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Jitendra Kumar
Ph.D. Research Scholar, Department of Agronomy, R.B.S. College, Bichpuri, Agra, Uttar Pradesh, India

Sant Bahadur Singh
Professor& Head, Department of Agronomy, R.B.S. College, Bichpuri, Agra, Uttar Pradesh, India

Corresponding Author:
Sant Bahadur Singh
Professor& Head, Department of Agronomy, R.B.S. College, Bichpuri, Agra, Uttar Pradesh, India

Effect of nutrient and weed management on growth, yield and nutrient uptake of field pea [*Pisum sativum* L. var. *arvense*]

Jitendra Kumar and Sant Bahadur Singh

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Abstract
Pulses are important for the nutritional security point of view of the cereal based vegetarian diet of large scale of country. India is the largest producer, consumer and importer of pulses in the world. It has been projected that 32 million tonnes of total pulse requirement for the burgeoning population of India, which will grow to 1.69 billion by 2050. To attain up to this level an annual growth rate of 2.2% is required. The demand for pulses continues to grow at 2.8% per annum. Although challenges are diverse including climate changing scenario, decreasing land and water resources, this target is not unattainable. Increasing the average productivity of pulses to > 1200 kg ha^{-1} and bringing an additional area of about 3.5 million hectare under pulses cultivation will be a concrete step in this direction. In order to study the effect of different nutrient and weed management practices a field experiment, entitled "Effect of Nutrient and Weed management on growth, yield and nutrient uptake of field pea (*Pisum sativum* L. var. *arvense*)" was conducted at the Agricultural Research Farm (Department of Agronomy), Raja Balwant Singh College, Bichpuri (Agra) during *Rabi* seasons of 2021-22 and 2022-23 with the objectives, to study the effect of nutrient management on yield and quality of field pea, to find out the suitable nutrient and weed management for field pea and to study the economic feasibility of the treatments. Experiment was laid out using two factor *viz.*, main plot treatments (4): NM_0-Control, NM_1-100% RDF (20:40:20 NPK kg ha^{-1}), NM_2-75% RDF + 2 t FYM ha^{-1}, NM_3-75% RDF + 2 t FYM ha^{-1} + *Rhizobium* + *PSB* and sub plot treatments (5): WM_0-Unweeded, WM_1-Weed free, WM_2-Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS, WM_3-Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS, WM_5-Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS. The treatments were replicated thrice and laid out under split plot design (SPD). Highest per plant studies and yield attributes *viz.*, number of plants per running metre, number of pods plant^{-1}, number of grains pod^{-1}, seed weight (g), shelling percent and number of pods plant^{-1}, weight of pods plant^{-1} (g), length of pods plant^{-1} (cm), number of grains plant^{-1}, biological yield plant^{-1} (g), grain yield plant^{-1} (g) and straw yield plant^{-1} (g) of field pea has been achieved with the application of 75% RDF + 2 t FYM ha^{-1} + *Rhizobium* + *PSB* with weed control using pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS during first year, second year and pooled respectively. The data pertaining to the qualitative studies *viz.*, nutrient content (N P K %), protein (%) and protein yield (kg ha^{-1}) in grain and straw, nutrient uptake (N P K kg ha^{-1}) by grain and straw are presented in table 4 to 7.
The data related to weed studies *viz.*, weed density of broad leaved weeds (no. m^{-2}), weed density of grassy weeds (no. m^{-2}), weed density of sedges (no. m^{-2}), total weed density (no. m^{-2}), number of weed species (m^{-2}), fresh & dry weight of weeds (g m^{-2}) and weed control efficiency (WCE %) are presented in tables from 8 to 12 during both the year of experimentation. Highest productivity of field pea have been achieved with the application of 75% RDF + 2 t FYM ha^{-1} + *Rhizobium* + *PSB* with weed control using pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS and the maximum net returns was fetched when nutrient management was done by application of 75% RDF + 2 t FYM ha^{-1} + *Rhizobium* + *PSB* and weeds were controlled with pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS. But, Maximum B: C ratio was fetched when nutrient management was done by application of 75% RDF + 2 t FYM ha^{-1} + *Rhizobium* + *PSB*, (2.06, 2.27 and 2.16) and weeds were controlled by Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS, (2.16, 2.36 and 2.26) during first year, second year and pooled respectively.

Keywords: Pea, field pea, yield and yield attributes, per plant studies, weed, herbicide, nutrient management and weed management

Introduction
Pulses are rich source of protein (20 to 25%), ability to fix atmospheric nitrogen (30-150 kg ha^{-1}) and consistent source of income and employment to small and marginal farmers; and thus hold a premier position in the world agriculture. The United Nations declared 2016 as "International Year of pulses" with the objectives of increasing production and consumption of pulses by 10% by 2020 and creating awareness of benefits of pulses by utilizing social media. In India, pulses constitute a group of 12 crops that include mainly pigeonpea (*Cajanus cajan* L.), chickpea (*Cicer arietinum* L.), mungbean (*Vigna radiata* L. *wilczek*), urdbean (*Vigna mungo* L. *Hepper*), lentil (*Lens culinaris* L.) and field pea (*Pisum sativum* L.). Field pea, one of the important pulse

crop of winter season has great potential to contribute to the pulse basket in India. It provides protein rich food for majority of Indians. The major constraints that hinder the realization of potential yield of field pea in our country are well known. These include unavailability of the quality seeds of improved varieties in required quantities, traditional cultivation practices, inadequate supply of nutrients, improper weed management, biotic and abiotic stresses prevailing in the field pea growing areas besides the social and economic factors, the integrated approach of nutrient supply by chemical fertilizers along with bio-fertilizers is gaining importance, as this system not only reduces the excessive use of inorganic fertilizers, but also sustains the crop productivity by improving soil health besides being an environment friendly approach. Integration of inorganic fertilizers and biofertilizers resulted in better growth, yield and nutrient uptake in field pea. This study was aimed to evaluate the effect of integrated application of bio-fertilizers and inorganic (Jackson, 1973) [20].

Integrated crop management is one of the ways which increases the production as well as sustainability. Amongst the different agro-techniques required to raise the production of field pea, a timely carried out crop management has emerged as one of the major constraints of production. In recent years due to increased labour cost and their non-availability for weeding, insect-pest and disease management at peak requirement, the use of integrated crop management in field pea is indispensable. Integrated crop management is a pragmatic approach to the production of crops. Unlike integrated pest management which focuses on crop protection, integrated crop management includes more aspects. Yield of field pea can be increased by adopting improved varieties, nutrient management, weed management, integrated pest management module (Ali and Kumar, 2007) [4]. An integrated weed management may be defined as the combination of two or more weed-control methods at low input levels to reduce weed competition in a given cropping system below the economical threshold level. IWM involves the utilization of a combination of mechanical, chemical, cultural and biological practices of weed management in a planned sequence, so designed as not to affect the ecosystem. IWM is a science-based decision-making process that co-ordinates the use of environmental information, weed biology and ecology, all available technologies to control weeds by the most economical means, while posing the least possible risk to people and the environment. The information on nutrient and weed management of pulses especially on field pea is quite meager. Therefore, to understand the integrated crop management in relation to field pea variety for maximization of yield, the experiment was conducted at the Agricultural Research Farm of Raja Balwant Singh College, Bichpuri (Agra) during *Rabi* seasons of 2021-22 and 2022-23 to study the Effect of Nutrient and Weed management on growth, yield and nutrient uptake of field pea (*Pisum sativum* L. var. *arvense*).

