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Effect of different phosphorus sources and seed priming on growth, yield parameters and yield of chickpea

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ABSTRACT : Field experiment was conducted during *Rabi* seasons of 2005-06 and 2006-07 at Agricultural Research Station, Gangavati, Karnataka, India, to study the effect of phosphorus sources and seed priming on growth and yield of chickpea. The pooled results of two seasons indicated that application of phosphorus through FYM cured DAP (P_5) recorded significantly higher grain yield (1581 kg/ha) than other sources of phosphorus, while the lowest grain yield of 1167 kg/ha was recorded with application of recommended phosphorus in the form of FYM. Seed priming with 2 % SSP (S_3, 1500 kg/ha), 2 % $CaCl_2$ (S_2, 1477 kg/ha.), 5 % cow urine (S_6, 1401 kg/ha) recorded significantly higher grain yield which were at par with each other. Interaction of recommended dose of phosphorus through FYM cured DAP and seed priming with 2% SSP (P_5S_3) recorded higher grain yield of 1705 kg/ha which was significantly superior over other interactions. Similar trend was also observed with respect to yield and growth parameters.

Key Words : Chickpea, FYM cured DAP, Seed priming

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The pulses are known to improve the physical properties of soil through their tap root system and add leaf litter to the soil apart from fixing atmospheric nitrogen through biological nitrogen fixation (BNF). Pulse has special significance in the diet of the predominantly vegetarian population of India as it contains more protein which is complimentary with cereals in amino acid profile. About 90 per cent of world's chickpea is grown under rain fed conditions where the crop grows and matures on a progressively depleting soil moisture and generally experience terminal drought (Kumar *et al*., 1996). Terminal drought is therefore, one of the major production constraints in limiting chickpea productivity and yield stability.

Chickpea production remained static for the last three decades due to number of biotic and abiotic stresses. In India, chickpea cultivation is restricted mainly to rainfed areas or cultivated under residual soil moisture, lack of nutrient input, inadequate management practices, higher incidence of pests and diseases and unscientific management of these pests are the some constraints in its cultivation which led to instability of yield and low harvest index. Among these, major constraints are lack of nutrient management/ imbalanced nutrition, unscientific management of pests and diseases and soil moisture stress, perceived as a marginal farmers crop laden with high risk and poor yields. This perception discourages farmers to invest on requisite inputs which are vital for its successful cultivation.

RESEARCH PROCEDURE

A field experiment was conducted at Agricultural Research Station, Gangavati, Karnataka India, during *Rabi* seasons of 2005-2006 and 2006-07 to study the effect of phosphorus sources and seed priming on growth and yield of chickpea. The details of the materials used and techniques adopted during the course of investigations are presented.

The soil of the experimental site was medium deep black (vertisols) with clay texture, low in nitrogen (237 kg/ha), low in phosphorus (25.2 kg/ha) and medium in potassium (422 kg/ ha). The experiment consisted of different phosphorus sources as main plots and different seed priming treatments as sub plots.

Main plots: (Phosphorus sources) P_1: Entire P through DAP, P_2:75% P through DAP + 25% through FYM, P_3:50% P through DAP + 50% P through FYM, P_4: Entire P through FYM and P_5: FYM Cured DAP (DAP : FYM 1:5 ratio,FYM was sprinkeled with water and DAP fertilizer mixed with FYM then kept in a air tight bag for one week). Sub plots (Seed priming) S_1: Seed soaking in water for 2 hr, S_2: Seed soaking in 2% $CaCl_2$ for 1 hr, S_3: Seed soaking in 2% SSP for 1 hr, S_4: Seed soaking in 2% KH_2PO_4 for 1 hr, S_5: Seed soaking in 2% $ZnSO_4$ for1 hr, S_6: Seed soaking in 5% cow urine for1hr and S_7: Control (without soaking).The experiment was laid out in a split plot design with three replication. The crop was sown with spacing of 30 x 10 cm, recommended fertilizer dose of 10: 25: 0 N:P:K kg/ha was applied in the form of DAP and FYM and variety used for experiment was Annigeri-1.Observations on growth parameters were recorded at 30, 60 DAS and at harvest by tagging five plants in each treatment, yield obtained from net plot is converted into yield kg/ha.

RESEARCH ANALYSIS AND REASONING

Different phosphorus source had significant influence on grain yield of chickpea over two season and pooled results indicated that application of phosphorus through FYM cured DAP recorded significantly higher grain yield (P_5, 1581 kg/ha) than other sources of phosphorus, while the lowest grain yield of 1167 kg/ha was recorded with application of recommended phosphorus in the form of FYM (Table 1). These results are in agreement with the findings of Yadavaia *et al*. (1991) and Billore *et al*. (2009). The increase in grain yield in treatment receiving recommended phosphorus through FYM cured DAP was mainly due to the faster availability of nutrient, since the DAP was incubated with FYM for one week before sowing and applied to the crop which helped in better and faster release of phosphorus as evident from the crop response.

The grain yield of chickpea is mainly determined by yield attributing parameters *viz.*, number of pods per plant, grain weight per plant and test weight. Significantly higher number of pods per plant, grain weight per plant and test weight was recorded in treatment receiving recommended phosphorus through FYM cured DAP(Table 2). These results are in conformity with the findings of Yadavaia *et al*.(1991).

