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# Nutrient uptake by weeds and pea as influenced by phosphorus and weed management

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**ABSTRACT**

Three $P_2O_5$ levels, *viz*. 0, 30 and 60 kg/ha were evaluated under six weed management practices, *viz.* weedy check, pendimethalin followed by (*fb*) hand weeding (HW), stale seedbed (SSB), SSB + pendimethalin *fb* HW, raised stale seedbed (RSSB) and RSSB + pendimethalin *fb* HW in pea during *Rabi* 2006-07 and 2007-08 on a silty clay loam soil at Palampur. *Phalaris minor*, *Vicia* sp. and *Polygonum alatum* were the major weeds found growing in association with peas. Stale seedbed and raised stale seedbed were significantly superior to weedy check in reducing total weed dry weight, weed growth rate, NPK depletion by weeds and increasing crop dry matter, crop growth rate (CGR), relative growth rate (RGR), NPK uptake by crop and subsequent radish yield. Superimposition of pendimethalin + hand weeding further improved the effectiveness of stale seedbed and raised stale seedbed in reducing total growth rate of weeds and NPK depletion by weeds and increasing crop dry matter, CGR, RGR, NPK uptake by crop and subsequent radish yield. Weeds in weedy check removed 39.3 and 53.6 kg N/ha, 16.5 and 16.6 kg P/ha and 24.1 and 27.4 kg K/ha during the first and second year, respectively. All weed control methods being at par resulted in significantly higher available P content after pea harvest. Weed dry weight and growth rate of weeds, NPK uptake by green pods and straw of pea, nodules/plant, available soil N and P after harvest of pea and subsequent radish yield increased with increase in the rate of P. NPK depletion by weeds, crop dry weight, CGR and RGR increased upto 30 kg $P_2O_5$/ha.

**Key words**: Hand weeding, Nutrient uptake, Pendimethalin, Peas, Phosphorus, Stale seedbed

Pea is one crop, which builds up the soil fertility by atmospheric nitrogen fixation through the root nodules. Besides residual effect on soil fertility, pea has great potential as an exceptionally nutritive and very rich protein food. However, it has higher requirement of phosphorus for symbiotic nitrogen fixation. However, weeds are the major threat in harnessing the full potential of applied and native plant nutrients. They remove considerable amount of nutrients and adversely affect the yield of the crops (Kumar *et al*. 2005). Rana *et al.* (2013) reported 56.8 - 60.1% reduction in peas green pod yield due to full season weed competition. In order to achieve enhanced crop production and higher benefits from applied inputs, there must be a strong weed management strategy. Thus, the judicious management of weeds through integrated weed management practices is imperative to enhance the nutrient use efficiency. Stale seedbed is useful in depleting the weed seed pool (Rasmussen 2004). Raised stale seedbed has an added advantage of easy planting because the soil on a raised bed warms up and dries out faster, better drainage eliminating the problems of water stagnation too close to the plant roots, fewer diseases and easy irrigation by simply running water between the beds and allowing water to seep into the root zone and ultimately enhancing the nutrient use efficiency. The subsequent flushes of weeds after sowing of the crop may be controlled with herbicidal weed management (Rana *et al*. 2004, 2007). Therefore, present study was conducted to work out nutrient removal by weeds and crops as influenced by P levels in relation to weed management methods.