Materials and Methods

The present field experiment, entitled "Effect of Nutrient and Weed management on growth, yield and nutrient uptake of field pea (*Pisum sativum* L. var. *arvense*)" was conducted at the Agricultural Research Farm (Department of Agronomy), Raja Balwant Singh College, Bichpuri (Agra) during *Rabi* seasons of 2021-22 and 2022-23 with the objectives, to study the effect of nutrient management on yield and quality of field pea, to find out the suitable nutrient and weed management for field pea and to study the economic feasibility of the treatments. Agricultural Research Farm, of Raja Balwant Singh College, Agra which is situated at the distance of about 11 km away from Agra city on Agra-Bharatpur road at an elevation (altitude) of 163.4 metre above mean sea level with 27.2° N latitude and 77.9° E longitude with all required facilities for cultivation of above mentioned experiment crop. The region has a semi-arid and sub – tropical climate with hot and dry summers and severe cold winters. The soil of the experimental field was gangetic alluvial with calcareous layer at the depth of about 1.5 m to 2.0 m and was well drained. To know the exact nature and physico- chemical properties of the experimental soil, a composite soil sample from the surface of soil (0-15 cm depth) was taken before application of fertilizers and sowing of the experimental plot with the help of an auger and subjected to mechanical and chemical analysis. Soil of experimental site was deficient in available total nitrogen (192.40 kg ha^{-1} N) was determined by Alkaline permanganate method (A.O.A.C., 1960) [1], low in organic carbon (0.44%) was determined by Walkley and Black's method (Jackson, 1973) [20]; medium in available phosphorus (26.42 kg ha^{-1} P_2O_5) was determined by Olsen's method (Olsen *et al.*, 1954) [32] and fairly rich in potassium (204.20 kg ha^{-1} K_2O) was determined by Ammonium acetate method (Jackson, 1973) [20] content and soil pH (7.62) was determined by Method No. 21(b) USDA Handbook No. 60 (Richards, 1954) [40], Electrical conductivity (0.35 dSm^{-1}) was determined by Electrical conductivity bridge (Richards, 1954) [40], bulk density (1.41) and particle density (2.61) was determined by Method of soil analysis part 1. Physical and mineralogical method (Blake and Hartge, 1986) [10], the soil was slightly alkaline in reaction. Experiment was laid out using two factor *viz.*, main plot treatments (4): NM_0-Control, NM_1-100% RDF (20:40:20 NPK kg ha^{-1}), NM_2-75% RDF + 2 t FYM ha^{-1}, NM_3-75% RDF + 2 t FYM ha^{-1} + *Rhizobium* + *PSB* and sub plot treatments (5): WM_0-Unweeded, WM_1-Weed free, WM_2-Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS, WM_3-Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS, WM_5-Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS. The treatments were replicated thrice and laid out under split plot design (SPD). The seed material of variety Jay (KPMR-522) was sown @ 80 kg ha^{-1} (120 g sub^{-1} plot) in furrows 30 cm apart of the depth of 7-10 cm with the help of kudali and was covered by light planking. The observations on yield and yield attributing characters were recorded manually on four (tagged plants) randomly selected representative plants from each plot of each replication separately as well as per plant studies were recorded as per the standard method. The seed and straw yield was recorded from net plot area of each treatment. Above ground plant parts harvested from net plot (Gross plot: 5.0 × 3.0 and Net plot: 4.0 × 2.40 m) area including the grain and straw were carefully bundled, tagged and taken to the threshing floor separately. The individual bundle was weighed after complete drying in the sun before threshing and weighed in kg $plot^{-1}$ then converted in to quintal ha^{-1} by multiplying with conversion factor *i.e.* 10.416. Total biomass of net plot was threshed out by manual labour and grains were separated by winnowing and weighed in kg $plot^{-1}$ then converted in to quintal ha^{-1} by multiplying with conversion factor *i.e.* 10.416. This calculated by subtracting grain yield (q ha^{-1}) from total biological yield (q ha^{-1}). Harvest index was calculated as per the formula suggested by Donald (1962) [18]. The data pertaining to the qualitative studies *viz.*, nutrient content (N P K %), protein (%) and protein yield (kg ha^{-1}) in grain and straw, nutrient uptake (N P K kg ha^{-1}) by grain and straw were recorded as per the standard method given by (Chapman and Pratt, 1961) [12], (Piper, 1996) [36] and (Jones, 1941) [21]. The data related to weed studies *viz.*, weed density of

broad leaved weeds (no. m^{-2}), weed density of grassy weeds (no. m^{-2}), weed density of sedges (no. m^{-2}), total weed density (no. m^{-2}), number of weed species (m^{-2}), fresh & dry weight of weeds (g m^{-2}) were counted from an area of 0.25 m (quadrant size) randomly selected and converted to per square meter (m^{-2}) basis, fresh & dry weight of weeds (g m^{-2}) the weeds present within the quadrant area were uprooted and weighed for fresh weight. After air drying, the weeds were dried in the hot air oven at 65-70˚C till the constant for dry weights at 30, 60, 90 DAS and at harvest. Later the original values were transformed to square root values ($\sqrt{x} + 1.0$) given by (Chandel, 1984) [11], and Weed control efficiency was calculated on dry weight basis at 30, 60, 90 DAS and at harvest by adopting the formula WCE = $\frac{DWc - DWt}{DWc} \times 100$ given by Mani *et al.*, (1976), [27] whereas, WCE- Weed control efficiency, DW_C- Dry matter of weeds in weedy check and DW_t- Dry matter of weeds in treated plot. The data obtained from various characters under study were analyzed by the method of analysis of variance as described by (Panse and Sukhatme, 1967) [34].

Results and Discussion

Per plant Studies: The data pertaining to per plant studies *viz.*, number of pods plant^{-1}, weight of pods plant^{-1} (g), length of pods plant^{-1} (cm), number of grains plant^{-1}, biological yield plant^{-1} (g), grain yield plant^{-1} (g) and straw yield plant^{-1} (g) have been tabulated in table 1.

