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Ghanshyam Dwivedi
Ph. D. Student, Deptt. of Agrilculture M.G.C.G.V.C. Satna, Madhya Pradesh, India

RK Pathak
Asstt. Prof., Deptt.of Agronomy, N.D.U.A.T Faizabad, Uttar Parades, India

Amar Pal Singh
Asstt. Prof., Deptt. of Vegetable Science, N.D.U.A.T Faizabad, Uttar Parades, India

Anand Singh
Student M.Sc. (Ag) G.P.B. N.D.U.A.T Faizabad, Uttar Pradesh, India

Abhineet
Student M.Sc. (Ag) Deptt.of Agronomy, N.D.U.A.T Faizabad, Uttar Parades, India

KK Singh
Asstt. Prof., Deptt.of Agril. Eco, N.D.U.A.T Faizabad, Uttar Parades, India

Ravindra Singh
Asstt. Prof., Deptt.of Agril. Eco. N.D.U.A.T Faizabad, Uttar Parades, India

Ankit Singh
Student M.Sc. (Ag) Deptt.of Agronomy, N.D.U.A.T, Faizabad, Uttar Parades, India

Himanshu Singh
Student M.Sc. (Ag) G.P.B. N.D.U.A.T Faizabad, Uttar Parades, India

Correspondence
Ghanshyam Dwivedi
Ph. D. Student, Deptt. of Agrilculture M.G.C.G.V.C. Satna, Madhya Pradesh, India

Impact of varieties and phosphorus levels on yield attributes, yield and economics of green gram (Mung) (*Vigna radiata* L.)

Ghanshyam Dwivedi, RK Pathak, Amar Pal Singh, Anand Singh, Abhineet, KK Singh, Ravindra Singh, Ankit Singh and Himanshu Singh

Abstract

The experiment entitled "Impact of varieties and phosphorus levels on yield attributes, yield and economics of green gram (Mung) (*Vigna radiata* L.)" was conducted at the Agronomy Research Farm of the "Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Faizabad (U.P.). The farm is situated at south-east of Faizabad-Raibareilly road in a main campus of the university which is 42 Km. away from faizabad city. During the kharif season of 2014-15 and 2015-16 to find out the Impact of varieties and phosphorous levels on the growth and yield of kharif mungbean (*Vigna radiata* (L.) Wilczek). The experiment was laid out in Factorial Randomized Complete Block Design with three replications and constitute of four levels of phosphorous levels viz., 20 kg P_2O_5 ha^{-1}, 40 kg P_2O_5 ha^{-1}, 60 kg P_2O_5 ha^{-1}, control (no phosphorous application in 25 varieties *ie* NDM-1, Meha, Samrat, Amrit, KM 1, Mohni, Pannt mung-1, Pant mung-2, PDM-11, Pusa-105, Pusa Vaisakhi, Sabarmati, Sunaina, Varsa, Type-1, Type-44, Type-51, ML-1, ML-5, ML-131,CO-4, Jawahar-45, K-851, Gujrat-1and Gujrat-2 of mung,. Results showed that dry weight of plant at different growth stages were significantly increased due to application of phosphate fertilizer over control on the similar way application of phosphorous significantly increased the yield and yield contributing characters also, such as number of pods per plant, pod length, number of seeds per plant, and seed yield. The varieties also exhibited their pronounced impact on above parameters and maximum yield was noted in cultivar NDM-1 while minimum yield was recorded in cultivar KM-1. Economic study revealed that maximum benefit cost ratio was associated with cultivar NDM-1 with combination of 40 kg P_2O_5/ha. *Vigna radiata* (L.) Wilczek, Phosphorous levels, Growth and Yield characters of mung bean.

Keywords: Impact of varieties, phosphorus levels, economics of green gram, *Vigna radiata* L.