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## MATERIALS AND METHODS

The field experiment was conducted during *Rabi* 2006-07 and 2007-08 at Bhadiarkhar farm (Palampur). The soil of the experimental field was silty clay loam in texture, acidic in reaction (pH 5.2) and medium is available N (313.6 kg/ha) and K (202.1 kg/ha) and high in P (25.7 kg/ha). The experiment was conducted in split plot design with four replications. Six weed control treatments, *viz.* weedy check, pendimethalin *fb* hand weeding (HW), stale seedbed (SSB), SSB + pendimethalin *fb* HW, raised stale seedbed (RSSB), and RSSB + pendimethalin *fb* HW were accommodated in main plots while three $P_2O_5$ levels, *viz.* 0. 30 and 60 kg/ha in the sub-plots (Table 1). Sowing of pea variety '*Palampriya*' was done during the second fortnight of November using 75 kg/ha seed rate in a row to row spacing of 30 cm. Application of herbicides was made with power sprayer using 700 L water per hectare. Except weed control treatments and phosphorus, the crop was raised in accordance with the recommended package of practices. In addition to $P_2O_5$ as per the treatment, the crop was fertilized with 20 kg N, and 40 kg $K_2O$/ha as basal dose. Required amount of N, P and K was supplied through urea, single super phosphate and muriate of potash, respectively. Weed dry weight was recorded at 60, 90, 120 DAS and at harvest from two randomly selected spots (0.25 $m^2$) in each plot and expressed as g $m^{-2}$. The data on dry weight of weeds were subjected to square root transformation ($\sqrt{x + 0.5}$). Yields were harvested from net plot (4.0 x 2.3 m). Oven dried samples of weeds, green pods and straw were analyzed for N, P (Jackson 1967) and K (Black 1965) content as per standard procedures. Uptake of N, P and K by weeds, pods and straw was obtained by multiplying their nutrient content with corresponding dry matter. Total uptake by crop was obtained by adding the uptake by pods and straw. Radish variety '*Pusa Chetki*' was also grown after the harvest of peas in the residual fertility using manual weed control.

## RESULTS AND DISCUSSION

*Phalaris minor* (60.9 and 64.4% of the total weed flora during 2006-7 and 2007-8, respectively), *Vicia* sp. (20.4 and 19.8%) and *Polygonum alatum* (15.2 and 13.6%) were the major weeds found growing in association with pea crop. The other weeds (*Lathyrus aphaca*, *Spergula arvensis* and *Avena ludoviciana*) as a whole constituted 3.5 and 2.2% of the total weed flora during the first and second year, respectively.

### Weed control methods

Weed control treatments brought about significant variation in total weed dry weight (120 DAS) during both the year (Table 1). Stale seedbed and raised stale seedbed where one flush of the weeds was destroyed before sowing of pea, were significantly superior to weedy check in reducing total weed dry weight upto 120 DAS during both the year. Depleting the weed seed pool in the top few centimeters of soil by such practices as stale seedbed has been reported quite effective in different crops by a number of workers (Kumar *et al.* 2003, Kumar *et al*. 2005). However, these had higher weed dry weight as compared to pendimethalin + hand weeding. Superimposition of pendimethalin + hand weeding further improved the effectiveness of stale seedbed and raised stale seedbed in reducing total weed dry weight during both the year. Superiority of pendimethalin 1.0 kg/ha in controlling weeds in pea + maize intercropping system on raised seedbed has been reported (Singh *et al.* 2012). The trend in weed growth rate between 60-90 DAS was similar as it was for weed dry weight during both the year. Weed control treatments significantly affected RGR of weeds during 2006-07. Stale or raised stale seedbed alone could not bring down the weed RGR between 60-90 DAS over weedy check. However, pendimethalin + hand weeding alone and along with stale/raised seedbed resulted in significant reduction in the RGR of weeds over the weedy check as well as stale or raised stale seedbed. Superiority of pendimethalin + hand weeding against weeds has been documented (Vaishya *et al.* 1999).

Nutrient uptake is a function of dry weight and nutrient content is expected to follow the trend of dry weight influenced by the content. Like weed dry

**Table 1. Effect of weed control methods and P levels on weed dry weight (g/$m^2$), weed growth rate (g/$m^2$/day) and weeds RGR (g/g/day) in peas**