Effect of nutrient management

The data related to per plant studies were influenced significantly due to different nutrient management practices during both the years and pooled respectively, of experimentation. The maximum number of pods plant^{-1} (16.06, 16.89 & 16.47) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) *fb* NM_1 (100% RDF) and NM_2 (75% RDF+ 2 t FYM ha^{-1}), however, the minimum number of pods plant^{-1} (12.40, 12.74 & 12.57) were recorded under control treatment (NM_0) at harvest. The maximum weight of pods plant^{-1} (22.76, 23.60 & 23.18 g) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) which was found at par with NM_1 (100% RDF) and NM_2 (75% RDF+ 2 t FYM ha^{-1}), however, the minimum weight of pods plant^{-1} (18.04, 18.74 & 18.39 g) were recorded under control treatment (NM_0) at harvest. The maximum length of pods plant^{-1} (8.53, 9.97 & 9.25 cm) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) *fb* NM_1 (100% RDF) and NM_2 (75% RDF+ 2 t FYM ha^{-1}), however, the minimum length of pods plant^{-1} (6.80, 7.46 & 7.13 cm) were recorded under control treatment (NM_0) at harvest. The maximum number of grains plant^{-1} (85.20, 87.20 & 86.20) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) followed by NM_1 (100% RDF), NM_2 (75% RDF+ 2 t FYM ha^{-1}) was found at par in comparison of NM_1 (100% RDF), however, the minimum number of grains plant^{-1} (66.46, 70.55 & 68.50) were recorded under control treatment (NM_0). The maximum biological yield plant^{-1} (52.13, 57.59 & 54.86 g), grain yield plant^{-1} (16.21, 16.96 & 16.58 g) and straw yield plant^{-1} (35.92, 40.63 & 38.27 g) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) *fb* NM_1 (100% RDF). NM_2 (75% RDF+ 2 t FYM ha^{-1}) was found at par with NM_1 (100% RDF), however, the minimum biological yield plant^{-1} (41.26, 45.60 & 43.43 g), grain yield plant^{-1} (11.48, 12.43 & 11.95 g) and straw yield plant^{-1} (29.78, 33.17 & 31.47 g) were recorded under control treatment (NM_0). It is due to higher availability of the nutrients in concern treatment. Per plant studies were rapid in this treatment due to sufficiency of the nutrients available to the crop in association with other inputs *viz.*, moisture, oxygen, solar radiation and space. Similar results were also reported by Desai *et al.*, (2016) [15], Dhiman (2016) [17], Pandey *et al.*, (2017) [33], Saikia *et al.*, (2018) [42], Singh *et al.*, (a) (2023) [47] and Singh *et al.*, (b) (2023) [48].

Effect of weed management

Maximum number of pods plant^{-1} (15.16, 15.88 & 15.52) were recorded under weed free treatment (WM_1), whereas, unweeded plots recorded minimum number of pods plant^{-1} (11.58, 12.06 & 11.82). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum number of pods plant^{-1} (14.66, 15.32 & 14.99) which was found at par with WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) and WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS) at harvest during both the years and pooled respectively, of experimentation. Maximum weight of pods plant^{-1} (22.00, 23.03 & 22.51 g) were recorded under weed free treatment (WM_1), whereas, unweeded plots recorded minimum weight of pods plant^{-1} (20.04, 20.76 & 20.40 g). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum weight of pods plant^{-1} (21.17, 21.95 & 21.56 g) *fb* WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) and WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS) at harvest. Maximum length of pods plant^{-1} (8.33, 9.91 & 9.12 cm) were recorded under weed free treatment (WM_1), whereas, unweeded plots recorded minimum length of pods plant^{-1} (7.33, 7.92 & 7.62 cm). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum length of pods plant^{-1} (8.08, 9.52 & 8.80 cm) which was found at par with WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS), WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS) was found at par in comparison of WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) at harvest during first year, second year and pooled respectively, of experimentation. Maximum number of pods grains plant^{-1} (85.41, 88.06 & 86.73) were recorded under weed free treatment (WM_1), whereas, unweeded plots recorded minimum number of grains plant^{-1} (70.41, 73.57 & 71.99) which was found at par with WM_2. Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum number of grains plant^{-1} (78.83, 82.07 & 80.45) which was found at par with WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) and WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS) at harvest during both the years and pooled respectively, of experimentation. Maximum biological yield plant^{-1} (62.83, 69.42 & 66.12 g), grain yield plant^{-1} (16.39, 17.40 & 16.89 g) and straw yield plant^{-1} (46.44, 52.02 & 49.23 g) were recorded under weed free treatment (WM_1), whereas, unweeded plots recorded minimum biological yield plant^{-1} (35.33, 39.05 & 37.19 g), grain yield plant^{-1} (11.97, 12.77 & 12.37 g) and straw yield plant^{-1} (23.36, 26.28 & 24.82 g). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum biological yield plant^{-1} (45.83, 50.63 & 48.23 g), grain yield plant^{-1} (14.75, 15.65 15.20 g) and straw yield plant^{-1} (31.08, 34.98 & 33.03 g) which was found at par with WM_3

(Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) and WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS) at harvest during both the years and pooled respectively, of experimentation. It may be due to controlled density of weeds resulting less or no competition of weeds with crop for inputs concerned. Similar findings were also reported by Rather *et al.,* (2010) [39], Bhat *et al.,* (2013) [8], Uikey *et al.,* (2015) [49], Desai *et al.,* (2016) [15], Pandey *et al.,* (2017) [33], Abera and Abebe (2018) [2], Raja *et al.,* (2022) [38] and Singh *et al.,* (a) (2023) [47].

Yield attributes: The data related to yield attributes *viz.,* number of plants per running metre, number of pods plant^{-1}, number of grains pod^{-1}, seed weight (g) and shelling percent have been tabulated in Table 2.

Effect of nutrient management

The data related to yield attributes were influenced significantly due to different nutrient management practices during both the years and pooled respectively, of experimentation. The maximum number of plants per running metre (9.46, 9.40 & 9.43) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) *fb* NM_1 (100% RDF) and NM_2 (75% RDF+ 2 t FYM ha^{-1}), however, the minimum number of plants per running metre (8.13, 8.09 & 8.11) were recorded under control treatment (NM_0) at harvest. The maximum number of pods plant^{-1} (16.06, 16.89 & 16.47) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3), NM_2 (75% RDF+ 2 t FYM ha^{-1}) was found at par in comparison of NM_1 (100% RDF), however, the minimum number of pods plant^{-1} (12.40, 12.74 & 12.57) were recorded under control treatment (NM_0) at harvest stage of crop growth. The maximum number of grains pod^{-1} (6.53, 7.08 & 6.80) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) which was found at par with NM_1 (100% RDF), NM_2 (75% RDF+ 2 t FYM ha^{-1}) was found at par in comparison of NM_1 (100% RDF), however, the minimum number of grains pod^{-1} (5.26, 5.76 & 5.51) were recorded under control treatment (NM_0) at harvest stage of crop growth. The maximum seed weight (19.00, 19.40 & 19.20 g) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) followed by NM_1 (100% RDF) and NM_2 (75% RDF+ 2 t FYM ha^{-1}), however, the minimum seed weight (17.20, 17.33 & 17.26 g) were recorded under control treatment (NM_0) at harvest. Shelling (%) was influenced non-significantly due to different nutrient management practices. The maximum shelling (71.22, 71.86 & 72.54%) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) *fb* NM_1 (100% RDF) and NM_2 (75% RDF+ 2 t FYM ha^{-1}), however, the minimum shelling (63.63, 66.32 & 64.97%) were recorded under control treatment (NM_0) during both the years and pooled respectively, of experimentation. Yield attributes are the result of growth parameters, crop growth was rapid in this treatment due to sufficiency of the nutrients available to the crop in association with other inputs *viz.,* moisture, oxygen, solar radiation and space which resulted in higher values of yield attributes. Similar results were also reported by Rather *et al.,* (2010) [39], Kumar (2011) [24], Anupama *et al.,* (2012) [5], Bhat *et al.,* (2013) [8], Mishra (2014) [31], Desai *et al.,* (2016) [15], Dhiman (2016) [17], Pandey *et al.,* (2017) [33], Saikia *et al.,* (2018) [42], Gahatraj and Uprety (2019) [19], Ruheentaj and Sarawad (2020) [41], Raja *et al.,* (2022) [38], Singh *et al.,* (a) (2023) [47] and Singh *et al.,* (b) (2023) [48].

