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Research Article

Weed Management in Pulse Based Intercropping System by Crop Arrangement and Fertilization through Nano Phosphorus

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Abstract

A field experiment entitled was conducted under All India Coordinated Research Project on (Pulse Research) of Birsa Agricultural University, Ranchi (Jharkhand) during *Kharif* season of two consecutive years 2016 and 2017 to study the suitability of Black gram as intercropped with Pigeon pea (*Cajanus cajan*) and Maize under varied source of Phosphorus. The experiment was laid out in Split-plot Design with seven crop geometry in main plot and four P management techniques under sub plot and replicated thrice. Data recorded to weed study reflects that, Maximum weed density as well as weed dry weight at 20 and 40 DAS was recorded under sole pigeon pea which remained at par with sole maize. Minimum weed density was recorded at 20 DAS (312 m^{-2}) and 40 DAS (125 m^{-2}) under sole black gram which remained at par with pigeon pea + black gram 1:1and pigeon pea + black gram 1:2. Significantly lower weed dry weight at 20 DAS was recorded under sole black gram compared to rest of the systems except pigeon pea + black gram 1:2 where they remained at par. At 40 DAS, all the intercropping systems recorded lower weed dry weight compared to sole pigeon pea and maize and remained at par with sole black gram. With regard to phosphorus management, weed density (392 and 170 m^{-2}) as well as weed dry weight (93.56 and 55.17 g m^{-2}) recorded at 20 and 40 DAS, respectively were maximum with 100% RDP which remained at par with 50% RDP + Nano-P 40 ppm.

Keywords: Pigeon pea, Black gram, Maize, Nano-P, weed control, and legume based intercropping system

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Introduction

Jharkhand became 19 years of age is Middle to Southern part of undivided Bihar. At present it comprises total 24 districts, which comes under Agro climatic sub division IV, V and VI. Land of this state is undulating, platue, plain and red laterite soil *ie Alfisol* is major class of soil is mainly rain fed with predominance of upland condition. Soil of the state is characterized by undulating terrain, shallow soil depth, low water retention capacity and poor soil fertility and fragmented holdings with meager irrigation facility. Black gram is one of the important pulse crops in India. The crop has special importance in intensive cropping system of the country due to its short maturity period and weeds being less competitive against it during early crop growth stage. Under upland situation of Jharkhand pulses and maize can be successfully grown as sole and as intercropped. As a intercropping of legumes with cereals offers scope for developing energy efficient and sustainable agriculture. Efficiency of production in cereal-legume intercropping systems could be improved by minimizing inter-specific competition between the component crops for growth limiting factors. Intercrop of black gram with pigeon pea or maize can be a suitable option for rain fed upland condition, as this region largely depends upon vagaries of monsoon. Black gram being a good option being short duration crop fits well in the intercropping system and its roots fix atmospheric nitrogen, breaks hardpans and utilize nutrients from deeper region besides, luxuriant initial growth habits suppress weed growth. Apart from crop selection its proper fertilization is considered as a barometer of agricultural production, which plays a key role in agricultural productivity and transforms the country from a food scarce region to food sufficient nation. Besides nitrogen, Phosphorus being the major nutrient plays a vital role in energy transformation, uniform grain filling, grain quality and higher yield. Also, contribution of P for protein and oil production is un-debatable. Phosphorus, as usual helps in better root proliferation which extracts moisture from deeper layer of the soil particularly during moisture stress condition. However, acid lateritic soil of Jharkhand witnesses the major problem of applied P fixation and thereby causes low nutrients use efficiency and low yield of crops. This condition demands a smart nutrient delivery system so that crop can be supplied with proper and balanced amount of plant nutrients particularly P-in acidic soil for maximum yield realization. In the recent past, application of Nano-P fertilizer has given a new dimension to crop production [1]. Weed is major challenge during Kharif and its control during early stages of growth is important. Proper crop selection and its cultivation at optimum crop geometry and proper fertilization through right sources & its form of P is much important. Keeping the above facts in view present experiments "Weed management in intercropped pulses through crop arrangement and fertilization through nano Phosphorus" was conducted.