| Treatment | Weed dry weight (120 DAS) | | Weed growth rate (60-90 DAS) | | Weed RGR (60-90 DAS) | |
|---|---|---|---|---|---|---|
| | 2006-07 | 2007-08 | 2006-07 | 2007-08 | 2006-07 | 2007-08 |
| *Weed control method* | | | | | | |
| Weedy | 301.9 | 340.2 | 8.5 | 9.7 | 0.09 | 0.08 |
| Pendimethalin + HW | 135.8 | 133.6 | 3.7 | 2.5 | 0.08 | 0.04 |
| Stale seedbed (SSB) | 237.0 | 256.2 | 6.8 | 5.9 | 0.09 | 0.07 |
| SSB + pendimethalin + HW | 74.0 | 50.0 | 1.8 | 1.8 | 0.07 | 0.06 |
| Raised stale seedbed (RSSB) | 233.7 | 233.0 | 6.7 | 5.8 | 0.09 | 0.07 |
| RSSB + pendimethalin + HW | 65.3 | 50.8 | 1.6 | 1.4 | 0.07 | 0.05 |
| LSD (P=0.05) | 51.8 | 56.3 | 1.5 | 1.8 | 0.01 | NS |
| *$P_2O_5$ (kg/ha)* | | | | | | |
| 0 | 130.9 | 150.2 | 3.5 | 3.5 | 0.08 | 0.06 |
| 30 | 178.6 | 185.2 | 5.0 | 4.6 | 0.08 | 0.06 |
| 60 | 214.4 | 196.5 | 6.0 | 5.5 | 0.08 | 0.07 |
| LSD (P=0.05) | 25.8 | 31.2 | 0.7 | 0.8 | NS | NS |

weight, weed control treatments brought about significantly variation in N, P and K uptake by weeds during both the years (Table 2). Weeds in weedy check removed 39.3 and 53.6 kg N/ha during the first and second year, respectively. All weed control treatments were significantly superior to weedy check in reducing N depletion by weeds. Pendimethalin *fb* hand weeding alone and along with stale/raised seedbed resulted in significant reduction in N depletion by weeds over the weedy check as well as stale or raised stale seedbed. Weeds in weedy check took 16.5 and 16.6 kg P/ha from soil during the first and second year, respectively. Except stale/ raised stale seedbed all other weed control treatments had significantly brought down P depletion by weeds over weedy check. Integration of pendimethalin + hand weeding with the stale/raised stale seedbed was significantly better than pendimethalin + hand weeding alone in reducing P depletion by weeds. Uninterrupted growth of weeds in the weedy check removed 24.1 and 27.4 kg K/ha during the first and second year, respectively. Stale/raised stale seed bed was significantly superior to weedy check in reducing K depletion by weeds. Pendimethalin *fb* hand weeding was superior to both of these. In integration with stale/raised stale seedbed, pendimethalin *fb* hand weeding further significantly reduced K depletion by weeds over its application alone.

Controlling one flush of weeds before sowing peas under the stale or the raised stale seedbeds resulted in significantly higher crop dry matter accumulation, crop growth rate (CGR) and relative growth rate (RGR) over the weedy check (Table 3). The subsequent suppression of other flushes with pendimethalin fb hand weeding gave further boost in crop dry matter accumulation, crop growth rate and relative growth rate. The superiority of pendimethalin in peas has been reported (Rana *et al*. 2004, 2007). The nodule count, however, was not significantly influenced under different weed management treatments (Table 5).

**Table 2. Effect of weed control methods and P levels on NPK uptake (kg/ha) by weeds**

| Treatment | N | | P | | K | |
|---|---|---|---|---|---|---|
| | 2006-07 | 2007-08 | 2006-07 | 2007-08 | 2006-07 | 2007-08 |
| *Weed control method* | | | | | | |
| Weedy | 39.3 | 53.6 | 16.5 | 16.6 | 24.1 | 27.4 |
| Pendimethalin + HW | 15.3 | 18.1 | 10.2 | 8.2 | 9.7 | 9.7 |
| Stale seedbed (SSB) | 34.3 | 45.8 | 20.6 | 19.3 | 16.6 | 17.8 |
| SSB + pendimethalin + HW | 12.2 | 9.9 | 4.7 | 2.9 | 5.3 | 3.5 |
| Raised stale seedbed (RSSB) | 30.0 | 36.0 | 17.0 | 15.1 | 15.8 | 15.9 |
| RSSB + pendimethalin + HW | 10.1 | 9.7 | 4.9 | 3.2 | 4.7 | 3.6 |
| LSD (P=0.05) | 6.2 | 7.6 | 5.0 | 4.2 | 2.2 | 3.0 |
| *$P_2O_5$ (kg/ha)* | | | | | | |
| 0 | 19.3 | 26.6 | 9.3 | 9.5 | 9.3 | 10.4 |
| 30 | 24.4 | 30.4 | 13.2 | 11.9 | 13.6 | 14.3 |
| 60 | 26.9 | 29.5 | 14.5 | 11.2 | 15.2 | 14.3 |
| LSD (P=0.05) | 4.3 | NS | 4.1 | NS | 2.4 | 3.3 |