Effect of weed management

Maximum number of plants per running metre (9.66, 9.64 & 9.65) were recorded under weed free treatment (WM_1), whereas, unweeded plots recorded minimum number of plants per running metre (7.75, 7.62 & 7.68). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum number of plants per running metre (9.25, 9.20 & 9.22) *fb* WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) and WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS) at harvest. Maximum number of pods plant^{-1} (15.16, 15.88 & 15.52) were recorded under weed free treatment (WM_1), whereas, unweeded plots recorded minimum number of pods plant^{-1} (11.58, 12.06 & 11.82). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum number of pods plant^{-1} (14.66, 15.32 & 14.99) which was found at par with WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) *fb* WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS) at harvest. Maximum number of grains pod^{-1} (6.66, 7.20 & 6.93) were recorded under weed free treatment (WM_1), whereas, unweeded plots recorded minimum number of grains pod^{-1} (5.41, 5.94 & 5.67). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum number of grains pod^{-1} (6.25, 6.77 & 6.51) *fb* WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS), WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS) was found at par in comparison of WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) at harvest. Maximum seed weight (19.16, 19.70 & 19.43 g) was recorded under weed free treatment (WM_1), whereas, unweeded plots recorded minimum seed weight (16.19, 17.29 & 17.10 g). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum seed weight (18.66, 19.03 & 18.84 g) which was found at par with WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS), WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS) was found at par in comparison of WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) at harvest. Weed management practices also influenced shelling (%) of pea crop significantly. Maximum shelling (74.50, 75.55 & 75.02%) were recorded under weed free treatment (WM_1), whereas, unweeded plots recorded minimum shelling (59.73, 60.51 & 61.62%). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum shelling (69.67, 71.29 & 70.48%) which was found at par with WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS), WM_4 (Quizalofop ethyl 5% EC @ 75 g a.*i.* ha^{-1} as *PoE* at 10-15 DAS) was found at par in comparison of WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) during first year, second year and pooled respectively, of experimentation. Similar results were also reported by Desai *et al.,* (2016) [15], Dhiman (2016) [17], Pandey *et al.,* (2017) [33], Saikia *et al.,* (2018) [42], Singh *et al.,* (a) (2023) [47] and Singh *et al.,* (b) (2023) [48].

Yield: The yield has been expressed in terms of grain yield (q ha^{-1}), straw yield (q ha^{-1}), biological yield (q ha^{-1}) and harvest index (%) as influenced by different treatments of this investigation has been presented in Table 3. Yield is the result of estimation of all the yield attributing characters of a crop. Higher

yield under concern treatments is due to higher values of yield attributes as well. Controlled weed density allow crop to unhindered growth and development hence higher productivity and quality produce under associated treatments in trends.

Effect of nutrient management

The data related to yield were influenced significantly due to different nutrient management practices during both the years and pooled respectively, of experimentation. The maximum grain yield (20.25, 21.91 & 21.08 q ha^{-1}), straw yield (38.90, 39.47 & 39.18 q ha^{-1}), biological yield (59.15, 61.38 & 60.26 q ha^{-1}) and harvest index (34.23, 35.69 & 34.96%) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) *fb* NM_1 (100% RDF) and NM_2 (75% RDF+ 2 t FYM ha^{-1}) was found at par with NM_1, however, the minimum grain yield (11.04, 11.69 & 11.36 q ha^{-1}), straw yield (34.42, 35.16 & 34.79 q ha^{-1}), biological yield (45.46, 46.85 & 46.15 q ha^{-1}) and harvest index (24.28, 24.95 & 24.61%) were recorded under control treatment (NM_0) during first year, second year and pooled respectively. Treatment NM_3 (75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB*) produced more grain yield (83.34, 87.42 and 85.56%), straw yield (13.01, 12.25 and 12.61%), biological yield (30.11, 31.01 and 30.57%) and harvest index 9.95, 10.74 and 10.35% during first year, second year and as pooled, respectively over control treatment. Similar results were also reported by Desai *et al.,* (2016) [15], Dhiman (2016) [17], Pandey *et al.,* (2017) [33], Saikia *et al.,* (2018) [42], Singh *et al.,* (a) (2023) [47] and Singh *et al.,* (b) (2023) [48].

Effect of weed management

Maximum grain yield (20.29, 21.42 & 20.85 q ha^{-1}), straw yield (38.71, 38.38 & 39.04 q ha^{-1}), biological yield (59.00, 60.80 59.90 q ha^{-1}) and harvest index (34.38, 35.23 & 34.80%) were recorded under weed free treatment (WM_1), whereas, unweeded plots recorded minimum grain yield (10.11, 11.24 & 10.67 q ha^{-1}), straw yield (32.68, 33.35 & 33.01 q ha^{-1}), biological yield (42.79, 44.59 & 43.69 q ha^{-1}) and harvest index (23.62, 25.20 & 24.41%). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum grain yield (18.63, 19.75 & 19.19 q ha^{-1}), straw yield (38.16, 38.84 & 38.50 q ha^{-1}), biological yield (56.79, 58.59 & 57.69 q ha^{-1}) and harvest index (32.80, 33.70 & 33.25%) *fb* WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) and WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS) during both the year of study. Treatment WM_1 recorded an increment of grain yield 37.88, 36.35 and 37.10%, straw yield 18.45, 18.08 and 18.26%, biological yield 37.88, 36.35 and 37.10% and harvest index 10.76, 10.03 and 10.39% during first year, second year and pooled respectively, over unweeded treatment (WM_0). Among herbicide treatments, WM_2 (Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS), WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) and WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS) produced (84.27, 75.71 and 79.85%), (51.82, 46.79 and 49.20%) and (26.80, 23.30 and 25.02%) more grain yield, respectively, over unweeded treatment during first year, second year and as pooled, respectively. Similar results were also reported by Rather *et al.,* (2010) [39], Kumar (2011) [24], Anupama *et al.,* (2012) [5], Bhat *et al.,* (2013) [8], Mishra (2014) [31], Desai *et al.,* (2016) [15], Dhiman (2016) [17], Pandey *et al.,* (2017) [33], Saikia *et al.,* (2018) [42], Gahatraj and Uprety (2019) [19], Ruheentaj and Sarawad (2020) [41], Raja *et al.,* (2022) [38], Singh *et al.,* (a) (2023) [47] and Singh *et al.,* (b) (2023) [48].

