted at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology Kumarganj, Faizabad (U.P) during rabi season two consecutive years of 2011-12 and 2012-13. The experiment was laid out in Randomized Block Design having twenty treatment combinations consisted of four levels of phosphorus application (0, 20,40and 60 kg ha^{-1}) and five weed management practices (weedy, weed free, hand weeding at 25&45DAS, pendimethalin 1.0kg ha^{-1} and pendimethalin 1.0kg ha^{-1} + one hand weeding at 45DAS) and replicated three times. The results obtain during the course of investigation indicated that the application of 60kg ha^{-1} phosphorus with Pendimethalin 1.0kg ha^{-1} + One hand weeding at 45DAS, gave Significantly the lowest weed density was recorded with 60 kg P_2O_5 ha^{-1} as compared with its lower doses and control at all the stages of crop growth during both the years but it was statically similar to 40 kg P_2O_5 ha^{-1} during both years of study. Significantly higher Nitrogen and phosphorus uptake, more protein content over control during both the years of experimentation.

Keywords: phosphorus, nutrient, chickpea, *Cicer arietinum*

Introduction
A pulse occupies a unique place in Indian agriculture by virtue of its high protein content and its capacity to enrich the soil fertility through the mechanism of symbiotic nitrogen fixation. As per its nomenclature Pulse (P= People, U= Umbrella, L= Livestock, S= Soil and E= Energy) is an energy umbrella for the people as dietary protein, for the livestock as green nutrition, fodder and feed and for the soil as a mini nitrogen plant and green manure (Ali, 1988) [2]. Pulses are heavy feeder of phosphorus and less response of nitrogen because of their capacity to meet their own nitrogen requirement through symbiotic fixation. Phosphate fertilization of chickpea promotes growth, nodulation enhance yield of chickpea. Phosphorus also imparts hardiness to shoots, improves grain quality, regular the photosynthesis, governs other physico-bio-chemical processes and also helps in root enlargement, nodule production and thereby increases nitrogen fixation (Singh and Ram, 1990).

It is well established that for proper control of weeds only one weed control method would not be sufficient and an integrated approach may be required. Weed infestation in winter pulses has been reported to offer serious competition and causes yield reduction up to the extent 75% in chickpea. High cost and non-availability of labor at right time make the farmer forcibly to go for alternate cheaper and easy methods of weed control. Various chemicals and cultural methods to control weeds in chickpea have been tried by various workers (Chaudhary *et al.*, 2005) [3, 4]. Use of herbicides also may not be effective to control all species of weeds. It has also been observed that some of susceptible weed species are replaced by tolerant species, due to continuous use of herbicides on vast scale. Thus it becomes necessary to develop a method of weed control which is cheaper, effective and acceptable to the farmers. (Ali and Bhanmurthy, 1985) [1] reported that chemical weed control and integrated weed management are cheaper than hand weeding. Chickpea, although is an important winter pulse crop, yet no adequate information at integrated weed management aspects is available. It is needless to mention here that now a days and package of practices for any crop remains incomplete unless information on weed management is incorporated. Thus the optimum dose of phosphorus and suitable weed management practice may play an important role for achieving quality production of chickpea.

Methods and Materials

A field experiment was conducted at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology Kumarganj, Faizabad (U.P) during rabi season two consecutive years of 2011-12 and 2012-13. The experiment was laid out in Randomized Block Design having twenty treatment combinations consisted of four levels of phosphorus application (0, 20,40and 60 kg ha^{-1}) and five weed management practices (weedy, weed free, hand weeding at 25&45DAS, pendimethalin 1.0kg ha^{-1} and pendimethalin 1.0kg ha^{-1} + one hand weeding at 45DAS) and replicated three times. The soil of experimental site was silt loam in texture with low organic carbon (0.38persent) and nitrogen (179.8-188.6kg ha^{-1}) medium in phosphorus (14.8-15.6kg ha^{-1}) and potassium (264.6-255.4kg ha^{-1}). There was 42.6mm and 6.8mm rainfall during the crop season 2011-12 and 2012-13, respectively. The chickpea variety K-850`was used. The sowing was done with the using of seed rate 80kg ha^{-1} in line at 45cm apart on 26th October during both the years. The results obtain during the course of investigation indicated that the application of 60kg ha^{-1} phosphorus with Pendimethalin 1.0kg ha^{-1} + One hand weeding at 45DAS, gave significantly higher weed density and weed control efficiency, higher nitrogen, phosphorus and protein content in chickpea.