The yield and yield attributes of chickpea are mainly governed by total dry matter produced and distributed in different plant parts during crop growth period. Total dry matter accumulation at 30 DAS (1.27 g/plant), at 60 DAS (7.44 g/plant) and at harvest (12.18 g/plant) was significantly higher in treatment receiving phosphorus through FYM cured DAP (P_5) (Table 2). These results are in agreement with the findings of Kulkarni *et al*. (2000) .

The total dry matter produced and its contribution towards grain yield are mainly governed by the better performance of growth parameters *viz.*, leaf area, leaf area index, leaf area duration, number of branches per plant and the plant height. These growth parameters were significantly higher in treatment receiving phosphorus through FYM cured DAP (P_5) at all growth stages (Table 3 and 4). These results are in line with the findings of Yadavaia *et al*. (1991), wherein application of 20 kg N + 40 kg P_2O_5 had resulted in significant improvement in growth and yield attributes than application of either pressmud or FYM alone @ 5 tonnes per ha which might be due to the slow release of nutrient from applied pressmud or FYM to the crop as the crop is grown during post rainy season under residual soil moisture, the residual soil moisture present in soil profile may not be sufficient for mineralization of nutrient from FYM that leads to slow release of nutrient inturn lower uptake by crop which led to poor crop yields.

Seed priming with 2 % SSP (S_3, 1500 kg/ha), 2 % $CaCl_2$ (S_2, 1477 kg/ha.), 5 % cow urine (S_6, 1401 kg/ha) recorded significantly higher grain yield which were at par with each other (Table 1). This yield increase in these seed priming treatments was mainly due to better performance of the yield attributing parameters *viz.*, number of pods per plant, grain weight per plant and test weight. Seed priming with 2% SSP recorded significantly higher number of pods per plant at 60 DAS (28.2) and at harvest (36.3 per plant), grain weight per plant (8.27g/plant) and 100 grain weight (15.68 g) (Table 2). These results are in agreement with the findings of Duraisami *et al.* (2001) wherein soaking of seeds in 2% SSPsolution before sowing along with soil application of 18.75 kg SSP / ha registered higher grain yield and yield parameters in greengram. Similar findings were also reported by Kaur *et al*. (2002) in chickpea and Ashraf (2002) in cotton.

Yield attributes and yield of any crop is generally governed by the total dry matter produced and distributed among the plant parts. Seed priming with 2% SSP solution (S_3) recorded higher total dry matter accumulation at 30 DAS (1.31 g/plant), 60 DAS (7.49 g/plant) and at harvest (12.73 g/plant) which was at par with $CaCl_2$ and cow urine seed treatment (Table 2). These results are in agreement with the findings of Karivartharaju and Ramakrishnan (1985) who reported that seed treatment with 2.5 per cent $CaCl_2$ recorded significantly higher total dry matter production, due to better partitioning of dry matter into different plant parts.

Higher total dry matter accumulation and distribution in different plant parts are determined by growth parameters *viz.*, plant height, number of branches, leaf area, leaf area index and leaf area duration. Significantly higher plant height of 20.6 cm was recorded in seeds primed with $CaCl_2$ (S_2) at 30 DAS, whereas at 60 DAS (36.3 cm) and at harvest (36.8 cm) seeds primed with 2% SSP solution recorded significantly higher plant height. At 30 DAS (3.45), 60 DAS (5.15) and at harvest (6.35) number of primary branches per plant, leaf area, leaf area index and LAD were significantly higher in seed primed with 2% SSP solution (S_3) (Table 3 and 4). The higher growth parameters recorded with seeds primed with 2% SSP solution or 2% $CaCl_2$ or 5% cow urine could be attributed for better cell elongation and increased normal cell division (Karivaratharaju and Ramakrishnan, 1985). Similar results were also observed by Salakinkop *et al*. (1996).

Interaction of recommended dose of phosphorus through

Table 1: Grain and haulm yield of chickpea as influenced by phosphorus sources and seed priming