1. Introduction

Greengram (*Vigna radiata* L. Wilczec) is one of the most ancient and extensively grown leguminous crops of India. It is valued for the protein enriched seed as an important dietary ingredient to overcome protein malnutrition of human beings. According to Vavilov (1926) [23] it is a native of India and Central Asia. It occupies prime position among pulses by virtue of its short growth period, high biomass and outstanding nutrient value as food, feed and forage. Its seed contain 24.7 % protein, 0.6 % fat, 0.9 % fiber and 3.7% ash as well as sufficient quantity of calcium, phosphorus and important vitamins. Due to cheaper protein source it is designated as "poor man‟s meat" (Aslam *et al.*, 2010) [2]. It does not produce heaviness or flatulence is fairly rich in carbohydrate and appreciable amount of riboflavin and thiamine. In India, greengram occupies an area of about 3.51 million hectare, producing 1.80 million tones with the productivity of 511 kg ha-1 (Anon., 2012) [1]. Greengram has tremendous scope for improving pulse production and area, because greengram cultivation is done during summer season also has received wider acceptance from farming community as it provides extra income, improve soil fertility, efficient land utilization, low incidence of pest and diseases and long term sustainability of agriculture without any harm to main crops (Idnani and Gautam, 2008) [5] as well as it is good for sowing because of its short duration and good quality protein (Dewangan *et al*. 1992) [4].

Materials and Methods

Experiments were carried out under partially reclaimed sodic soil during two consecutive years *i.e.*, 2014-15 and 2015-16. The experimental site is located at Agronomy Research Farm of the "Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Faizabad (U.P.). The farm is situated at south-east of Faizabad-Raibareilly road in a main campus of the university which is 42 Km. away from faizabad city. The experimental site falls under subtropical region Indo-Gangatic Plains and situated at 26.49^{0}N latitude and 82.29^{0}E longitude at an altitude of 113 meters from mean sea level. The region receives a mean annual rainfall of about 1200mm. The climate is sub-tropical with remarkable humidity. It is extremely hot and dry in summer (March to May), having maximum temperature ranging between 32.7-40.8 ^{0}C. The experimental field was well leveled having good irrigation and drainage facilities.25 mung varieties *viz* NDM-1, Meha, Samrat, Amrit, KM 1,Mohni, Pannt mung-1, Pant mung-2, PDM-11, Pusa-105, Pusa Vaisakhi, Sabarmati, Sunaina, Varsa, Type-1, Type-44, Type-51, ML-1, ML-5, ML-131,CO-4, Jawahar-45, K-851, Gujrat-1and Gujrat-2 were tested along with 4 levels of phosphorus *ie* 0,20,40and 60kg P_2O_5 ha^{-1}. Thus (25x4) treatment combinations were tested in randomized block design in factorial cincept. All agronomic cultural practices for razing good crop were followed during course of study. Data different attributes viz; dry matter accumulation at different growth stages, number of pod per plant, length of pod, number of grain per pod and grain yield q ha^{-1} were recorded and subjected to statistical analysis with the help of method suggested by Cocharan and Cox (1961) for randomized block design. Economics of various treatments was also calculated to sea benefit cost ratio.

Results and Discussion

Effect of Varieties

Summary of data presented in Tabe-1 indicates that dry matter accumulation differed significantly among the varieties at all stages of growth during both the years of study. It might be due to their own genetic capacity. The similar findings were also supported by Sharma *et al.* (1993) [19] and Mishra (2003) [12].

Table 1: Impact of varieties and phosphorus levels on dry matter accumulation (g) plant^{-1} at different stages of growth