Materials and Method

Soil of experimental field was sandy loam in texture whose different physical and chemical properties were as Water holding capacity at saturation (37.6 %), Bulk density (1.58M gcc^{-3}), Organic carbon (4.20g kg^{-1}), Available N (191.7 kg ha^{-1}), Available P (23.21 kg ha^{-1}),Total P (511.4 kg ha^{-1}), Available K (157.8 kg ha^{-1}), pH (5.4) and EC (0.06 d S m^{-1} at 25°Cand their method of estimation are elaborated in **Table 1**. The experiment was laid out in split plot- Design (SPD) with seven crop arrangement *viz.* C_1 : Sole black gram (30 cm), C_2 : Sole pigeon pea (60 cm), C_3 : Sole maize (60 cm), C_4 : Pigeon pea + Black gram (60/30cm) 1:1, C_5 : Maize + Black gram (60/30cm) 1:1, C_6 : Pigeon pea + Black gram (90/30cm) 1:2 and C_7 : Maize + Black gram (90/30cm) 1:2 under main plot and four different Phosphorus management *i.e.* P_1- Control, P_2- Nano-P @ 40 ppm as foliar spray at 20 days after sowing (DAS), P_3- 50% Recommended-P + Nano-P @ 40 ppm as foliar spray at 20 DAS and P_4-100 % Recommended-P under sub plot. Data were collected and analyzed through standard statistical procedure and presented through tables.

Table 1 Total weed density (no.m^{-2}) at 20 DAS as influenced by legume based crop geometry and phosphorus management (pooled of 2016 and 2017)

Treatment		P_1-Control	P_2-Nano-P 40 ppm	P_3-50 % RDP + Nano- P 40 ppm	P_4-100% RDP	Mean
C_1-Sole BG.		16.81(282)	16.80(285)	18.35(336)	18.65(347)	17.65
C_2-Sole PP		18.24(333)	18.20(331)	20.09(403)	20.40(416)	19.24
C_3-Sole M		18.45(341)	18.46(344)	19.92(397)	20.06(402)	19.22
C_4-PP+BG(1:1)		17.70(313)	17.71(317)	19.37(375)	19.48(379)	18.56
C_5-M+BG(1:1)		18.16(330)	18.15(330)	19.47(379)	19.81(392)	18.90
C_6-PP+BG(1:2)		17.30(300)	17.35(302)	18.68(349)	18.97(360)	18.08
C_7-M+BG(1:2)		17.95(323)	18.04(326)	19.05(362)	19.28(371)	18.58
Mean		17.80	17.82	19.28	19.52	
				S. Em (±)	**CD at (5%)**	**CV (%)**
Crop combination				0.237	0.729	7.8
Phosphorus management				0.187	0.5335	
Interaction	Between P, at same level of C			0.474	NS	
	Between C, at same or different levels of P			0.489	NS	

*BG-black gram, PP- pigeon pea, M- maize.*Data in parenthesis (original value) was subjected to $\sqrt{X} \pm 0.5$

Result and Discussion

Weed dynamics in terms of weed density and its dry weight at 20 and 40 DAS are more important character which directly affects the growth and yield of crops.

Weeds density

Data pertaining to total weed density at 20 and 40 DAS as influenced by crop combination and phosphorus management have been presented in Table 1 and **Table 2**.

At 20 DAS, significantly lower weed density was recorded under sole black gram compared to sole pigeon pea and sole maize. All the intercropping systems recorded lower weed density compared to sole cropping of maize or pigeon pea. Pigeon pea + black gram 1:1 as well as pigeon pea + black gram 1:2 were found at par with sole black gram in suppressing the weed flora. With regard to phosphorus management reduced weed density was recorded with control followed by Nano-P 40 ppm and 50% RDP + Nano-P 40 ppm. Maximum weed density value was recorded with 100 % RDP (392 m^{-2}) [2].