**Table 3. Effect of weed control methods and P levels on growth of crop**

| Treatment | Crop dry weight | | CGR (30–60 DAS) ($g/m^2$/day) | | RGR (30–60 DAS) (g/g/day) | |
|---|---|---|---|---|---|---|
| | 2006-07 | 2007-08 | 2006-07 | 2007-08 | 2006-07 | 2007-08 |
| *Weed control method* | | | | | | |
| Weedy | 126.4 | 117.4 | 0.67 | 0.81 | 0.01 | 0.02 |
| Pendimethalin + HW | 200.0 | 179.6 | 1.32 | 1.08 | 0.01 | 0.01 |
| Stale seedbed (SSB) | 182.7 | 183.3 | 1.86 | 2.13 | 0.01 | 0.02 |
| SSB + pendimethalin + HW | 261.5 | 246.1 | 2.67 | 2.15 | 0.02 | 0.02 |
| Raised stale seedbed (RSSB) | 185.4 | 177.1 | 1.87 | 1.70 | 0.01 | 0.02 |
| RSSB + pendimethalin + HW | 267.6 | 251.2 | 3.74 | 3.61 | 0.02 | 0.03 |
| LSD (P=0.05) | 32.1 | 33.2 | 1.2 | 1.1 | 0.005 | 0.001 |
| *$P_2O_5$ (kg/ha)* | | | | | | |
| 0 | 183.7 | 169.7 | 1.40 | 1.42 | 0.01 | 0.02 |
| 30 | 206.1 | 204.6 | 2.57 | 2.31 | 0.02 | 0.02 |
| 60 | 222.0 | 203.0 | 2.10 | 2.01 | 0.02 | 0.02 |
| LSD (P=0.05) | 19.0 | 11.5 | 0.5 | 0.4 | 0.002 | 0.002 |

The crop having higher growth rate is expected to have higher nutrients assimilation by it. Stale or the raised stale seedbeds because of having higher dry matter accumulation resulted in significantly higher N, P and K uptake by pea crop over the weedy check (Table 4) during the first year. However, in the second year, raised stale seed could not significantly increase NPK uptake by crop over the weedy check. Because of higher dry matter accumulation, stale/raised stale seedbeds in integration with pendimethalin + hand weeding were further superior to other treatments in general.

The available N after the first year was not significantly affected under the weed control treatments. The initial available N content before sowing peas was 313.6 kg/ha. The available soil N content ranged from 328.0 to 334.5 kg/ha under the treatments. The gain in N content ranges from 14.4-20.9 kg/ha which may be referred to as the part of atmospheric nitrogen fixation under the prevailing circumstances. The minimum of 14.4 kg/ha was under the weedy check and maximum 20.9 kg/ha under pendimethalin alone and along with stale/raised stale seedbeds. Weed control methods brought about significant variation in the soil available P status after the harvest of peas. All weed control methods being at par resulted in significantly higher available P content after pea harvest. Residual effects of P were also significant on the yield of radish cultivated (clean cultivation-weed free) after the harvest of peas. All weed control methods resulted in significantly higher radish yield over weedy check. Stale/raised stale seed bed had significantly higher yield over weedy check. Pendimethalin + hand weeding alone and its imposition in stale/raised stale seedbed had further higher yield over stale/raised stale seedbed. This clearly indicated that weeds not only have direct effect on the growth, development and yield of the present crop but had subsequent after effects.