Results and discussion

Response of phosphorus doses and weed control methods on weed density (m^2) in chickpea:

Weed density was recorded at different interval of crop growth period. The results of weed density recorded at different stages are interpreted on the basis of transformed values of original data. The original data were transformed by √n+1 procedure. The data in respect of weed density at 30, 60, 90 day and at harvest has been presented in Table 1. It is evident from the data that the number of weeds per unit area was decreased with increasing levels of phosphorus and the minimum density was recorded with 60 kg P_2O_5 ha^{-1}, while the maximum was recorded with control at all the stages of crop growth during both years of study. Significantly the highest weed density per unit area was recorded with control as compared to rest of the phosphorus doses at all stages of crop growth during both the years. Significantly the lowest weed density was recorded with 60 kg P_2O_5 ha^{-1} as compared with its lower doses and controls at all the stages of crop growth during both the years but it was statically similar to 40 kg P_2O_5 ha^{-1} during both years of study. Weedy treatment recorded the maximum weed density while the minimum was recorded in weed free at all stages of growth during both the years. At 30, 60, 90 days at harvest stages the pre emergence application of pendimethalin @ 1.0 kg ha^{-1} + HW 45 DAS significantly reduced the weed density as compared with rest of weed management practices except weed free treatment during both the years. Significantly higher number of weeds was noted under weedy treatment as compared with remaining weed management practices at all the stages of crop growth during both the years of study. Weed management with pendimethalin @ 1 kg ha^{-1} + HW at 45 DAS proved superior to weedy and two hand weeding at 25 & 45DAS in respect of controlling the weeds at all the stages of crop growth during both the years of study.The interaction effect was found non significant at all the stages of crop growth during both the years. The superiority of integrated method of weed control in respect of controlling the weeds has also been reported by Saxena and Ali (1995) [13] and (1996), Vaishya *et al.* (1996)

Response of weed management practices on weed control efficiency in chickpea

The data in respect of weed control efficiency have been presented in Table 2. It is evident from the data that the weed control efficiency was recorded highest next to the weed free treatment in treatment like pendimethalin @ 1.0 kg ha^{-1}+0ne HW at 45 DAS during both the years of experimentation. This may be attributed to lower weed dry weight recorded under the effect of above treatments. These results also corroborate with the findings of Vaishya *et al.* (1995), Saxena and Ali (1995) [13] and Seshadree *et al*. (1996) [14]

Response of phosphorus doses and weed management practices on Nitrogen uptake, phosphorus and protein content in chickpea

The data recorded on nitrogen uptake by crop have been presented in Table 3. It is evident from the data that the 60 kg P_2O_5 ha^{-1} provided the maximum nitrogen uptake by crop followed by 40 and 20 kg P_2O_5 ha^{-1}.The nitrogen uptake by crop was increased with increasing levels of phosphorus during both the years.

It is also clear from the table that gave weed free situations contained the highest nitrogen uptake by the crop fallowed by pendimethalin at the rate of 1.0 kg ha^{-1} + one hand weeding at 45 DAS and the lowest value of nitrogen uptake by crop was recorded under weedy treatment during both the years.