Qualitative studies: The data pertaining to the qualitative studies *viz.,* nutrient content (N P K %), protein (%) and protein yield (kg ha^{-1}) in grain and straw, nutrient uptake (N P K kg ha^{-1}) by grain and straw are presented in tables from 4 to 7.

Effect of nutrient management

Nutrient content (N P K %) in grain and straw, nutrient uptake (N P K kg ha^{-1}) by grain and straw and protein (%) and protein yield (kg ha^{-1}) were influenced significantly due to different nutrient management practices. The highest nitrogen content in grain (3.65, 3.83 & 3.74%) & in straw (1.60, 1.71 & 1.65%) and nitrogen uptake by grain (66.61, 76.25 & 71.43 kg ha^{-1}) & by straw (60.64, 65.78 & 63.21%) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) which was at par with NM_2 (75% RDF+ 2 t FYM ha^{-1}) and NM_1 (100% RDF), however, the lowest nitrogen content in grain (2.93, 3.11 & 3.02%) & in straw (1.20, 1.25 & 1.22%) and nitrogen uptake by grain (32.34, 36.35 34.34 kg ha^{-1}) & by straw (41.30, 43.95 & 42.62 kg ha^{-1}) were recorded under control treatment (NM_0). The highest phosphorus content in grain (0.68, 0.75 & 0.71%) & in straw (0.40, 0.49 & 0.44%) and phosphorus uptake by grain (12.41, 14.93 & 13.67 kg ha^{-1}) & by straw (15.16, 18.85 & 17.00%) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) followed by NM_2 (75% RDF+ 2 t FYM ha^{-1}) and NM_1 (100% RDF), however, the lowest phosphorus content in grain (0.41, 0.47 & 0.44%) & in straw (0.20, 0.23 & 0.21%) and phosphorus uptake by grain (4.52, 5.49 & 5.00 kg ha^{-1}) & by straw (6.88, 8.08 & 7.48 kg ha^{-1}) were recorded under control treatment (NM_0). The highest Potassium content in grain (0.80, 0.89 & 0.84%) & in straw (1.42, 1.59 & 1.50%) and Potassium uptake by grain (14.60, 17.71 & 16.15 kg ha^{-1}) & by straw (53.81, 61.16 & 57.48%) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) *fb* NM_2 (75% RDF+ 2 t FYM ha^{-1}), NM_1 (100% RDF) was found at par with NM_2 (75% RDF+ 2 t FYM ha^{-1}), however, the lowest Potassium content in grain (0.60, 0.63 & 0.62%) & in straw (1.15, 1.19 & 1.17%) and Potassium uptake by grain (6.73, 7.36 & 7.04 kg ha^{-1}) & by straw (39.58, 41.84 & 40.71 kg ha^{-1}) were recorded under control treatment (NM_0). The highest protein percent in grain (22.81, 23.93 & 23.37%) & in straw (10.00, 10.68 & 10.34%) and protein percent yield in grain (416.28, 476.44 & 446.36 kg ha^{-1}) & in straw (379.00, 410.85 & 394.92 kg ha^{-1}) were recorded with application of 75% RDF + 2 t FYM ha^{-1} + *Rhizobium* + *PSB* (NM_3), NM_1 (100% RDF) was found at par with NM_2 (75% RDF + 2 t FYM ha^{-1}), however, the lowest protein percent in grain (18.31, 19.43 & 18.87%) & in straw (7.50, 7.81 & 7.65%) and protein yield in grain (202.14, 227.13 & 214.63 kg ha^{-1}) & in straw (258.15, 274.59 & 266.37 kg ha^{-1}) were recorded under control treatment (NM_0) during first year, second year and pooled respectively, of experimentation. Similar findings were also reported by Qureshi *et al.,* (2015) [37], Desai *et al.,* (2016) [15], Dhiman (2016) [17], Pandey *et al.,* (2017) [33], Saikia *et al.,* (2018) [42], Gahatraj and Uprety (2019) [19] and Manker *et al.,* (2020) [28].

Effect of weed management

Highest nitrogen content in grain (3.60, 3.89 & 3.74%) & in straw (1.53, 1.65 & 1.59%) and nitrogen uptake by grain (73.04, 83.32 & 78.18 kg ha^{-1}) & by straw (59.22, 64.97 & 62.09 kg ha^{-1}) were recorded under weed free treatment (WM_1), whereas, unweeded plots recorded lowest nitrogen content in grain (3.16, 3.23 & 3.19%) & in straw (1.17, 1.16 & 1.16%) and nitrogen

uptake by grain (31.94, 36.30 & 34.12 kg ha^{-1}) & by straw (38.23, 38.68 & 38.45 kg ha^{-1}). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum nitrogen content (%) and nitrogen uptake (kg ha^{-1}) followed by WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) and WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS). Highest phosphorus content in grain (0.70, 0.73 & 0.66%) & in straw (0.46, 0.50 & 0.48%) and phosphorus uptake by grain (14.20, 15.63 & 14.91 kg ha^{-1}) & by straw (17.80, 19.69 & 18.74 kg ha^{-1}) were recorded under weed free treatment (WM_1), whereas, unweeded plots recorded lowest phosphorus content in grain (0.44, 0.55 & 0.49%) & in straw (0.21, 0.28 & 0.24%) and phosphorus uptake by grain (4.44, 6.18 & 5.31 kg ha^{-1}) & by straw (6.86, 9.33 & 8.09 kg ha^{-1}). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum phosphorus content (%) and phosphorus uptake (kg ha^{-1}) *fb* WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) and WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS). Highest Potassium content in grain (0.82, 0.88 & 0.85%) & in straw (1.39, 1.64 & 1.51%) and Potassium uptake by grain (16.63, 18.84 & 17.73 kg ha^{-1}) & by straw (53.80, 64.58 & 59.19 kg ha^{-1}) were recorded under weed free treatment (WM_1), whereas, unweeded plots recorded lowest Potassium content in grain (0.60, 0.67 & 0.63%) & in straw (1.13, 1.16 & 1.14%) and Potassium uptake by grain (6.06, 7.53 & 6.79 kg ha^{-1}) & by straw (36.92, 38.68 & 37.80 kg ha^{-1}). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum Potassium content (%) and Potassium uptake (kg ha^{-1}) was found at par with WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) and WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS). Weed management practices also influenced protein (%) and protein yield (kg ha^{-1}) of fieldpea crop non-significantly as percent but significant as yield (kg ha^{-1}). The highest protein percent in grain (22.50, 24.31 & 23.40%) & in straw (9.56, 10.31 & 9.93%) and protein yield in grain (456.52, 520.21 & 488.61 kg ha^{-1}) & in straw (370.06, 406.00 & 388.03 kg ha^{-1}) were recorded under weed free treatment (WM_1) whereas unweeded plots recorded lowest protein in grain (19.75, 20.18 & 19.96%) & in straw (7.31, 7.25 & 7.28%) and protein yield in grain (199.67, 226.21 & 212.94 kg ha^{-1}) & in straw (238.89, 241.78 & 240.33 kg ha^{-1}). Among herbicide treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum protein (%) and protein yield (kg ha^{-1}) *fb* WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) and WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS) during first year, second year and pooled respectively, of experimentation. Similar findings were also reported by Qureshi *et al.,* (2015) [37], Desai *et al.,* (2016) [15], Dhiman (2016) [17], Pandey *et al.,* (2017) [33], Saikia (2018) [42], Gahatraj and Uprety (2019) [19] and Manker *et al.,* (2020) [28].