Treatments	DMA 30 DAS		DMA 30 DAS		DMA 30 DAS		DMA 30 DAS	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Varieties								
NDM-1	5.20	5.28	7.62	7.72	14.93	15.05	15.59	15.74
Meha	4.58	4.65	6.71	6.80	13.15	13.26	13.73	13.86
Samarat	4.48	4.55	6.57	6.66	12.88	12.98	13.44	13.57
Amrit	4.72	4.79	6.92	7.01	13.56	13.67	14.16	14.30
KM 1	4.34	4.40	6.36	6.44	12.47	12.57	13.01	13.14
Mohini	4.82	4.89	7.06	7.15	13.84	13.95	14.44	14.58
Pant Mung-1	4.91	4.99	7.20	7.29	14.11	14.22	14.73	14.87
Pant Mung-2	5.01	5.08	7.34	7.43	14.39	14.50	15.02	15.16
PDM-11	4.63	4.69	6.78	6.87	13.29	13.40	13.87	14.01
Pusa-105	4.44	4.50	6.50	6.58	12.74	12.84	13.30	13.43
Pusa Vaisakhi	4.87	4.94	7.13	7.22	13.97	14.09	14.59	14.73
Sabarmati	4.96	5.03	7.27	7.36	14.25	14.36	14.87	15.02
Sunaina	4.87	4.94	7.13	7.22	13.97	14.09	14.59	14.73
Varsha	4.41	4.48	6.47	6.55	12.67	12.77	13.23	13.36
Type-1	4.98	5.06	7.30	7.40	14.32	14.43	14.94	15.09
Type-44	4.89	4.96	7.16	7.26	14.04	14.16	14.66	14.80
Type-51	4.85	4.92	7.10	7.19	13.92	14.03	14.53	14.67
ML-1	4.88	4.96	7.16	7.25	14.03	14.14	14.64	14.79
ML-5	4.84	4.91	7.09	7.19	13.91	14.02	14.51	14.66
ML-131	4.98	5.06	7.30	7.40	14.32	14.43	14.94	15.09
CO-4	4.51	4.57	6.61	6.69	12.95	13.05	13.51	13.65
Jawahar-45	4.95	5.02	7.25	7.34	14.21	14.32	14.83	14.97
K-851	4.92	4.99	7.21	7.31	14.14	14.25	14.76	14.90
Gujrat-1	4.63	4.69	6.78	6.87	13.29	13.40	13.87	14.01
Gujrat-2	4.58	4.65	6.72	6.80	13.17	13.27	13.74	13.88
SEm±	0.129	0.121	0.180	0.183	0.351	0.345	0.370	0.366
CD (P=0.05)	0.359	0.337	0.501	0.508	0.977	0.960	1.029	1.019
Phosphorus levels (kg ha^{-1})								
0	4.55	4.62	6.43	6.51	12.60	12.71	13.16	13.28
20	4.63	4.69	6.64	6.73	13.02	13.12	13.59	13.72
40	4.92	4.99	7.27	7.36	14.25	14.36	14.87	15.02
60	4.99	5.06	7.62	7.72	14.93	15.05	15.59	15.74
SEm±	0.037	0.034	0.051	0.052	0.099	0.098	0.105	0.104
CD (P=0.05)	0.102	0.095	0.142	0.144	0.276	0.272	0.291	0.288

Table 2: Impact of varieties and phosphorus levels on number of pod plant^{-1}, length of pod (cm), number of grain pod^{-1} and seed yield q ha^{-1}.

Treatments	N of pod plant^{-1}		Length of pod (cm)		N of grain pod^{-1}		Seed yield q ha^{-1}	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Varieties								
NDM-1	34.98	37.74	8.99	9.08	8.80	8.90	10.36	10.63
Meha	31.68	34.18	7.92	8.00	7.97	8.06	9.12	9.36
Samarat	31.35	33.82	7.76	7.83	7.89	7.98	8.93	9.17
Amrit	31.65	34.14	8.17	8.25	7.96	8.06	9.41	9.65
KM 1	32.18	34.71	7.51	7.58	8.09	8.19	8.65	8.87
Mohini	33.66	36.31	8.33	8.41	8.47	8.57	9.60	9.85
Pant Mung-1	33.33	35.96	8.50	8.58	8.38	8.48	9.79	10.04
Pant Mung-2	34.16	36.85	8.66	8.75	8.59	8.69	9.98	10.24
PDM-11	32.34	34.89	8.00	8.08	8.13	8.23	9.22	9.46
Pusa-105	31.35	33.82	7.67	7.75	7.89	7.98	8.84	9.07
Pusa Vaisakhi	33.00	35.60	8.42	8.50	8.30	8.40	9.69	9.95
Sabarmati	33.83	36.49	8.58	8.66	8.51	8.61	9.88	10.14
Sunaina	33.17	35.78	8.42	8.50	8.34	8.44	9.69	9.95
Varsha	30.36	32.75	7.63	7.71	7.64	7.73	8.79	9.02
Type-1	34.55	37.27	8.62	8.70	8.69	8.79	9.93	10.19
Type-44	34.09	36.77	8.46	8.54	8.57	8.68	9.74	9.99
Type-51	33.86	36.53	8.38	8.46	8.52	8.62	9.65	9.91
ML-1	33.86	36.53	8.45	8.53	8.52	8.62	9.73	9.98
ML-5	33.46	36.10	8.37	8.45	8.42	8.52	9.64	9.90
ML-131	33.89	36.56	8.62	8.70	8.52	8.63	9.93	10.19
CO-4	32.01	34.53	7.80	7.87	8.05	8.15	8.98	9.21
Jawahar-45	34.32	37.02	8.56	8.64	8.63	8.74	9.85	10.11
K-851	34.22	36.92	8.51	8.60	8.61	8.71	9.80	10.06
Gujrat-1	31.71	34.21	8.00	8.08	7.98	8.07	9.22	9.46
Gujrat-2	32.01	34.53	7.93	8.01	8.05	8.15	9.13	9.37
SEm±	0.858	0.899	0.241	0.232	0.263	0.246	0.243	0.257
CD (P=0.05)	2.387	2.501	0.670	0.647	0.731	0.686	0.675	0.716
Phosphorus levels (kg ha^{-1})								
0	31.35	33.82	6.52	6.58	7.89	7.98	7.51	7.70
20	32.34	34.89	7.51	7.58	8.13	8.23	8.65	8.87
40	33.99	36.67	9.41	9.50	8.55	8.65	10.83	11.12
60	34.32	37.02	9.57	9.66	8.63	8.74	11.02	11.31
SEm±	0.243	0.254	0.068	0.066	0.074	0.070	0.069	0.073
CD (P=0.05)	0.675	0.707	0.189	0.183	0.207	0.194	0.191	0.203