The interaction effect was found non-significant in respect of nitrogen uptake in seed during both the years of experimentation. Nitrogen uptake was also increased with increasing doses of phosphorus from zero to 60 kg P_2O_5 ha^{-1} during both the years of study. This may be due to the fact that nitrogen uptake was influenced appreciably due to more root proliferation and nodulation which supply more nitrogen to plant. The results are in agreement with the finding of Das *et al.* (1999) [5] and Khan *et al.* (2005) [8].

The maximum nitrogen uptake was associated with weed free check followed by pendimethalin @ 1.0 kg ha^{-1} + HW45 DAS. This may be because of reduced weed density per unit area under the effect of above treatment which might have provided better opportunities to the crop for better growth and development that trapped ample amount of nitrogen from the soil. Qazi (1989) has also reported that fluchloralin @ 1.0 kg ha^{-1} PPI either alone or in combination with the HW 45 DAS registered more nitrogen uptake of chickpea.

The interaction effect was found non-significant in respect of protein nitrogen uptake during both the years of experimentation.

Phosphorus uptake by crop (kg ha^{-1})

The data recorded on phosphorus uptake have been presented in Table 3. It is evident from the data that the 60 kg P_2O_5 ha^{-1} gave the maximum phosphorus uptake by crop followed by 40 and 20 kg P_2O_5 ha^{-1}.The phosphorus uptake by crop with the increasing levels of phosphorus during both the years.

It is also clear from the table that the phosphorus uptake by crop was highest in weed free situation followed by pendimethalin at the rate of 1.0 kg ha^{-1} + one hand weeding at 45 DAS and the lowest value of phosphorus uptake by crop was recorded under weedy treatment during both the years.

The interaction effect was found non-significant in respect of phosphorus uptake by the crop during both the years of experimentation. Phosphorus uptake was also increased with increasing doses of phosphorus from zero to 60 kg P_2O_5 ha^{-1} during both the year of study. This may be due to the fact that phosphorus uptake was influenced appreciably due to more root proliferation and nodulation which supply more nitrogen to plant for protein synthesis under 0 kg P_2O_5 ha^{-1}. The results are in agreement with the finding of Das *et al.* (1999) [5] and Khan *et al.* (2005) [8].

The maximum phosphorus uptake was associated with weed free check followed by pendimethalin @ 1.0 kg ha^{-1} + HW 45 DAS. This may be because of reduced weed density per unit area under the effect of above treatment which might have provided better opportunities to the crop for better growth and development. Qazi (1989) has also reported that fluchloralin @ 1.0 kg ha^{-1} PPI either alone or in combination with the HW 45 DAS registered more phosphorus uptake of chickpea.

The interaction effect was found non-significant in respect of phosphorus uptake during both the years of experimentation.

Protein content in seed (%)

The data in respect of protein content have been presented in Table 3.It is evident from the data that the 60 kg P_2O_5 ha^{-1} provided the maximum protein content in seed followed by 40 and 20 kg P_2O_5 ha^{-1}.The protein content in seed was increased with the increasing levels of phosphorus during both the years.

It is also clear from the data that the protein content in seed was recorded highest in weed free situations followed by pendimethalin at the rate of 1.0 kg ha^{-1} + one hand weeding at 45 DAS and the lowest protein content was recorded by weedy treatment during both the years.

The interaction effect was found non-significant in respect of protein content in seed during both the years of experimentation. Protein content in seed was also increased with increasing doses of phosphorus from zero to 60 kg P_2O_5 ha^{-1} during both the year of study. This may be due to the fact that protein content in seed was influenced appreciably due to more root proliferation and nodulation which supply more nitrogen to plant for protein synthesis under 60 kg P_2O_5 ha^{-1}. The results are in agreement with the finding of Kumar and Sharma (2005) [9] and Meena *et al*. (2006) [11].