**Phosphorus**

The data on weed dry weight, weed growth rate and weed RGR as affected by phosphorus levels have been given in Table 1. Phosphorus application could bring about significant variation in the dry weight and growth rate of weeds. Both weight and growth rate of weeds were significantly higher under P application over no application of P. Weed weight during the first year and growth rate during both the years increased with increase in the application rate of

**Table 4. Effect of weed control methods and P levels on NPK uptake by crop**

| Treatment | N (kg/ha) | | | P (kg/ha) | | | K (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Pod | Haulm | Total | Pod | Haulm | Total | Pod | Haulm | Total |
| | | | | 2006-07 | | | | | |
| *Weed control method* | | | | | | | | | |
| Weedy | 15.5 | 1.4 | 16.9 | 5.8 | 0.6 | 6.4 | 10.4 | 1.3 | 11.6 |
| Pendimethalin + HW | 33.6 | 3.5 | 37.1 | 12.3 | 1.3 | 13.7 | 21.7 | 2.9 | 24.5 |
| Stale seedbed (SSB) | 37.9 | 4.2 | 42.2 | 13.6 | 1.6 | 15.2 | 19.9 | 3.3 | 23.5 |
| SSB + pendimethalin + HW | 41.4 | 4.7 | 46.1 | 15.4 | 1.9 | 17.3 | 23.3 | 3.8 | 27.0 |
| Raised stale seedbed (RSSB) | 28.5 | 3.6 | 32.1 | 11.0 | 1.4 | 12.4 | 15.2 | 2.7 | 17.9 |
| RSSB + pendimethalin + HW | 46.3 | 4.8 | 51.1 | 17.0 | 1.8 | 18.8 | 27.5 | 4.2 | 30.8 |
| LSD (P=0.05) | 9.9 | 1.0 | 10.7 | 3.3 | 0.4 | 3.6 | 5.6 | 1.0 | 5.5 |
| *$P_2O_5$ (kg/ha)* | | | | | | | | | |
| 0 | 25.8 | 2.6 | 28.4 | 9.9 | 1.1 | 11.0 | 16.9 | 2.5 | 19.3 |
| 30 | 36.3 | 4.0 | 40.3 | 13.2 | 1.5 | 14.6 | 20.0 | 3.1 | 22.9 |
| 60 | 39.6 | 4.5 | 44.1 | 14.5 | 1.7 | 16.2 | 22.0 | 3.5 | 25.5 |
| LSD (P=0.05) | 3.4 | 0.6 | 3.8 | 0.9 | 0.1 | 1.1 | 2.2 | 0.4 | 2.1 |
| | | | | 2007-08 | | | | | |
| *Weed control method* | | | | | | | | | |
| Weedy | 6.0 | 1.5 | 7.6 | 1.8 | 0.5 | 2.3 | 4.3 | 1.5 | 5.8 |
| Pendimethalin + HW | 15.5 | 4.9 | 20.4 | 4.3 | 1.5 | 5.8 | 9.7 | 4.0 | 13.8 |
| Stale seedbed (SSB) | 19.5 | 6.5 | 26.0 | 5.7 | 2.0 | 7.7 | 10.5 | 5.2 | 18.7 |
| SSB + pendimethalin + HW | 17.2 | 6.3 | 23.5 | 5.2 | 2.1 | 7.3 | 10.2 | 4.8 | 16.5 |
| Raised stale seedbed (RSSB) | 7.4 | 2.7 | 10.1 | 2.2 | 0.8 | 3.1 | 4.2 | 2.2 | 6.4 |
| RSSB + pendimethalin + HW | 21.5 | 6.6 | 28.1 | 6.5 | 2.1 | 8.6 | 13.3 | 5.9 | 20.6 |
| LSD (P=0.05) | 4.1 | 2.1 | 5.9 | 1.3 | 0.8 | 2.1 | 2.8 | 2.1 | 4.1 |
| *$P_2O_5$ (kg/ha)* | | | | | | | | | |
| 0 | 10.2 | 3.2 | 13.4 | 3.3 | 1.1 | 4.4 | 6.9 | 3.1 | 10.8 |
| 30 | 15.4 | 4.9 | 20.3 | 4.4 | 1.5 | 5.8 | 8.8 | 3.9 | 13.4 |
| 60 | 17.9 | 6.3 | 24.2 | 5.3 | 2.0 | 7.2 | 10.3 | 4.9 | 16.6 |
| LSD (P=0.05) | 2.2 | 1.0 | 3.0 | 0.6 | 0.3 | 0.8 | 1.3 | 0.7 | 2.3 |