Weed studies: The data pertaining to the weed studies *viz.*, weed density of broad leaved weeds (no. m^{-2}), weed density of grassy weeds (no. m^{-2}), weed density of sedges (no. m^{-2}), total weed density (no. m^{-2}), number of weed species (m^{-2}), fresh & dry weight of weeds (g m^{-2}) and weed control efficiency (WCE %) are presented in tables from 8 to 12.

Effect of nutrient management

Weed density of broad leaved weeds (m^{-2}), grassy weeds (m^{-2}), sedges (m^{-2}) and total weed density (m^{-2}) were influenced significantly due to different nutrient management practices. The lowest weed density of broad leaved weeds (m^{-2}), grassy weeds (m^{-2}), sedges (m^{-2}) and total weed density (m^{-2}) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) which was at par with NM_1 (100% RDF) and NM_2 (75% RDF+ 2 t FYM ha^{-1}), however, the highest weed density of broad leaved weeds (m^{-2}) were recorded under control treatment (NM_0) at 30, 60, 90 DAS and at harvest. Number of weed species (m^{-2}) were influenced non-significantly at 30 DAS and at harvest and significantly at 60 DAS and 90 DAS due to different nutrient management practices. The highest number of weed species (m^{-2}) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) at 30 DAS and 60 DAS, which was found at par with NM_1 (100% RDF) at 60 DAS. NM_1 (100% RDF) was found highest no. of weed species at 90 DAS and at harvest *fb* NM_3 (75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB*) and NM_2 (75% RDF+ 2 t FYM ha^{-1}), however, the lowest number of weed species (m^{-2}) were recorded under control treatment (NM_0) at 30 DAS and 60 DAS, NM_3 (75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB*) were recorded lowest no. of weed species at 90 DAS and at harvest. The lowest fresh weight of weeds (g m^{-2}) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) which was found at par with NM_1 (100% RDF) at 30 DAS and 60 DAS *fb* NM_2 (75% RDF+ 2 t FYM ha^{-1}), however, the highest fresh weight of weeds (g m^{-2}) were recorded under control treatment (NM_0) at 30, 60, 90 DAS and at harvest. The lowest dry weight of weeds (g m^{-2}) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) followed by NM_1 (100% RDF) and NM_2 (75% RDF+ 2 t FYM ha^{-1}), however, the highest dry weight of weeds (g m^{-2}) were recorded under control treatment (NM_0) at 30, 60, 90 DAS and at harvest. Weed control efficiency (%) were influenced non-significantly at 30 DAS and significantly at 60, 90 DAS and at harvest due to different nutrient management practices. The highest weed control efficiency (%) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) followed by NM_1 (100% RDF), NM_2 (75% RDF+ 2 t FYM ha^{-1}) was found at par with NM_1 (100% RDF) at 60, 90 DAS and at harvest, however, the lowest WCE (%) were recorded under control treatment (NM_0) at 30, 60, 90 DAS and at harvest during first year, second year and pooled respectively, of experimentation. Several research workers like Kumar (2011) [24], Vasilakoglou and Dhima (2012) [51], Peer *et al.,* (2013) [35], Kaushik *et al.,* (2014) [22], Shalini and Singh (2014) [44], Awal and Roy (2015) [6] and Mathukia *et al.,* (2015) [29], also observed similar findings with field pea crop.

Effect of weed management

Weed management practices also influenced weed density of broad leaved weeds (m^{-2}), grassy weeds (m^{-2}), sedges (m^{-2}) and total weed density (m^{-2}) were influenced significantly due to different nutrient management practices. Lowest weed density of broad leaved weeds (m^{-2}), grassy weeds (m^{-2}), sedges (m^{-2}) and total weed density (m^{-2}) were recorded under weed free treatment (WM_1), whereas, unweeded plots recorded highest weed density of broad leaved weeds (m^{-2}). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded minimum weed density of broad leaved weeds (m^{-2}) *fb* WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) and WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at

10-15 DAS). Lowest numbers of weed species (m^{-2}) were recorded under weed free treatment (WM_1), whereas, unweeded plots recorded highest number of weed species (m^{-2}). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded minimum number of weed species (m^{-2}) *fb* WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) and WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS), WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) was found at par with WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS) at 90 DAS and at harvest. Lowest fresh weight of weeds (g m^{-2}) was recorded under weed free treatment (WM_1), whereas, unweeded plots recorded highest fresh weight of weeds (g m^{-2}). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded minimum fresh weight of weeds (g m^{-2}) *fb* WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) and WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS). Lowest dry weight of weeds (g m^{-2}) was recorded under weed free treatment (WM_1), whereas, unweeded plots recorded highest dry weight of weeds (g m^{-2}). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded minimum dry weight of weeds (g m^{-2}) *fb* WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) and WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS) was found at par with WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS). Highest weed control efficiency (%) were recorded under weed free treatment (WM_1), whereas, unweeded plots recorded lowest weed control efficiency (%). Among herbicides treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum weed control efficiency (%) *fb* WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS), WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS) was found at par with WM_3 (Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS) at 30, 60, 90 DAS and at harvest during first year, second year and pooled respectively, of experimentation. Several research workers like Chaubey *et al.*, (2016), [13] Das (2016) [14], Kumar *et al.*, (2016) [23], Mawalia *et al.*, (2017) [30], Kumar *et al.*, (2019) [25], Sharma *et al.*, (2021) [45], Akhilesh Sah (2022) [3], Barla and Upasani (2022) [7], Kumar *et al.*, (2023) [26] and Sinchana and Raj (2023) [46] also observed similar findings with field pea crop.

Economics: The economics has been expressed in terms of cost of cultivation (Rs. ha^{-1}), gross returns (Rs. ha^{-1}), net returns (Rs. ha^{-1}) and B: C ratio as influenced by different treatments of this investigation has been presented in table 13.