Table 3: Impact of varieties and phosphorus levels on economics of various treatment combinations

Treatment combinations	Cost of cultivation (Rs ha^{-1})	Gross incomr (Rs ha^{-1}) 14-15	Gross incomr (Rs ha^{-1}) 15-16	Net return (Rs ha^{-1}) 14-15	Net return (Rs ha^{-1}) 15-16	B: C 14-15	B:C 15-16
V_1P_0	16400	37010.98	37986.56	20610.98	21586.56	1.26	1.32
V_1P_1	17425	42070.74	43179.51	24645.74	25754.51	1.41	1.48
V_1P_2	18450	51686.70	53048.55	33236.70	34598.55	1.80	1.88
V_1P_3	19475	52783.17	54173.98	33308.17	34698.98	1.71	1.78
V_2P_0	16400	32703.74	33565.82	16303.74	17165.82	0.99	1.05
V_2P_1	17425	37162.27	38141.71	19737.27	20716.71	1.13	1.19
V_2P_2	18450	45633.60	46836.00	27183.60	28386.00	1.47	1.54
V_2P_3	19475	46605.98	47834.06	27130.98	28359.06	1.39	1.46
V_3P_0	16400	32062.88	32908.08	15662.88	16508.08	0.96	1.01
V_3P_1	17425	36429.36	37389.50	19004.36	19964.50	1.09	1.15
V_3P_2	18450	44725.05	45903.53	26275.05	27453.53	1.42	1.49
V_3P_3	19475	45679.71	46883.39	26204.71	27408.39	1.35	1.41
V_4P_0	16400	33600.30	34485.97	17200.30	18085.97	1.05	1.10
V_4P_1	17425	38195.54	39202.17	20770.54	21777.17	1.19	1.25
V_4P_2	18450	46928.99	48165.47	28478.99	29715.47	1.54	1.61
V_4P_3	19475	47923.92	49186.68	28448.92	29711.68	1.46	1.53
V_5P_0	16400	31263.44	32087.64	14863.44	15687.64	0.91	0.96
V_5P_1	17425	35495.23	36430.83	18070.23	19005.83	1.04	1.09
V_5P_2	18450	43530.83	44677.91	25080.83	26227.91	1.36	1.42
V_5P_3	19475	44469.00	45640.87	24994.00	26165.87	1.28	1.34
V_6P_0	16400	34447.53	35355.59	18047.53	18955.59	1.10	1.16
V_6P_1	17425	39139.11	40170.67	21714.11	22745.67	1.25	1.31
V_6P_2	18450	48052.50	49318.65	29602.50	30868.65	1.60	1.67
V_6P_3	19475	49078.06	50371.29	29603.06	30896.29	1.52	1.59
V_7P_0	16400	35007.46	35930.24	18607.46	19530.24	1.13	1.19
V_7P_1	17425	39789.41	40838.06	22364.41	23413.06	1.28	1.34