Treatments	Grain yield (kg/ha)			Haulm yield (kg/ha)		
	2005-06	2006-07	Pooled	2005-06	2006-07	Pooled
Source of phosphorus(P)						
P_1:Rec. P (DAP)	1527 b	1432 b	1480 b	2390 a	1908 a	2149 a
P_2:75% P(DAP) + 25% P (FYM)	1430 c	1334 c	1382 c	2237 b	1753 b	1995b
P_3:50% P (DAP) + 50% P (FYM)	1381 c	1279 c	1330 c	2148 b	1711 b	1929 b
P_4:Rec. P (FYM)	1210 d	1124 d	1167d	1867 c	1471 c	1669 c
P_5:Rec. P (FYM cured DAP)	1631 a	1532 a	1581a	2402 a	1910 a	2156 a
S.E.±	25.69	19.09	22.26	33.07	17.78	24.74
Seed priming (S)						
S_1:Soaking in water	1415 cd	1324 bc	1369 bc	2258 ab	1791 a-c	2024 ab
S_2:Soaking in $CaCl_2$	1535 ab	1419 a	1477 a	2327 a	1832 ab	2080 a
S_3:Soaking in SSP	1562 a	1438 a	1500 a	2353 a	1862 a	2108 a
S_4:Soaking in KH_2PO_4	1395 cd	1309 bc	1352 bc	2146 bc	1682 de	1914 bc
S_5:Soaking in $ZnSO_4$	1386 cd	1300 bc	1343 bc	2130 bc	1707 c-e	1919 bc
S_6:Soaking in cow urine	1450bc	1352 ab	1401 ab	2213 ab	1761 b-d	1987 ab
S_7:Control	1309 d	1239 c	1274 c	2035 c	1620 e	1827 c
S.E.±	37.04	29.51	33.17	51.09	29.59	39.77
Interaction (P x S)						
P_1 S_1	1485 b-j	1396 c-j	1441 b-i	2441 a-d	2059 a	2250 ab
P_1 S_2	1616 a-e	1503 a-f	1560 a-e	2490 a-c	1982 a-c	2236 a-c
P_1 S_3	1641 a-d	1520 a-e	1581 a-d	2518 a-c	2030 ab	2274 a
P_1 S_4	1456 c-k	1375 c-k	1415 c-i	2277 a-g	1786 c-h	2031 a-g
P_1 S_5	1539 a-i	1439 a-i	1489 a-h	2388 a-e	1907 e-d	2147 a-e
P_1 S_6	1570 a-g	1469 a-g	1519 a-g	2425 a-d	1879 a-f	2152 a-e
P_1 S_7	1385 d-l	1321 d-l	1353 d-j	2188 a-h	1716 d-i	1952 b-h
P_2 S_1	1497 a-j	1373 c-k	1435 c-i	2401 a-e	1901 a-e	2151 a-e
P_2 S_2	1555 a-h	1435 a-i	1495 a-h	2376 a-f	1864 a-g	2120 a-e
P_2 S_3	1567 a-h	1444 a-h	1505 a-g	2391 a-e	1833 b-g	2112 a-e
P_2 S_4	1388 c-l	1304 d-m	1346 d-k	2175 a-h	1704 d-i	1940 c-h
P_2 S_5	1382 d-l	1299 e-m	1341 d-k	2151 b-i	1706 d-i	1928 d-i
P_2 S_6	1363 d-l	1281 f-o	1322 e-f	2141 c-i	1677 e-i	1909 d-i
P_2 S_7	1262 i-l	1204 j-o	1233 i-k	2024 e-i	1589 h-k	1807 f-k
P_3 S_1	1312 g-l	1230 h-o	1271 g-k	2151 b-i	1637 g-j	1894 d-i
P_3 S_2	1493 a-j	1368 c-k	1431 c-i	2299 a-g	1779 c-h	2039 a-f
P_3 S_3	1506 a-j	1374 c-k	1440 b-i	2293 a-g	1824 b-g	2058 a-f
P_3 S_4	1345 e-l	1250 g-o	1298 f-k	2086 d-i	1724 d-i	1905 d-i
P_3 S_5	1336 e-l	1244 g-o	1290 f-k	2074 d-i	1669 f-j	1871 e-j
P_3 S_6	1395 c-l	1288 f-n	1341 d-k	2148 c-i	1759 c-h	1953 b-h
P_3 S_7	1280 h-l	1196 j-o	1238 h-k	1987 f-i	1585 h-k	1786 f-k
P_4 S_1	1172 kl	1089 m-o	1131 jk	1833 hi	1440 jk	1636 i-k
P_4 S_2	1256 i-l	1162 k-o	1209 i-k	1925 g-i	1511 i-k	1718 h-k
P_4 S_3	1327 f-l	1212 i-o	1270 g-k	2012 e-i	1578 h-k	1795 f-k
P_4 S_4	1200 kl	1117 l-o	1159 jk	1858 hi	1429 jk	1643 i-k
P_4 S_5	1136 l	1066 no	1101 jk	1765 i	1403 k	1584 jk
P_4 S_6	1250 j-l	1156 k-o	1203 i-k	1907 g-i	1561 h-k	1734 g-k
P_4 S_7	1129 l	1062 o	1096 k	1768 i	1374 k	1571 k
P_5 S_1	1608 a-f	1531 a-d	1569 a-e	2462 a-d	1919 a-d	2191 a-d
P_5 S_2	1753 ab	1625 ab	1689 ab	2546 ab	2026 ab	2286 a
P_5 S_3	1771 a	1638 a	1705 a	2552 a	2044 ab	2298 a
P_5 S_4	1586 a-g	1496 a-f	1541 a-f	2333 a-f	1765 c-h	2049 a-f
P_5 S_5	1537 a-j	1453 a-h	1495 a-h	2271 a-g	1853 a-g	2062 a-f
P_5 S_6	1673 a-c	1566 a-c	1619 a-c	2444 a-d	1929 a-d	2186 a-d
P_5 S_7	1487 a-j	1413 b-j	1450 b-i	2206 a-h	1836 a-g	2021 a-g
S.E.	82.83	65.99	74.18	114.2	66.17	87.82

Note : Means followed by the same letter(s) in a column do not differ significantly by DMRT(P=0.05), DAS : Days after sowing

Table 2: Number of pods per plant, grain weight (g/plant), test weight (g) and total dry matter accumulation (g/plant) in chickpea as influenced by phosphorus sources and seed priming (Pooled)