The maximum protein content in seed was associated with weed free check followed by pendimethalin @ 1.0 kg ha^{-1} + HW45 DAS. This may be because of reduced weed density per unit area under the effect of above treatment which might have provided better opportunities to the crop for better growth and development that trapped ample amount of nitrogen from the soil and increased the protein content in seed. Qazi (1989) has also reported that fluchloralin @ 1.0 kg ha^{-1} PPI either alone or in combination with the HW 45 DAS registered more protein content in seeds of chickpea.

The interaction effect was found non significant in respect of protein content in seed during both the years of experimentation.

Response of phosphorus doses and weed control methods on seed yield of chickpea

The data in respect of seed yield have been presented in Table 4. It is evident from the data that the seed yield was increased consistently with increasing doses of phosphorus and the maximum seed yield was recorded by 60 kg P_2O_5 ha^{-1} but it was at par with 40 kg P_2O_5 ha^{-1} and the minimum yield of chickpea was recorded with control treatment during both the years. The weed control treatments were also significantly affected the seed yield of chickpea during both the years and the maximum seed yield was recorded in weed free treatment which was followed by pendimethalin 1.0 kg ha^{-1} + HW 45 DAS and the minimum seed yield was recorded in weedy treatment during both the years. Weed free treatment registered significantly the highest seed yield of chickpea as compared with rest of the weed management practices except Pre-emergence application of pendimethalin @ 1.0 kg ha^{-1} supplemented with one hand weeding at 45 DAS which was at par with weed free treatment in number of seed yield of chickpea. He interaction effect was found non-significant in respect of seed yield of chickpea during both the years. Significant increase in seed yield of chickpea due to higher dose of phosphorus has also been reported by Chaudhary and Goswami (2005) [3, 4], Singh *et al*. (2005) and Meena *et al*. (2006) [11].

Response of phosphorus doses and weed control methods on straw yield of chickpea

The data in respect straw yield have been presented in Table 4. It is evident from the data that the maximum and the minimum straw yield were recorded under 60 kg P_2O_5 ha^{-1} and control treatments respecting during both the years of study. With the application of phosphorus at the rate of 60 kg ha^{-1} recorded the highest straw yield which was significantly heigher than rest of treatments but it was at par with 40 kg P_2O_5 ha^{-1} during both the years. The data given table also indicated that the overall effects of different weed management practices exhibits that the maximum and minimum straw yields were recorded under weed free and weedy treatments respectively during in both the years. The weed free treatment recorded the maximum straw yield but it was at par with pendimethalin @ 1.0 kg ha^{-1} + one hand weeding at 45 DAS during the years of study. The interaction effect was found non significant in respect of straw yield of chickpea during both the years of experimentation. Similar results have been recorded by Singh and Singh (2003) [16], Jat and Ahalawt (2004) [6] and Janade *et al*. (2006) [7].

Table 1: Effect of phosphorus doses and weed management practices on weed density (m^2) of chickpea