Effect of nutrient management

The highest cost of cultivation (Rs. 32089, 32089 and 32089 ha^{-1}) was involved with treatment NM_3 (application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB*) *fb* NM_2 (Rs. 31629, 31629 and 31629) and NM_1 (Rs. 28344, 28344 and 28344 ha^{-1}), however, the lowest cost of cultivation (Rs. 25818, 25818 and 25818 ha^{-1}) was estimated under control treatment (NM_0). The highest gross returns (Rs. 98425, 105184 and 101804 ha^{-1}) was found with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) *fb* NM_1 (Rs. 82151, 87565 and 84858 ha^{-1}) and NM_2 (Rs. 80053, 83654 and 81853 ha^{-1}), however, the lowest gross returns (Rs. 60266, 63171 and 61718 ha^{-1}) was recorded under control treatment (NM_0). The highest net returns (Rs. 66336, 73095 and 69715 ha^{-1}) were recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) followed by NM_1 (Rs. 53807, 59221 and 56514 ha^{-1}) and NM_2 (Rs. 48424, 52025 and 50224 ha^{-1}), however, the lowest net returns (Rs. 34448, 37353 and 35900 ha^{-1}) were recorded under control treatment (NM_0). The maximum B: C ratio (2.06, 2.27 and 2.16) was recorded with application of 75% RDF+ 2 t FYM ha^{-1}+ *Rhizobium*+ *PSB* (NM_3) *fb* NM_1 (1.89, 2.08 and 1.98) and NM_2 (1.53, 1.64 and 1.58), however, the minimum B:C ratio (1.33, 1.44 and 1.39) was recorded under control treatment (NM_0) during first year, second year and pooled respectively, of experimentation. Similar economic interventions were reported by Varsha *et al.*, (2015) [50], Dhiman (2016) [17], Bhavya and Hiremath (2017) [9], Devi *et al.*, (2018) [16], Gahatraj and Uprety (2019) [19], Sengar *et al.*, (2020) [43], Sharma *et al.*, (2021) [45], Raja *et al.*, (2022) [38], Kumar *et al.*, (2023) [26], Singh *et al.*, (a) (2023) [47] and Singh *et al.*, (b) (2023) [48].

Effect of weed management

Highest cost of cultivation (Rs. 39227, 39227 and 39227 ha^{-1}) was calculated under weed free treatment (WM_1), whereas, Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS (WM_3) involved lowest cost of cultivation (Rs. 24754, 24754 and 24754 ha^{-1}). Among herbicide treatments, application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded highest cost of cultivation (Rs. 31142, 31142 and 31142 ha^{-1}) *fb* WM_4 (Rs. 26457, 26457 and 26457 ha^{-1}) and WM_0 (Rs. 25753, 25753 and 25753 ha^{-1}). Highest gross returns (Rs. 98486, 103228 and 100857 ha^{-1}) was recorded under weed free treatment (WM_1), whereas, unweeded treatment recorded the lowest gross returns of (Rs. 55769, 60511 and 58140 ha^{-1}). Among herbicide treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded highest gross returns (Rs. 91737, 96445 and 94091 ha^{-1}) *fb* WM_3 (Rs. 78405, 83215 and 80810 ha^{-1}) and WM_4 (Rs. 66338, 70824 and 68606 ha^{-1}). Highest net returns (Rs. 60595, 65303 and 62949 ha^{-1}) were recorded under Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) *fb* weed free treatment (Rs. 59259, 64001 and 61630 ha^{-1}), WM_3 (Rs. 53651, 58461 and 56056 ha^{-1}) and WM_4 (Rs. 39931, 44367 and 42149 ha^{-1}), whereas, unweeded plots recorded lowest net returns (Rs. 30016, 34758 and 32387 ha^{-1}). Maximum B: C ratio (2.16, 2.36 and 2.26) was recorded under Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS (WM_3), whereas, unweeded plots recorded minimum B: C ratio (1.16, 1.34 and 1.25). Among herbicide treatments application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 hand weeding at 30 DAS (WM_2) recorded maximum B: C ratio (1.94, 2.09 and 2.01) *fb* WM_4 (Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS) and weed free treatment (WM_1) during first year, second year and pooled respectively, of experimentation. Similar economic interventions were reported by Chaubey *et al.*, (2016) [13], Kumar *et al.*, (2016) [23], Mawalia *et al.*, (2017) [30], Kumar *et al.*, (2019) [25], Sharma *et al.*, (2021) [45], Akhilesh Sah (2022) [3], Barla and Upasani (2022) [7], Kumar *et al.*, (2023) [26] and Sinchana and Raj (2023) [46].

Table 1: Per plant studies of field pea as influenced by nutrient and weed management practices

Treatments	Per plant studies																				
	Number of pods plant^{-1}			Weight of pods plant^{-1} (g)			Length of pods plant^{-1} (cm)			No. of grains plant^{-1}			Biological yield plant^{-1} (g)			Grain yield plant^{-1} (g)			Straw yield plant^{-1} (g)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
A. Main plot – Nutrient Management - 04																					
NM_0	12.40	12.74	12.57	18.04	18.74	18.39	6.80	7.46	7.13	66.46	70.55	68.50	41.26	45.60	43.43	11.48	12.43	11.95	29.78	33.17	31.47
NM_1	13.46	14.06	13.76	21.75	22.53	22.14	8.26	9.46	8.86	80.93	83.23	82.08	45.86	50.68	48.27	14.91	15.68	15.29	30.95	35.00	32.97
NM_2	13.06	13.67	13.36	21.40	22.00	21.70	7.60	8.50	8.05	78.06	81.95	80.00	44.86	49.12	46.99	14.19	15.22	14.70	30.27	33.90	32.08
NM_3	16.06	16.89	16.47	22.76	23.60	23.18	8.53	9.97	9.25	85.20	87.20	86.20	52.13	57.59	54.86	16.21	16.96	16.58	35.92	40.63	38.27
S.E(m)±	0.26	0.19	0.22	0.38	0.60	0.46	0.08	0.07	0.06	0.98	1.04	1.00	0.37	0.39	0.38	0.29	0.42	0.35	0.29	0.67	0.59
C.D. (P = 0.05)	0.93	0.68	0.78	1.36	2.15	1.64	0.30	0.26	0.22	3.45	3.69	3.55	1.30	1.38	1.34	1.04	1.51	1.26	1.04	2.38	2.09
B. Sub plot – Weed Management - 05																					
WM_0	11.58	12.06	11.82	20.04	20.76	20.40	7.33	7.92	7.62	70.41	73.57	71.99	35.33	39.05	37.19	11.97	12.77	12.37	23.36	26.28	24.82
WM_1	15.16	15.88	15.52	22.00	23.03	22.51	8.33	9.91	9.12	85.41	88.06	86.73	62.83	69.42	66.12	16.39	17.40	16.89	46.44	52.02	49.23
WM_2	14.66	15.32	14.99	21.17	21.95	21.56	8.08	9.68	8.88	78.83	82.07	80.45	45.83	50.63	48.23	14.75	15.65	15.20	31.08	34.98	33.03
WM_3	14.16	14.71	14.43	20.75	21.56	21.15	7.75	8.62	8.18	77.91	81.09	79.50	43.66	48.25	45.95	14.41	15.21	14.81	29.25	33.04	31.14
WM_4	13.16	13.74	13.45	20.39	21.28	20.83	7.50	8.44	7.97	75.75	78.87	77.31	42.00	46.40	44.20	13.49	14.32	13.90	28.51	32.08	30.29
S.E(m)±	0.18	0.15	0.16	0.58	0.60	0.57	0.09	0.08	0.25	2.14	2.15	2.14	0.51	0.56	0.53	0.41	0.49	0.44	0.69	0.79	0.74
C.D. (P = 0.05)	0.52	0.56	0.55	NS	NS	NS	0.25	0.23	0.73	6.19	6.23	6.20	1.49	1.62	1.56	1.19	1.42	1.29	2.01	2.30	2.14