Treatments	Number of pods/plant		Grain wt/pl	100 grain wt	Total dry matter		
	60 DAS	At harvest			30 DAS	60 DAS	harvest
Source of phosphorus(P)							
P_1:Rec. P (DAP)	25.2 b	34.4 a	8.60 a	15.54 a	1.25 ab	7.30 ab	12.10 ab
P_2:75% P(DAP) + 25% P (FYM)	25.1 b	34.3 a	7.74 b	15.53 a	1.24 a-c	7.17 bc	11.96 a-c
P_3:50% P (DAP) + 50% P (FYM)	25.1 b	34.3 a	7.37 b	15.28 b	1.21 b	7.17 bc	11.86 bc
P_4:Rec. P (FYM)	24.3 b	30.9 b	7.25 b	15.04 c	1.20 c	7.02 c	11.79 c
P_5:Rec. P (FYM cured DAP)	26.1 a	34.7 a	8.71 a	15.67 a	1.27 a	7.44 a	12.18 a
S.E.±	0.27	0.40	0.184	0.061	0.014	0.063	0.071
Seed Priming (S)							
S_1:Soaking in water	23.2 d	32.3 c	7.77 c	15.37 cd	1.13 c	6.99 cd	11.35 bc
S_2:Soaking in $CaCl_2$	26.4 b	35.1 ab	8.15 a	15.58 b	1.31 a	7.39 ab	12.66 a
S_3:Soaking in SSP	28.2 a	36.3 a	8.27 a	15.68 a	1.32 a	7.49 a	12.73 a
S_4:Soaking in KH_2PO_4	25.0 c	34.0 b	7.91 bc	15.32 de	1.23 b	7.24 b	11.60 b
S_5:Soaking in $ZnSO_4$	24.7 c	34.4 b	7.90 bc	15.23 f	1.24 b	7.20 bc	11.62 b
S_6:Soaking in cow urine	27.1 b	34.8 b	8.06 ab	15.43 c	1.31 a	7.39 ab	12.70 a
S_7:Control	21.5 e	29.1 d	7.47 d	15.26 ef	1.09 d	6.83 d	11.18 c
S.E.±	0.35	0.46	0.748	0.024	0.013	0.078	0.106
Interaction (P x S)							
P_1 S_1	23.3 k-o	33.8 b-e	8.64 ab	15.47 g-j	1.14 h-l	7.13 a-h	11.42 i-k
P_1 S_2	25.8 e-k	35.2 a-d	8.73 ab	15.76 cd	1.34 a-d	7.49 a-d	12.83 bc
P_1 S_3	28.5 a-d	37.7 a	8.82 ab	15.80 bc	1.34 a-d	7.59 a-c	12.91 ab
P_1 S_4	25.4 f-l	36.2 a-c	8.44 b-d	15.30 j-l	1.23 c-f	7.26 a-g	11.73 gh
P_1 S_5	25.4 f-l	34.9 a-d	8.51 a-d	15.50 f-i	1.27 c-f	7.27 a-g	11.73 gh
P_1 S_6	26.5 c-j	35.1 a-d	8.55 ab	15.57 e-h	1.31 b-f	7.48 a-e	12.82 bc
P_1 S_7	21.7 n-p	29.1 f-h	8.50 a-d	15.35 i-l	1.11 kl	6.89 d-h	11.2 k-m
P_2 S_1	24.0 j-n	32.3 d-f	7.14 i-k	15.49 f-i	1.13 i-l	6.95 d-h	11.36 j-l
P_2 S_2	25.9 d-k	34.9 a-d	8.01 c-f	15.61 d-g	1.28 b-f	7.36 a-g	12.62 d
P_2 S_3	27.3 a-g	36.5 a-c	8.38 b-e	15.76 cd	1.33 a-e	7.44 a-e	12.73 b-d
P_2 S_4	24.7 g-m	34.7 a-d	7.88 e-g	15.47 g-j	1.26 c-f	7.14 a-h	11.58 hi
P_2 S_5	24.7 g-m	35.4 a-d	7.81 e-h	15.21 k-m	1.27 c-f	7.17 a-h	11.57 hi
P_2 S_6	27.0 b-i	35.7 a-d	8.00 d-f	15.68 c-e	1.31 b-f	7.32 a-g	12.66 cd
P_2 S_7	22.2 m-p	29.4 f-h	6.95 jk	15.45 g-j	1.10 kl	6.79 f-i	11.20 lm
P_3 S_1	22.8 l-p	32.3 d-f	7.09 i-k	15.27 kl	1.12 j-l	6.91 d-h	11.25 mn
P_3 S_2	26.3 d-j	34.8 a-d	7.72 f-h	15.40 h-k	1.30 b-f	7.30 a-g	12.51 ef
P_3 S_3	28.3 a-e	37.4 ab	7.65 f-i	15.50 f-i	1.29 b-f	7.42 a-e	12.63 e
P_3 S_4	24.5 h-m	34.8 a-d	7.35 g-k	15.24 kl	1.22 f-i	7.18 a-h	11.43 k-m
P_3 S_5	24.4 i-m	33.9 b-e	7.37 g-k	15.02 n	1.24 d-g	7.15 a-h	11.53 kl
P_3 S_6	27.2 a-g	37.3 ab	7.56 f-i	15.31 j-l	1.27 c-f	7.33 a-g	12.53 ef
P_3 S_7	21.9 a-f	29.2 f-h	6.85 kl	15.22 kl	1.06 l	6.87 e-h	11.12 n
P_4 S_1	22.4 m-p	30.8 e-h	7.29 h-k	15.05 mn	1.10 kl	6.75 g-i	11.20 n
P_4 S_2	24.7 g-m	33.9 b-e	7.46 f-j	15.20 lm	1.26 c-f	7.21 a-g	12.42 f
P_4 S_3	27.1 b-h	33.5 c-e	7.48 f-j	15.25 kl	1.27 c-f	7.32 a-g	12.48 ef
P_4 S_4	24.8 g-m	28.7 h	7.32 h-k	15.01 n	1.20 f-j	6.99 c-h	11.41 lm
P_4 S_5	24.7 g-m	30.1 f-h	7.31 h-k	14.84 n	1.21 f-j	7.02 b-h	11.46 kl
P_4 S_6	26.0 d-k	30.2 f-h	7.43 g-j	14.94 n	1.26 c-f	7.22 a-g	12.43 f
P_4 S_7	20.5 p	28.8 gh	6.43 l	14.99 n	1.06 l	6.60 hi	11.16 n
P_5 S_1	23.5 k-o	32.2 d-g	8.70 ab	15.56 e-h	1.16 g-k	7.21 a-g	11.54 h-j
P_5 S_2	29.5 ab	36.6 a-c	8.81 ab	15.94 ab	1.37 ab	7.59 a-c	12.92 ab
P_5 S_3	29.7 a	37.7 a	9.02 a	16.09 a	1.41 a	7.69 a	13.04 a
P_5 S_4	25.7 e-k	35.7 a-d	8.54 a-c	15.58 e-h	1.24 d-g	7.62 ab	11.82 g
P_5 S_5	24.3 j-m	36.4 a-c	8.51 a-d	15.57 e-h	1.23 e-h	7.39 a-f	11.83 g
P_5 S_6	28.9 a-c	35.7 a-d	8.76 ab	15.66 c-f	1.36 a-c	7.59 a-c	12.89 ab
P_5 S_7	21.4 op	29.0 f-h	8.63 ab	15.27 kl	1.12 j-l	7.01 b-h	11.21 lm
S.E.±	0.78	1.04	0.167	0.054	0.029	0.176	0.063