V_7P_2	18450	48876.75	50164.58	30426.75	31714.58	1.65	1.72
V_7P_3	19475	49914.98	51230.22	30439.98	31755.22	1.56	1.63
V_8P_0	16400	35709.02	36650.30	19309.02	20250.30	1.18	1.23
V_8P_1	17425	40584.27	41653.88	23159.27	24228.88	1.33	1.39
V_8P_2	18450	49848.53	51161.96	31398.53	32711.96	1.70	1.77
V_8P_3	19475	50908.28	52249.70	31433.28	32774.70	1.61	1.68
V_9P_0	16400	33084.87	33957.01	16684.87	17557.01	1.02	1.07
V_9P_1	17425	37590.69	38581.43	20165.69	21156.43	1.16	1.21
V_9P_2	18450	46151.10	47367.15	27701.10	28917.15	1.50	1.57
V_9P_3	19475	47136.14	48378.21	27661.14	28903.21	1.42	1.48
$V_{10}P_0$	16400	31762.68	32599.98	15362.68	16199.98	0.94	0.99
$V_{10}P_1$	17425	36083.57	37034.60	18658.57	19609.60	1.07	1.13
$V_{10}P_2$	18450	44291.85	45458.93	25841.85	27008.93	1.40	1.46
$V_{10}P_3$	19475	45238.91	46430.99	25763.91	26955.99	1.32	1.38
V_1P_0	16400	34666.80	35580.60	18266.80	19180.60	1.11	1.17
$V_{11}P_1$	17425	39402.30	40440.75	21977.30	23015.75	1.26	1.32
$V_{11}P_2$	18450	48401.40	49676.70	29951.40	31226.70	1.62	1.69
$V_{11}P_3$	19475	49429.50	50731.95	29954.50	31256.95	1.54	1.60
$V_{12}P_0$	16400	35368.36	36300.66	18968.36	19900.66	1.16	1.21
$V_{12}P_1$	17425	40197.17	41256.57	22772.17	23831.57	1.31	1.37
$V_{12}P_2$	18450	49373.18	50674.09	30923.18	32224.09	1.68	1.75
$V_{12}P_3$	19475	50422.80	51751.43	30947.80	32276.43	1.59	1.66
$V_{13}P_0$	16400	34687.03	35601.37	18287.03	19201.37	1.12	1.17
$V_{13}P_1$	17425	39422.95	40461.95	21997.95	23036.95	1.26	1.32
$V_{13}P_2$	18450	48422.48	49698.34	29972.48	31248.34	1.62	1.69
$V_{13}P_3$	19475	49451.84	50754.89	29976.84	31279.89	1.54	1.61
$V_{14}P_0$	16400	31491.19	32321.30	15091.19	15921.30	0.92	0.97
$V_{14}P_1$	17425	35786.74	36729.92	18361.74	19304.92	1.05	1.11
$V_{14}P_2$	18450	43948.80	45106.80	25498.80	26656.80	1.38	1.44
$V_{14}P_3$	19475	44884.47	46067.18	25409.47	26592.18	1.30	1.37
$V_{15}P_0$	16400	35607.48	36546.11	19207.48	20146.11	1.17	1.23
$V_{15}P_1$	17425	40460.94	41527.32	23035.94	24102.32	1.32	1.38
$V_{15}P_2$	18450	49682.51	50991.59	31232.51	32541.59	1.69	1.76
$V_{15}P_3$	19475	50741.49	52078.55	31266.49	32603.55	1.61	1.67
$V_{16}P_0$	16400	34950.43	35871.75	18550.43	19471.75	1.13	1.19
$V_{16}P_1$	17425	39711.51	40758.15	22286.51	23333.15	1.28	1.34
$V_{16}P_2$	18450	48757.10	50041.81	30307.10	31591.81	1.64	1.71
$V_{16}P_3$	19475	49797.34	51109.53	30322.34	31634.53	1.56	1.62
$V_{17}P_0$	16400	34651.93	35565.37	18251.93	19165.37	1.11	1.17
$V_{17}P_1$	17425	39371.38	40409.05	21946.38	22984.05	1.26	1.32
$V_{17}P_2$	18450	48337.71	49611.38	29887.71	31161.38	1.62	1.69
$V_{17}P_3$	19475	49369.35	50670.26	29894.35	31195.26	1.54	1.60
$V_{18}P_0$	16400	34892.09	35811.85	18492.09	19411.85	1.13	1.18
$V_{18}P_1$	17425	39648.02	40692.97	22223.02	23267.97	1.28	1.34
$V_{18}P_2$	18450	48684.27	49967.06	30234.27	31517.06	1.64	1.71
$V_{18}P_3$	19475	49721.99	51032.18	30246.99	31557.18	1.55	1.62
$V_{19}P_0$	16400	34573.35	35484.71	18173.35	19084.71	1.11	1.16
$V_{19}P_1$	17425	39287.23	40322.67	21862.23	22897.67	1.25	1.31
$V_{19}P_2$	18450	48243.81	49514.99	29793.81	31064.99	1.61	1.68
$V_{19}P_3$	19475	49271.65	50569.97	29796.65	31094.97	1.53	1.60
$V_{20}P_0$	16400	35526.55	36463.02	19126.55	20063.02	1.17	1.22
$V_{20}P_1$	17425	40378.33	41442.51	22953.33	24017.51	1.32	1.38
$V_{20}P_2$	18450	49598.21	50905.04	31148.21	32455.04	1.69	1.76
$V_{20}P_3$	19475	50652.13	51986.80	31177.13	32511.80	1.60	1.67
$V_{21}P_0$	16400	32293.91	33145.22	15893.91	16745.22	0.97	1.02
$V_{21}P_1$	17425	36684.88	37651.77	19259.88	20226.77	1.11	1.16
$V_{21}P_2$	18450	45025.95	46212.38	26575.95	27762.38	1.44	1.50
$V_{21}P_3$	19475	45989.46	47201.34	26514.46	27726.34	1.36	1.42
$V_{22}P_0$	16400	35339.00	36270.55	18939.00	19870.55	1.15	1.21
$V_{22}P_1$	17425	40155.39	41213.72	22730.39	23788.72	1.30	1.37
$V_{22}P_2$	18450	49306.44	50605.62	30856.44	32155.62	1.67	1.74
$V_{22}P_3$	19475	50357.58	51684.52	30882.58	32209.52	1.59	1.65
$V_{23}P_0$	16400	35176.76	36104.03	18776.76	19704.03	1.14	1.20
$V_{23}P_1$	17425	39970.10	41023.55	22545.10	23598.55	1.29	1.35
$V_{23}P_2$	18450	49077.20	50370.34	30627.20	31920.34	1.66	1.73
$V_{23}P_3$	19475	50123.77	51444.55	30648.77	31969.55	1.57	1.64
$V_{24}P_0$	16400	33007.99	33878.08	16607.99	17478.08	1.01	1.07
$V_{24}P_1$	17425	37512.20	38500.85	20087.20	21075.85	1.15	1.21
$V_{24}P_2$	18450	46071.02	47284.93	27621.02	28834.93	1.50	1.56