Treatment	30DAS		Pooled	60DAS		Pooled	90 DAS		Pooled	At harvest		Pooled
	2012	2013		2012	2013		2012	2013		2012	2013	
P_0 control	(67.55) 8.28	(88.66) 9.46	(78.10) 8.87	(94.04) 9.74	(147.58) 12.19	(120.81) 10.96	(149.53) 12.26	(212.72) 14.61	(181.12) 13.43	(101.60) 10.13	(147.09) 12.17	(124.34) 11.15
P_1 20 kg	(62.49) 7.96	(81.61) 9.09	(72.05) 8.52	(79.08) 8.94	(140.13) 11.87	(109.60) 10.40	(132.15) 11.53	(192.74) 13.92	(162.44) 12.72	(91.14) 9.6	(117.35) 10.87	(104.24) 10.23
P_2 40 kg	(59.51) 7.78	(77.83) 8.85	(68.67) 8.31	(69.04) 8.37	(127.39) 11.33	(98.21) 9.85	(116.70) 10.84	(167.42) 12.97	(142.06) 11.90	(80.09) 9.0	(101.39) 10.11	(90.74) 9.5
P_3 60 kg	(55.68) 7.52	(76.42) 8.8	(66.05) 8.16	(61.23) 7.88	(106.72) 10.37	(83.97) 9.12	(93.65) 9.72	(133.54) 11.6	(113.59) 10.66	(72.42) 8.56	(75.54) 8.74	(73.98) 8.65
CD 5%	0.24	0.21	0.20	0.40	0.30	0.29	0.17	0.17	0.15	0.14	0.21	0.19
W_0 Weedy	(330.97) 18.22	(305) 17.57	(317.98) 17.89	(427.46) 20.7	(501.0) 22.44	(464.23) 21.57	(493) 20.52	(531.67) 23.08	(512.33) 21.8	(420.06) 20.52	(323.70) 18.01	(371.88) 19.26
W_1 - Weed free	(00) 1	(00) 1	(00) 1	(00) 1	(00) 1	(00) 1	(00) 1	(00) 1	(00) 1	(00) 1	(00) 1	(00) 1
W_2 hand weeding	(51.40) 7.24	(63.95) 8.05	(57.67) 7.64	(33.55) 5.87	(84.00) 9.22	(58.77) 7.54	(61.39) 7.6	(151.75) 12.36	(106.57) 9.98	(56.74) 7.6	(115.62) 10.8	(86.18) 9.2

W_3 penda methiline	(26.65) 5.26	(26.33) 5.33	(26.49) 5.29	(76.76) 8.81	(138.74) 11.82	(107.75) 10.31	(156.23) 12.6	(203.41) 14.29	(179.82) 13.44	(157.74) 12.6	(150.52) 12.31	(154.13) 12.45
W_4 penda +HW	(24.78) 5.06	(25.09) 5.10	(24.93) 5.08	(31.93) 5.74	(40.84) 6.39	(36.38) 6.06	(50.09) 7.14	(69.88) 8.42	(59.98) 7.78	(75.19) 8.72	(42.94) 6.63	(59.06) 7.67
CD 5%	0.29	0.17	0.21	0.43	0.26	0.31	0.19	0.17	0.13	0.23	0.26	0.22
WXP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Treatment details P_0 = Control (Zero), P_1=20kg P_2O_5 $ha^{-1,}$ P_2=40kgP_2O_5 ha^{-1}, P_3 =60kg P_2O_5 $ha^{-1,}$ W_0= Weedy, W_1= Weed free, W_2= Hand weeding at 25& 45 DAS, W_3= Pendimethalin @ 1.0kg per hectare, W_4= Pendimethalin @ 1.0kg per hectare + HW at 45 DAS.

Table 2: Effect of weed management practices on weed control efficiency of chickpea

Treatments	Weed control efficiency		Pooled
	2012	2013	
W_0= Weedy	00	00	00
W_1= Weed free	100	100	100
W_2= Hand weeding at 25& 45 DAS	72.75	71.06	71.9
W_3= Pendimethalin @ 1.0kg per hectare	69.51	44.66	57.08
W_4= Pendimethalin @ 1.0kg per hectare + HW at 45 DAS	78.55	76.25	77.4

Table 3: Effect of phosphorus doses and weed management on nitrogen and phosphorus uptake (kg ha^{-1}) by crop and protein content (%) of chickpea