Note : Means followed by the same letter(s) in a column do not differ significantly by DMRT(P=0.05), DAS : Days after sowing

Table 3: Leaf area (dm^2/plant), leaf area index and leaf area duration (days) in chickpea as influenced by phosphorus sources and seed priming (pooled)

Treatments	Leaf area			Leaf area index			Leaf area duration	
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	31-60 days	61-harvest
Source of phosphorus(P)								
P_1:Rec. P (DAP)	1.83 a	2.18 ab	2.01 ab	0.61 ab	0.72 ab	0.67 ab	20.09 a	20.98 b
P_2:75% P(DAP) + 25% P (FYM)	1.82 a	2.20 ab	1.99 ab	0.60 ab	0.73 a	0.66 ab	20.10 a	20.99 b
P_3:50% P (DAP) + 50% P (FYM)	1.75 ab	2.11 b	1.93 b	0.58 bc	0.70 b	0.64 b	19.35 a	20.27 c
P_4:Rec. P (FYM)	1.69 b	1.98 c	1.92 b	0.56 c	0.66 c	0.64 b	18.40 c	19.57d
P_5:Rec. P (FYM cured DAP)	1.85 a	2.24 a	2.07 a	0.61 a	0.74 a	0.69 a	20.46 a	21.58 a
S.E.±	0.025	0.027	0.027	0.008	0.007	0.009	0.165	0.124
Seed priming (S)								
S_1:Soaking in water	1.74 b	2.01 d	1.96 bc	0.58 b	0.67 d	0.65 bc	18.81 cd	19.89 c
S_2:Soaking in $CaCl_2$	1.83 ab	2.20 bc	2.06 ab	0.61 ab	0.73 bc	0.68 ab	20.19 ab	21.33 b
S_3:Soaking in SSP	1.87 a	2.31 a	2.15 a	0.62 a	0.77 a	0.71 a	20.93 a	22.29 a
S_4:Soaking in KH_2PO_4	1.78 ab	2.12 c	1.92 c	0.59 ab	0.71 c	0.64 c	19.55 bc	20.29 c
S_5:Soaking in $ZnSO_4$	1.77 ab	2.13 c	1.92 c	0.59 ab	0.71 c	0.64 b	19.55 bc	20.30 c
S_6:Soaking in cow urine	1.79 ab	2.26 ab	2.03 b	0.59 ab	0.75 ab	0.67 b	20.27 ab	21.49 b
S_7:Control	1.72 b	1.97 d	1.86 c	0.57 b	0.65 d	0.62 c	18.46 d	19.17 d
S.E.±	0.036	0.027	0.036	0.118	0.009	0.012	0.269	0.147
Interaction (P x S)								
P_1 S_1	1.76 b-d	2.09 c-g	1.89 c-h	0.58 a-d	0.69 a-i	0.62 c-h	19.29 c-h	19.89 g-l
P_1 S_2	1.91 a-c	2.24 a-d	2.13 a-c	0.63 ab	0.74 a-d	0.71 a-c	20.78 a-e	21.88 a-e
P_1 S_3	1.92 ab	2.38 a	2.17 ab	0.66 a	0.78 ab	0.72 ab	21.70 a	22.59 ab
P_1 S_4	1.80 a-d	2.13 c-g	1.91 b-h	0.60 a-d	0.71 b-j	0.63 b-h	19.69 a-g	20.23 f-l
P_1 S_5	1.82 a-d	2.17 b-f	2.09 a-f	0.60 a-d	0.72 b-g	0.69 a-f	20.03 a-g	21.34 a-g
P_1 S_6	1.83 a-d	2.28 a-c	2.04 a-g	0.61 a-d	0.76 a-c	0.68 a-g	20.56 a-f	21.63 a-f
P_1 S_7	1.69 b-d	2.02 e-h	1.84 e-h	0.56 b-d	0.67 e-j	0.61 e-h	18.56 f-j	19.33 j-m
P_2 S_1	1.77 a-d	2.02 e-h	2.00 a-h	0.59 a-d	0.67 e-j	0.66 a-h	18.97 c-i	20.09 f-l