$V_{24}P_3$	19475	47051.25	48291.05	27576.25	28816.05	1.42	1.48
$V_{25}P_0$	16400	32774.23	33638.18	16374.23	17238.18	1.00	1.05
$V_{25}P_1$	17425	37238.16	38219.61	19813.16	20794.61	1.14	1.19
$V_{25}P_2$	18450	45719.07	46923.74	27269.07	28473.74	1.48	1.54
$V_{25}P_3$	19475	46694.74	47925.18	27219.74	28450.18	1.40	1.46

Significant dry matter accumulation by plants was because of more number of leaves per plant and number of branches per plant. Healthy plants due to higher nutrients absorption capacity. Healthy plant due to less morality resulted higher dry matter production. Minimum dry matter accumulation (12.70g/plant) recorded with variety Samrat at harvest. However, which reflected due to poor resulted less dry matter production. The similar findings were also supported by Singh and Pareek (2003) [20].

Yield is resultant coordinated interplay of yield attributes. Vigorously growing plants are able to absorb larger quantity of mineral nutrients through well developed nutrient system. The variety NDM-1 gave more number of pods per plant, length of pod (cm) and number of seeds per pod than other varities. It might be probably due to their genetic characters of variety like more number of pods per plant, length of pods (cm) and number of seeds per pod etc. minimum yield contributing characters was credited to KM 1. It was due to less number of pods per plant, length of pod (cm) as well as less number of seeds per pod. The similar findings were also supported by Singh and Pareek (2003) [20].