Table 2 Total weed density (no.m^{-2}) at 40 DAS as influenced by legume based crop geometry and phosphorus management (pooled of 2016 and 2017)

Treatment	P_1-Control	P_2-Nano-P 40 ppm	P_3-50 % RDP + Nano- P 40 ppm	P_4-100% RDP	Mean
C_1-Sole BG.	10.79(116)	10.76(119)	11.86(140)	12.07(145)	11.37
C_2-Sole PP	11.76(138)	11.80(141)	13.07(170)	13.28(176)	12.48
C_3-Sole M	11.89(141)	11.80(139)	13.10(171)	13.05(170)	12.14
C_4-PP+BG(1:1)	11.44(133)	1142(130)	12.56(157)	12.73(152)	12.04
C_5-M+BG(1:1)	11.73(137)	11.70(139)	12.63(159)	12.86165)	12.23
C_6-PP+BG(1:2)	11.21(126)	11.36(129)	12.14(147)	12.45(155)	11.79
C_7-M+BG(1:2)	11.59(134)	11.65(136)	12.38(153)	12.50(156)	12.05
Mean	11.49	11.50	12.53	12.52	
			S. Em±	**CD at5%**	**CV %**
Crop combination			0.134	0.414	8.9
Phosphorus management			0.181	0.516	
Interaction	Between P, at same level of C		0.269	NS	
	Between C at same or different levels of P		0.436	NS	

*BG-black gram, PP- pigeon pea, M- maize. Data in parenthesis (original value) was subjected to $\sqrt{X \pm 0.5}$ transformations

At 40 DAS, minimum weed density was recorded under sole black gram which was at par with all the intercropping systems *viz*. pigeon pea + black gram 1:1, pigeon pea + black gram 1:2, maize + black gram 1:2 and maize + black gram 1:1. A significant reduction in weed density (125 m^{-2}) was also recorded in all the intercropping system compared to sole cropping of pigeon pea and maize. With regard to phosphorus management, lower weed density was recorded with P controlled plot (130 no. m^2) compared to 100% RDP and 50% RDP + Nano-P 40 ppm applied plots. Increasing phosphorus level increased weed growth and development resulting in maximum weed density.

Weed dry weight

Weed dry weight at 20 DAS (75.47 g m^{-2}) recorded under sole black gram was significantly lower compared to sole pigeon pea and sole maize (**Table 3**). However, sole black gram was found statistically at par with pigeon pea + black gram 1:2 and both the systems remained superior over pigeon pea + black gram 1:1, maize + black gram 1:2 and maize + black gram 1:1, sole maize and pigeon pea with respect to reduction of weed dry weight. Maximum weed dry weight was registered in sole pigeon pea followed by sole maize. As regard to phosphorus management, lower weed dry weight was recorded with the application of Nano-P 40 ppm applied plot compared to 100% RDP and 50% RDP + Nano-P 40 ppm applied plots. Maximum weed dry weight was recorded with 100% RDP (93.56 g m^{-2}).

At 40 DAS, minimum weed dry weight (42.80 g m^{-2}) was recorded under sole black gram which remained at par with all the intercropping systems (**Table 4**). A significant reduction in weed dry weight was also recorded in all the intercropping systems compared to sole cropping of pigeon pea and maize. Among phosphorus management, P-control plot recorded lower weed dry weight compared to 50% RDP + Nano-P 40 ppm and 100% RDP. Maximum weed dry weight was recorded with 100% RDP (55.17 g m^{-2}). It is obvious from the results that intercropping systems were effective in considerably reducing weeds count and weed dry weight in comparison to sole pigeon pea and maize. Intercropping system have been found to suppress weeds through formation of canopies due to competitive planting pattern and thus provided an opportunity to utilize cropping systems as a tool of weed management to reduce weed intensity apart from efficient land utilization. Crops having vigorous growth such as black gram, soybean, ground nut, and moong bean reduced the weed infestation by smothering effect. [2] also reported that maize and legume intercropped either as paired rows + two rows of legume or one row of legume in between two rows of maize adversely affected the weed growth and caused 22.4 and 31.9% weed growth suppression compared with sole maize, respectively. [3] also reported similar findings. However, planting geometry alone is not sufficient to overpower weeds during *kharif* season because rains provide a congenial environment for weeds. [4] reported maximum reduction in number of total weeds in maize + black gram intercropping.

With regard to phosphorus management, lower weed density was recorded with P controlled plot compared to that with 100% RDF and 50% RDP + Nano-P 40 ppm. Nitrogen and potassium were given as per recommendation of the crop and hence, increasing phosphorus level increased weed growth and development resulting in maximum weed density [5].