Treatments	Nitrogen uptake (kg ha^{-1})			Phosphorus uptake (kg ha^{-1})			Protein content (%)		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
P_0	59.67	56.58	58.13	5.49	5.59	5.5	22.19	21.77	22.0
P_1	107.26	102.59	104.93	10.46	10.60	10.5	22.46	22.19	22.3
P_2	144.31	139.74	142.03	14.90	14.96	14.9	22.30	22.17	22.2
P_3	152.51	147.44	149.98	17.08	17.13	17.1	22.36	22.18	22.3
CD 5%	26.57	25.96	28.27	3.28	3.29	2.9	1.59	1.53	1.43
W_0	69.55	69.04	69.30	6.72	6.59	6.7	21.00	21.24	21.1
W_1	133.49	128.12	130.81	12.97	13.19	13.1	23.23	23.00	23.1
W_2	130.11	124.67	127.39	11.96	12.14	12.1	22.79	22.39	22.6
W_3	108.31	102.05	105.18	10.26	10.45	10.4	21.61	21.02	21.3
W_4	138.82	133.97	136.40	13.04	13.03	13.0	23.01	22.72	22.9
CD 5%	20.93	18.55	20.76	1.81	1.89	1.64	1.77	1.71	1.62
WXP	NS	NS	NS	NS	NS	NS	NS	NS	NS

Treatment details P_0 = Control(Zero), P_1=20kg P_2O_5 $ha^{-1,}$ P_2=40kgP_2O_5 ha^{-1}, P_3 =60kg P_2O_5 $ha^{-1,}$ W_0= Weedy, W_1= Weed free, W_2= Hand weeding at 25& 45 DAS, W_3= Pendimethalin @ 1.0kg per hectare, W_4= Pendimethalin @ 1.0kg per hectare + HW at 45 DAS.

Table 4: Effect of phosphorus doses and weed management on seed yield, straw yield and harvest index of chick pea

Treatments	Seed yield (qha^{-1})			Straw yield (qha^{-1})			Harvest index (%)		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
P_0	12.2	11.57	12	31.83	32.41	32	27.55	26.28	27
P_1	19.53	18.68	19	49.27	49.95	50	28.27	27.09	28
P_2	24.67	23.89	24	62.119	62.35	62	28.2	27.56	28
P_3	25.9	25.04	25	63.67	63.83	64	28.86	28.18	29
SEm±	0.47	0.51	0.47	1.36	1.45	1.39	0.64	0.65	0.63
CD 5%	1.38	1.47	1.41	3.94	4.19	4.05	1.85	1.87	1.84
W_0	13.82	13.72	14	38.97	38.25	39	26.26	26.45	26
W_1	24.12	23.15	24	57.39	58.35	58	29.42	28.11	29
W_2	22.1	21.3	22	53.1	52.9	53	27	26.3	27
W_3	18.17	17.12	18	48.34	49.24	49	27.63	25.74	27
W_4	23.79	22.96	23	57.69	57.63	58	29.14	28.45	29
SEm±	0.53	0.57	0.53	1.52	1.62	1.55	0.71	0.72	0.70
CD 5%	1.54	1.65	1.58	4.4	4.69	4.53	2.07	2.09	2.06
WXP	NS	NS	NS	NS	NS	NS	NS	NS	NS

Treatment details P_0 = Control(Zero), P_1=20kg P_2O_5 $ha^{-1,}$ P_2=40kgP_2O_5 ha^{-1}, P_3 =60kg P_2O_5 $ha^{-1,}$ W_0= Weedy, W_1= Weed free, W_2= Hand weeding at 25& 45 DAS, W_3= Pendimethalin @ 1.0kg per hectare, W_4= Pendimethalin @ 1.0kg per hectare + HW at 45 DAS.

Response of phosphorus doses and weed control methods on harvest index of chickpea:

The data recorded on harvest index have been presented in Table 4. It is evident from the data that 60 kg P_2O_5 ha^{-1} registered that highest harvest index followed by 40 and 20 kg P_2O_5 ha^{-1} and the lowest was recorded under by control during both the years of study. It is also clear from the table that weed free treatment registered the highest harvest index followed by pendimethalin 1.0 kg ha^{-1} + HW 45 DAS and the lowest value of harvest index was registered under weedy treatment during both the years of study. The interaction effect on harvest index was found non significant during both the years of experimentation. The results are in agreement with the finding of Tomar and Raghu (1994) [18], Ali *et al*. (2004) and Pyare and Dwivedi (2005) [12].

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