Grain yield maximum in variety NDM-1 which was significantly superior over variety rest varieties. It was because of good plant stands more number of pods per plant length of pod (cm) and number of seeds per pod with more test weight. Minimum grain yield recorded with variety KM 1 might be due to less number pods per plant, length of pod (cm), number of seeds per pod and poor grain development. These findings in close conformity with the findings of Sharma *et al.* (1993) [19], Mandal *et al.* (2005) [9] and Singh and Triphathi (2005).

The maximum cost of cultivation (Rs 19475/ha) recorded at 60 kg P_2O_5 with all the varieties, due to additional cost of phosphorous fertilizer and the same cost for each variety. The highest gross return (Rs 52783.17/ha during 2014-15 and Rs 54173.98/ha during 2015-16) was noted with 60 kg P_2O_5 with variety NDM-1 due to higher grain and straw yield. The lowest gross income (rs/ha) was obtained with variety KM 1 under control plot (Table.3). The similar findings were also supported by Khan *et al.* (2004) [7].

Highest net return (Rs/ha) was obtained under treatment combination of 60 kg P_2O_5 with variety NDM-1 and the lowest net return recorded with variety KM 1 under control plot was due to lowest gross return in proportion of cost of cultivation under this combination. Maximum benefit cost ratio (1:1.80 during 2014-15 and 1: 1.88 during 2015-16) obtained from treatment combination of 40 kg P_2O_5 /ha with varity NDM-1 while minimum befit cost ratio was recorded with variety KM 1 under control condition. The similar findings were also supported by Khan *et al.* (2004) [7].

Effect of Phosphorus

Dry matter in plant at different growth stages increased with increase in doses of phosphorus. This might be firstly due the fact that phosphorus being an energy bond compound which have great importance in transformation of energy required in almost all metabolic process *viz*., photosynthesis, respiration, cell elongation and cell division, activation of amino-acid for synthesis of protein and carbohydrate metabolism etc. Secondary, due to significant increase in almost all the growth characters *viz* Plant height, number of branches and number of leaf ultimately increased dry matter production with increasing levels of phosphorus. Similar results have also been reported by Patra and Sahoo (1994) [14], Bhattacharya and Pal (2001) and Singh and Pareek (2003) [20].

Application of phosphorus resulted significant increase in all yield attributing characters *viz.,* number of pod plant^{-1}, Grain pod^{-1} and length of pod with increasing levels of phosphorus. Phosphorus application acceleratedthe production of photosynthates and its translocation from source to sink in which ultimately reflected for higher values of yield attributing characters. Increase in yield attributing characters have also been reported by Ram and Dixit (2000) [17], Prakash *et al.* 2002 and Bhatia *et al.* (2005) [3].

Application of phosphorus increased grain and straw yield significantly with every increase in dose of phosphorous upto 60 kg P2O5/ha. Maximum grain yield (11.02q ha^{-1}in 2014-15 and 11.31 q ha^{-1} 2015-16) were obtained with 60 kg P2O5/ha. the increase in grain yield with phosphorous application was due to (i) increase in sourse capacity viz., plant height, branches per plant, and number of leaves per plant as well as sink capacity viz., pods per plant, grains per pods and test weight, (ii) better utilization of photosynthatase towards sink due to increase in translocation from source to sink may be attributed to increase in potassium uptake which is responsible for quick and easy translocation of the photosynthates from source to sink. The results findings of earlier research workers viz., Raghu *et al.* (1984) [16], Maqsood *et al.* (2001) [8], Singh *et al.* (2003) [20] and Mishra *et al.* (2006) [12] are in accordance with this finding.

The cost of cultivation, gross return and net return increase with increasing level of phosphorous application of 60 kg P2O5 /ha. contrary to this maximum benefit cost ratio was recorded with application of 40 kg P2O5/ha The results are in conformity with those of Mondal *et al.* (2005) [9], Mishra *et al.* (2006) [12], Singh *et al.* (2008) and Mehta *et al.* (2008).

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