P_2 S_2	1.87 a-d	2.28 a-c	2.03 a-g	0.62 a-d	0.76 a-c	0.67 a-g	20.81 a-d	21.61 a-f
P_2 S_3	1.82 a-d	2.34 ab	2.13 a-c	0.60 a-d	0.79 a	0.71 a-c	21.01 a-c	22.58 ab
P_2 S_4	1.89 a-c	2.18 a-f	2.01 a-h	0.63 a-c	0.72 a-g	0.67 a-g	20.37 a-g	21.00 c-h
P_2 S_5	1.78 a-d	2.24 a-d	1.88 c-h	0.59 a-d	0.74 a-d	0.62 c-h	20.14 a-g	20.60 e-j
P_2 S_6	1.79 a-d	2.34 ab	2.09 a-f	0.59 a-d	0.78 ab	0.69 a-f	20.73 a-e	22.20 a-d
P_2 S_7	1.79 a-d	1.95 g-i	1.82 f-h	0.59 a-d	0.65 h-k	0.60 f-h	18.70 e-i	18.88 lm
P_3 S_1	1.72 b-d	1.98 fi	2.12 a-d	0.57 a-d	0.66 g-k	0.70 a-e	18.57 f-i	20.55 e-k
P_3 S_2	1.79 a-d	2.16 b-f	2.01 a-h	0.59 a-d	0.72 b-h	0.67 a-g	19.76 a-g	20.90 c-i
P_3 S_3	1.87 a-d	2.28 a-c	2.14 a-c	0.62 a-d	0.76 a-c	0.70 a-d	20.81 a-d	22.06 a-e
P_3 S_4	1.71 b-d	2.04 d-h	1.85 d-h	0.57 b-d	0.68 d-j	0.61 d-h	18.82 d-i	19.50 h-m
P_3 S_5	1.73 a-d	2.08 c-g	1.82 f-h	0.57 a-d	0.69 c-i	0.60 f-h	19.08 c-i	19.53 h-m
P_3 S_6	1.77 a-d	2.23 a-d	1.87 c-h	0.59 a-d	0.74 a-e	0.62 c-h	20.03 a-g	20.53h-m
P_3 S_7	1.65 b-d	2.02 e-h	1.74 h	0.55 b-d	0.67 e-j	0.58 h	18.41 g-i	18.83 lm
P_4 S_1	1.60 d	1.85 h-i	1.79 gh	0.53 d	0.61 jk	0.59 gh	17.28 hi	18.23 m
P_4 S_2	1.70 b-d	2.04 d-h	2.00 a-h	0.56 b-d	0.68d-j	0.66 a-h	18.78 d-i	20.28 f-l
P_4 S_3	1.75 a-d	2.16 b-f	2.10 a-e	0.58 a-d	0.72 b-h	0.70 a-e	19.58 b-g	21.31 b-g
P_4 S_4	1.70 b-d	2.00 f-h	1.81 gh	0.56 b-d	0.66 f-j	0.60 f-h	18.57 f-i	19.13 j-m
P_4 S_5	1.71 b-d	1.94 g-i	1.85 d-h	0.57 b-d	0.64 i-k	0.61 d-h	18.30 g-i	18.98 k-m
P_4 S_6	1.72 b-d	2.10 c-g	2.04 a-g	0.57 b-d	0.69 c-j	0.68 a-g	19.10 c-j	20.73 d-i
P_4 S_7	1.63 cd	1.80 i	1.86 e-h	0.54 cd	0.60 k	0.62 c-h	17.18 i	18.33 m
P_5 S_1	1.86 a-d	2.12 c-g	2.01 a-h	0.62 a-d	0.70 c-j	0.67 a-g	19.95 a-g	20.70 d-j
P_5 S_2	1.87 a-d	2.28 a-c	2.11 a-e	0.62 a-d	0.76 a-c	0.70 a-e	20.83 a-d	22.01 a-e
P_5 S_3	2.00 a	2.38 a	2.19 a	0.64 a-d	0.79 a	0.73 a	21.57 ab	22.89 a
P_5 S_4	1.79 a-d	2.27 a-e	2.04 a-g	0.59 a-d	0.75 a-c	0.68 a-g	20.33 a-g	21.58 a-f
P_5 S_5	1.81 a-d	2.22 a-d	1.99 a-h	0.60 a-d	0.74 a-f	0.66 a-h	20.18 a-g	21.03 b-h
P_5 S_6	1.84 a-d	2.34 ad	2.13 a-c	0.61 a-d	0.78 ab	0.71 a-d	20.93 a-c	22.35 a-c
P_5 S_7	1.83 a-d	2.05 d-h	2.05 a-g	0.61 a-d	0.68 d-j	0.68 a-g	19.46 c-g	20.50 e-k
S.E.±	0.079	0.081	0.079	0.026	0.021	0.026	0.602	0.463