**Table 5. Effect of weed control methods and P levels on available nutrients after harvest**

| Treatment | Nodule count (no/plant) | N (kg/ha) 2006-07 | P (kg/ha) 2006-07 | Radish yield (t/ha) |
|---|---|---|---|---|
| *Weed control method* | | | | |
| Weedy | 21.2 | 328.0 | 26.3 | 1.9 |
| Pendimethalin + HW | 19.6 | 334.5 | 31.1 | 5.9 |
| Stale seedbed (SSB) | 21.8 | 331.1 | 30.5 | 4.4 |
| SSB + pendimethalin + HW | 21.6 | 334.5 | 31.6 | 6.2 |
| Raised stale seedbed (RSSB) | 21.5 | 330.6 | 30.4 | 3.3 |
| RSSB + pendimethalin + HW | 21.1 | 334.5 | 31.5 | 6.7 |
| LSD (P=0.05) | NS | NS | 2.2 | 1.3 |
| *$P_2O_5$ (kg/ha)* | | | | |
| 0 | 18.0 | 322.3 | 28.0 | 4.3 |
| 30 | 20.8 | 332.5 | 30.6 | 4.8 |
| 60 | 24.7 | 341.7 | 32.0 | 5.1 |
| LSD (P=0.05) | 0.7 | 7.6 | 0.7 | 0.4 |

**Table 6. Integrated effect of weed control methods and phosphorus levels on weed dry weight (120 DAS, transformed) and green pod yield**

| Treatment | 2006-07 | | | 2007-08 | | | Mean | | |
|---|---|---|---|---|---|---|---|---|---|
| | $P_0$ | $P_{30}$ | $P_{60}$ | $P_0$ | $P_{30}$ | $P_{60}$ | $P_0$ | $P_{30}$ | $P_{60}$ |
| *Weed dry weight (g/m$^2$)* | | | | | | | | | |
| Weedy | 15.3 (234.0) | 17.3 (298.5) | 19.3 (373.2) | 16.8 (283.2) | 18.3 (341.3) | 19.8 (396.1) | 16.0 (258.6) | 17.8 (319.9) | 19.6 (384.7) |
| Pendimethalin + HW | 10.0 (104.0) | 10.6 (114.8) | 13.2 (188.5) | 10.3 (109.4) | 11.6 (140.9) | 11.9 (150.5) | 10.2 (106.7) | 11.1 (127.8) | 12.6 (169.5) |
| Stale seedbed (SSB) | 13.8 (192.6) | 15.3 (235.5) | 16.6 (283.0) | 17.1 (292.6) | 15.6 (242.1) | 15.2 (234.1) | 15.6 (242.6) | 15.4 (238.8) | 15.9 (258.6) |
| SSB + pendimethalin + HW | 8.9 (80.1) | 8.1 (65.5) | 8.7 (76.6) | 6.6 (46.0) | 7.1 (51.2) | 7.2 (52.9) | 7.9 (63.0) | 7.6 (58.3) | 8.0 (64.7) |
| Raised stale seedbed (RSSB) | 10.9 (118.5) | 16.7 (280.5) | 17.4 (302.1) | 11.5 (135.8) | 16.4 (272.6) | 17.0 (290.7) | 11.2 (127.1) | 16.6 (276.6) | 17.2 (296.4) |
| RSS + pendimethalin + HW | 7.5 (56.5) | 8.7 (76.5) | 7.9 (63.0) | 5.9 (34.2) | 7.9 (63.1) | 7.3 (55.0) | 6.8 (45.3) | 8.3 (69.8) | 7.7 (59.0) |
| LSD (P=0.05) (1) | 2.0 | | | 2.5 | | | 2.0 | | |
| (2) | 2.3 | | | 2.6 | | | 2.3 | | |
| *Green pod yield (t/ha)* | | | | | | | | | |
| Weedy | 1.48 | 1.78 | 1.55 | 1.55 | 1.84 | 1.97 | 1.52 | 1.81 | 1.76 |
| Pendimethalin + HW | 2.76 | 3.62 | 3.63 | 2.52 | 3.51 | 3.46 | 2.64 | 3.57 | 3.54 |
| Stale seedbed (SSB) | 3.08 | 3.69 | 3.73 | 3.22 | 4.70 | 4.46 | 3.15 | 4.19 | 4.10 |
| SSB + pendimethalin + HW | 3.80 | 4.07 | 4.22 | 3.41 | 4.90 | 5.41 | 3.60 | 4.48 | 4.82 |
| Raised stale seedbed (RSSB) | 2.05 | 2.72 | 3.66 | 2.26 | 2.61 | 3.30 | 2.15 | 2.67 | 3.48 |
| RSSB + pendimethalin + HW | 4.16 | 4.54 | 5.35 | 4.14 | 4.78 | 4.84 | 4.15 | 4.66 | 5.09 |
| LSD (P=0.05) (1) | 0.60 | | | 0.63 | | | 0.47 | | |
| (2) | 1.08 | | | 0.74 | | | 0.50 | | |