Table 3 Total weed dry weight (gm^{-2}) at 20 DAS as influenced by legume based crop geometry and phosphorus management (mean of 2016 and 2017)

Treatment		P_1-Control	P_2-Nano-P 40 ppm	P_3-50 % RDP + Nano- P 40 ppm	P_4-100% RDP	Mean
C_1-Sole BG.		68.73	69.40	80.83	82.90	75.47
C_2-Sole PP		97.63	82.90	107.57	110.56	99.67
C_3-Sole M		85.67	82.17	98.47	103.00	92.33
C_4-PP+BG(1:1)		72.83	73.53	88.10	89.50	80.99
C_5-M+BG(1:1)		79.37	78.57	90.77	93.73	85.61
C_6-PP+BG(1:2)		71.76	72.77	83.87	86.30	78.68
C_7-M+BG(1:2)		74.83	75.87	86.87	88.90	81.62
Mean		78.69	76.46	90.92	93.56	
				S. Em±	**CD at5%**	**CV %**
Crop combination				2.033	6.26	8.2
Phosphorus management				1.488	4.25	
Interaction	Between P, at same level of C			4.067	NS	
	Between C at same or different levels of P			3.970	NS	
*BG-black gram, PP- pigeon pea, M- maize						

Table 4 Total weeds dry weight (gm^{-2}) at 40 DAS as influenced by legume based crop geometry and phosphorus management (mean of 2016 and 2017)

Treatment		P_1-Control	P_2-Nano-P 40 ppm	P_3-50 % RDP + Nano- P 40 ppm	P_4-100% RDP	Mean
C_1-Sole BG.		38.13	38.03	46.63	48.40	42.80
C_2-Sole PP		45.93	46.20	57.23	59.17	52.13
C_3-Sole M		47.07	46.20	57.63	46.78	49.42
C_4-PP+BG(1:1)		43.23	43.13	52.67	54.13	48.29
C_5-M+BG(1:1)		45.67	45.47	53.37	55.40	49.98
C_6-PP+BG(1:2)		41.47	42.77	49.20	51.90	44.60
C_7-M+BG(1:2)		44.60	45.10	51.03	52.10	48.21
Mean		43.73	43.84	52.54	52.55	
				S. Em±	CD at5%	CV %
Crop combination				1.146	3.531	13.99
Phosphorus management				1.470	4.198	
Interaction	Between P, at same level of C			2.293	NS	
	Between C, at same or different levels of P			3.559	NS	
*BG-black gram, PP- pigeon pea, M- maize.						

Conclusion

Result from this experiment it can be concluded that, intercropping system preferably with the black gram in different geometry in combination with maize and pigeon pea in *kharif* season considerably reduces weed flora count as well as weed dry weight and thereby increases crop yield. It also reduces dependencies on the herbicide and its harmful effects. Thus, crop geometry and Phosphorus has important role in the management of weed density and dry weight in the intercropping system.

References

[1] Tarafdar, J.C.,Raliya, R. and Rathore, I. (2012). Microbial synthesis of phosphorus nanoparticles from Tri-calcium phosphate using Aspergillus tubingensis TFR-5. Journal BionanoScience, 6:84-89.

[2] Pandey, A.K. and Prakash, V. 2002. Wwed management in maize and soybean intercropping system. Indian Journalof Weed Science, 34(1&2): 58-62.

[3] Pandey, A.K., Prakash, V., Singh, R.P. and Mani, V.P. 1999. Effect of intercropping patterns of maize and soybean on yield and economics under mid hills of N-W Himalays, Annal. of Agriculture Research, 20(2): 154-159.

[4] Shrivastava, G.K., Choubey, N.K., Khanna, P. and Tripathi, R.S. 2000, Planting pattern and weed management in pigeon pea + soybean intercropping system. Journal Indian Society of Soil Science, 42 (2): 313-315.
[5] Shah, M.H.; Koul, P.K.; Khanday, B.A. and Kachroo, D. 1991. Production potential and monetary advantage index of maize intercropped with different grain legumes. Indian Journal of Agronomy, 36(1): 23-28.

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