Note : Means followed by the same letter(s) in a column do not differ significantly by DMRT(P=0.05), DAS : Days after sowing

Table 4: Plant height and number of primary branches per plant in chickpea as influenced by phosphorus sources and seed priming (Pooled)

Treatments	Plant height (cm)			No. of primary branches/plant		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
Source of phosphorus(P)						
P_1:Rec. P (DAP)	20.2 a	34.1 a	34.9 ab	3.30 a	4.85 a	5.55 ab
P_2:75% P(DAP) + 25% P (FYM)	19.8 a	33.8 a	34.6 ab	3.27 a	4.71 a	5.47 bc
P_3:50% P (DAP) + 50% P (FYM)	19.7 a	32.9 a	33.8 b	3.25 a	4.65 a	5.41 bc
P_4:Rec. P (FYM)	19.6 a	32.9 a	33.4 b	3.16 a	4.54 a	5.37 c
P_5:Rec. P (FYM cured DAP)	20.3 a	35.0 a	35.8 a	3.35 a	4.92 a	5.66 a
S.E.±	0.25	0.48	0.42	0.061	0.118	0.049
Seed priming (S)						
S_1:Soaking in water	19.7 bc	32.0 c	32.7 c	3.12 cd	4.37 c	4.95 d
S_2:Soaking in $CaCl_2$	20.6 a	34.4 b	35.3 b	3.41 ab	5.10 a	5.89 b
S_3:Soaking in SSP	20.5 a	36.3 a	36.8 a	3.45 a	5.15 a	6.35 a
S_4:Soaking in KH_2PO_4	19.4 c	33.8 b	34.5 b	3.22 bc	4.65 b	5.30 c
S_5:Soaking in $ZnSO_4$	19.4 c	33.5 b	34.8 b	3.28 a-c	4.55 bc	5.34 c
S_6:Soaking in cow urine	20.4 ab	34.9 ab	35.3 b	3.43 ab	4.98 a	6.01 b
S_7:Control	19.5 c	31.3 c	32.0 c	2.94 d	4.35 c	4.59 e
S.E.±	0.27	0.51	0.48	0.068	0.093	0.1065
Interaction (P x S)						
P_1 S_1	19.8 a-c	32.0 e-g	33.6 e-j	3.27 a-f	4.52 f-l	5.18 g-m
P_1 S_2	20.6 a-c	34.1 b-g	35.6 a-g	3.27 a-f	5.06 a-i	6.01 a-f
P_1 S_3	20.5 a-c	35.7 a-e	37.7 a-c	3.46 a-c	5.09 a-h	6.39 ab
P_1 S_4	19.5 a-c	34.5 b-f	34.1 b-j	3.23 a-f	5.35 a-c	5.18 g-m
P_1 S_5	19.4 a-c	34.4 b-f	35.8 a-g	3.27 a-f	4.98 a-j	5.24 f-m
P_1 S_6	21.0 a	34.5 f-g	36.2 a-f	3.62 a	4.62 d-l	6.07 a-e
P_1 S_7	20.3 a-c	31.0 f-g	31.0 ij	2.98 c-f	4.32 j-l	4.53 lm
P_2 S_1	19.8 a-c	32.7 c-g	32.6 ej	3.01 b-f	4.56 e-l	4.80 j-m
P_2 S_2	20.5 a-c	34.8 a-f	34.7 a-i	3.55 ab	5.00 a-j	6.00 a-f
P_2 S_3	20.2 a-c	36.4 a-d	36.5 a-f	3.45 a-c	5.29 a-d	6.32 a-c
P_2 S_4	19.7 a-c	33.0 c-g	34.7 a-i	3.26 a-f	4.49 f-l	5.24 f-m
P_2 S_5	19.1 a-c	34.2 b-f	35.6 a-g	3.42 a-d	4.64 c-l	5.30 e-l
P_2 S_6	20.1 a-c	35.6 a-e	34.5 b-j	3.32 a-f	4.62 d-l	5.94 a-g
P_2 S_7	19.3 a-c	30.2 g	32.1 g-j	2.88 ef	4.34 j-l	4.67 k-m
P_3 S_1	19.9 a-c	31.1 fg	31.8 h-j	3.04 b-f	4.11 kl	4.92 i-m
P_3 S_2	20.7 a-c	33.7 b-g	34.6 a-i	3.49 a-c	4.99 a-j	5.75 b-h
P_3 S_3	20.5 a-c	34.7 a-f	36.2 a-f	3.59 a	5.27 a-e	6.13 a-d
P_3 S_4	18.6 c	32.5 d-g	33.5 e-j	3.23 a-f	4.48 f-l	5.37 d-k
P_3 S_5	19.2 a-c	32.1 e-g	33.3 e-j	3.20 a-f	4.32 j-l	5.24 f-m
P_3 S_6	20.0 a-c	34.9 a-f	36.4 a-e	3.35 a-f	5.01 a-j	5.82 b-h
P_3 S_7	19.1 a-c	31.1 fg	30.8 j	2.82 f	4.39 g-l	4.60 k-m
P_4 S_1	19.1 a-c	31.0 fg	31.7 h-j	3.10 a-f	3.93 l	4.80 j-m
P_4 S_2	20.1 a-c	33.8 b-g	35.1 a-h	3.20 a-f	5.06 a-i	5.75 b-h
P_4 S_3	20.5 a-c	34.6 a-f	34.0 c-j	3.30 a-f	5.11 a-g	6.26 a-c
P_4 S_4	19.4 a-c	32.5 d-g	32.6 e-j	3.11 a-f	4.38 h-l	5.18 g-m
P_4 S_5	18.7 bc	32.1 e-g	33.6 e-j	3.13 a-f	4.20 kl	5.30 e-l
P_4 S_6	20.1 a-c	34.9 a-f	34.3 b-j	3.39 a-f	4.80 b-k	5.82 b-h
P_4 S_7	19.0 a-c	31.1 fg	32.4 f-j	2.91 d-f	4.33 j-l	4.47 m
P_5 S_1	19.9 a-c	33.1 c-g	34.0 c-j	3.17 a-f	4.72 b-k	5.05 h-m
P_5 S_2	21.0 a	37.2 ab	37.8 ab	3.55 ab	5.38 ab	5.94 a-g
P_5 S_3	20.8 ab	38.4 a	38.6 a	3.45 a-c	5.65 a	6.65 a
P_5 S_4	19.8 a-c	36.7 a-c	37.5 a-d	3.26 a-f	4.55 f-l	5.56 c-j
P_5 S_5	20.5 a-c	34.4 b-f	35.7 a-g	3.39 a-e	4.60 d-l	5.62 b-i
P_5 S_6	20.7 ab	34.8 a-f	35.3 a-h	3.49 a-c	5.20 a-f	6.39 ab
P_5 S_7	19.7 a-c	33.2 c-g	33.8 b-j	3.11 a-f	4.34 i-l	4.66 k-m
S.E.±	0.59	1.15	1.08	0.153	0.21	0.24