Data given in parentheses are the means of original values subjected to square root transformation $\sqrt{x+0.5}$; LSD - (1), P level at the same weed control method; LSD - (2), Weed control method at the same or different P level.

P. Owing to higher dry weight due to P application, N and P depletion during the first year and K depletion by weeds during both years were increased with increase in the rate of P upto 30 kg/ha (Table 2).

Phosphorus is an indispensable nutrient in legumes because of its key role in nitrogen fixation. Therefore, increasing crop dry weight, CGR and RGR due to P application was quite obvious over its no application (Table 3). However, 30 and 60 kg $P_2O_5$/ha levels were statistically at par with each other in influencing crop dry weight, CGR and RGR of pea crop. The increase in growth and yield attributes of pea owing to phosphorus application over no phosphorus application has been amply documented (Dass *et al.* 2005). The accumulated amount of growth due to phosphorus was the result of higher assimilation of applied and native plant nutrients. N, P and K uptake by the economic and byproducts of peas and of total thereof was in general increased with increase in the dose of P (Table 4). The role of phosphorus in fixing atmospheric nitrogen is clearly visible through data on nodule count presented in Table 5, which revealed that they have increased with increase in the level of $P_2O_5$. Improved growth/yield due to P was also observed by several workers (Aga *et al*. 2004, Dass *et al*. 2005). Available soil N and P status after the harvest of peas crop increased with increase in the dose of phosphorus. Similarly, residual effects of P were significant on radish yield which showed increase in its yield with increase in the level of P.

### Interaction

Weed control methods interacted significantly with phosphorus levels for weed dry weight accumulation at 120 DAS (Table 6). Under weedy check, pendimethalin + hand weeding, stale seedbed and raised stale seedbed, phosphorus application resulted in higher weed dry weight over no phosphorus application. The weed dry weight in general increased with increase in the level of phosphorus. But under stale seedbed *fb* pendimethalin + hand weeding or raised stale seedbed *fb* pendimethalin fb hand weeding, weed dry weight was more or less similar under phosphorus application and no phosphorus application. In each phosphorus level, all weed control treatments were significantly superior to weedy check. However, weed dry weight under the stale/raised stale seedbed with P application was statistically at par to that under weedy check without phosphorus application.

Weed control and phosphorus levels also interacted significantly for green pod yield (Table 6). It was clearly evident that under the weedy check phosphorus application favoured weed growth at the cost of green pod yield as P application here could not significantly increase yield over no P application. However, under other treatments where weed competition was lower at the critical period of competition, phosphorus application gave significantly higher yield over no phosphorus application.

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