Note : Means followed by the same letter(s) in a column do not differ significantly by DMRT(P=0.05). DAS : Days after sowing

FYM cured DAP and seed priming with 2% SSP (P_5S_3) recorded higher grain yield of 1705 kg/ha which was significantly superior over other interactions except P_1S_2, P_1S_3, P_1S_5, P_1S_6, P_2S_2, P_2S_3, P_5S_1, P_5S_3, P_5S_4, P_5S_5 and P_5S_6 with which it was at par. While, the lowest yield was observed in P_4S_7 (1096 kg/ha) treatment combinations involving P application in the form of FYM and no seed treatment (Table 1).

The higher grain yield recorded in application of phosphorus through FYM cured DAP and seed priming with 2% SSP interaction (P_5S_3) was mainly due to increased number of pods per plant at 60 DAS (29.7) and at harvest (37.7), grain weight (16.09 g) and test weight (9.02 g) per plant (Table 2).

Significantly higher total dry matter (TDM) accumulation was observed in P_5S_3 interactions with a TDM of 1.48, 7.69 g and 13.04 g per plant, respectively at 30, 60 DAS and at harvest (Table 2). Significant increase in total dry matter accumulation in chickpea is dependent on the contribution from growth parameters. Significant increase in plant height, number of branches per plant, leaf area, leaf area index and leaf area duration at all stages of crop growth in P_5S_3 interaction compared to other interactions except P_1S_3, P_2S_2, P_2S_3, P_2S_6, P_5S_2 and P_5S_6 (Table 3 and 4).

The significant improvement in the sink size (Pods/pl, grain weight/pl, test weight etc.) could be due to increase in number of primary branches per plant, which resulted in development of more number of reproductive parts. These parameters have contributed for better dry matter partitioning and distribution into different plant parts. More leaf area, LAI, LAD and better dry matter partitioning have resulted in increased translocation of photosynthetes from source to sink in chickpea which received FYM cured DAP and seeds primed with 2 % SSP.

Chickpea is being cultivated under stored soil moisture during post rainy season where mineralization of soil organic matter and nutrient absorption are slow under such situations. Application of recommended dose of fertilizer in the form of DAP after curing with FYM for one week would enhance the availability of nutrient, their uptake and the crop yield. Further, there is a possibility of terminal drought under above situation, hence seed priming with either 2% SSP or 2% $CaCl_2$ or 5% cow urine could help in mitigating drought and increase the crop yield.

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