Table 2: Yield attributes of field pea as influenced by nutrient and weed management practices

Treatments	Notations	Yield attributes														
		Number of plants per running metre			Number of pods plant^{-1}			Number of grains pod^{-1}			Seed weight (g)			Shelling percent		
		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
A. Main plot – Nutrient Management - 04																
1. Control (No nutrient)	NM_0	8.13	8.09	8.11	12.40	12.74	12.57	5.26	5.76	5.51	17.20	17.33	17.26	63.63	66.32	64.97
2. 100% RDF (20:40:20 NPK kg ha^{-1})	NM_1	8.86	8.80	8.83	13.46	14.06	13.76	6.13	6.80	6.46	18.40	18.80	18.60	68.55	69.59	69.07
3. 75% RDF + 2 t FYM ha^{-1}	NM_2	8.60	8.58	8.59	13.06	13.67	13.36	5.80	6.66	6.23	18.13	18.52	18.32	67.79	69.18	68.48
4. 75% RDF + 2 t FYM ha^{-1} *+Rhizobium + PSB*	NM_3	9.46	9.40	9.43	16.06	16.89	16.47	6.53	7.08	6.80	19.00	19.40	19.20	71.22	71.86	72.54
S.E(m)±		0.06	0.05	0.05	0.26	0.19	0.22	0.12	0.11	0.12	0.38	0.44	0.39	2.24	3.26	2.66
C.D. (P = 0.05)		0.23	0.19	0.19	0.93	0.68	0.78	0.45	0.42	0.43	NS	NS	NS	NS	NS	NS
B. Sub plot – Weed Management - 05																
1. Unweeded	WM_0	7.75	7.62	7.68	11.58	12.06	11.82	5.41	5.94	5.67	16.91	17.29	17.10	59.73	61.51	61.62
2. Weed free	WM_1	9.66	9.64	9.65	15.16	15.88	15.52	6.66	7.20	6.93	19.16	19.70	19.43	74.50	75.55	75.02
3. Pendimethalin 30% EC@ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS	WM_2	9.25	9.20	9.22	14.66	15.32	14.99	6.25	6.77	6.51	18.66	19.03	18.84	69.67	71.29	70.48
4. Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS	WM_3	8.91	8.90	8.90	14.16	14.81	14.44	5.75	6.26	6.00	18.41	18.69	18.55	69.44	70.54	69.99
5. Quizalofop ethyl 5 % EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS	WM_4	8.25	8.21	8.23	13.16	13.74	13.45	5.58	6.07	5.82	17.85	18.10	17.97	66.15	67.29	66.72
S.E(m)±		0.08	0.10	0.08	0.18	0.15	0.16	0.12	0.10	0.12	0.15	0.24	0.18	2.02	2.31	2.12
C.D. (P = 0.05)		0.24	0.28	0.25	0.52	0.56	0.55	0.37	0.35	0.37	0.50	0.69	0.52	5.84	6.69	6.13

Table 3: Yield (Per hectare studies q ha^{-1}) of field pea as influenced by nutrient and weed management practices

Treatments	Notations	Per hectare studies											
		Grain yield (q ha^{-1})			Straw yield (q ha^{-1})			Biological yield (q ha^{-1})			Harvest Index (%)		
		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
A. Main plot – Nutrient Management - 04													
1. Control (No nutrient)	NM_0	11.04	11.69	11.36	34.42	35.16	34.79	45.46	46.85	46.15	24.28	24.95	24.61
2. 100% RDF (20:40:20 NPK kg ha^{-1})	NM_1	16.49	17.80	17.14	35.68	36.29	35.98	52.17	54.09	53.13	31.60	32.90	32.25
3. 75% RDF + 2 t FYM ha^{-1}	NM_2	15.97	16.81	16.39	35.54	36.19	35.86	51.51	53.00	52.25	31.00	31.71	31.35
4. 75% RDF + 2 t FYM ha^{-1} *+Rhizobium + PSB*	NM_3	20.25	21.91	21.08	38.90	39.47	39.18	59.15	61.38	60.26	34.23	35.69	34.96
S.E(m)±		0.26	0.33	0.21	0.32	0.35	0.43	0.81	0.89	0.64	0.28	0.46	0.22
C.D. (P = 0.05)		0.93	1.18	0.75	1.15	1.23	1.54	2.86	3.14	2.27	1.01	1.62	1.31
B. Sub plot – Weed Management - 05													
1. Unweeded	WM_0	10.11	11.24	10.67	32.68	33.35	33.01	42.79	44.59	43.69	23.62	25.20	24.41
2. Weed free	WM_1	20.29	21.42	20.85	38.71	39.38	39.04	59.00	60.8	59.9	34.38	35.23	34.80
3. Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE*	WM_2	18.63	19.75	19.19	38.16	38.84	38.50	56.79	58.59	57.69	32.80	33.70	33.25

+ 1 Hand weeding at 30 DAS													
4. Imazethapyr 10 % SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS	WM_3	15.35	16.50	15.92	37.08	37.73	37.40	52.43	54.23	53.33	29.27	30.42	29.84
5. Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS	WM_4	12.82	13.86	13.34	32.78	33.54	33.16	45.6	47.4	46.5	28.11	29.24	28.67
S.E(m)±		0.45	0.45	0.40	0.91	0.99	0.82	1.14	1.19	0.64	0.55	0.90	0.46
C.D. (P = 0.05)		1.30	1.66	1.57	2.63	2.86	2.38	3.31	3.44	3.21	1.59	1.62	1.33

Table 4: Nitrogen content (%) and uptake (kg ha^{-1}) of field pea as influenced by nutrient and weed management practices

Treatments	Notations	Nitrogen content (%) and uptake (kg ha^{-1})														
		Nitrogen content (%) in grain			Nitrogen content (%) in straw			Nitrogen uptake (kg ha^{-1}) by grain			Nitrogen uptake (kg ha^{-1}) by straw			Total nitrogen uptake (kg ha^{-1})		
		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
A. Main plot – Nutrient Management - 04																
1. Control (No nutrient)	NM_0	2.93	3.11	3.02	1.20	1.25	1.22	32.34	36.35	34.34	41.30	43.95	42.62	73.64	80.30	76.97
2. 100% RDF (20:40:20 NPK kg ha^{-1})	NM_1	3.47	3.60	3.53	1.40	1.47	1.43	57.22	64.08	60.65	49.95	53.34	51.64	107.17	117.42	112.29
3. 75% RDF + 2 t FYM ha^{-1}	NM_2	3.60	3.66	3.63	1.46	1.58	1.52	57.49	61.52	59.50	51.88	57.44	54.66	109.37	118.96	114.16
4. 75% RDF + 2 t FYM ha^{-1} +*Rhizobium* + *PSB*	NM_3	3.65	3.83	3.74	1.60	1.71	1.65	66.61	76.25	71.43	60.64	65.78	63.21	127.25	142.03	134.64
S.E(m)±		0.13	0.12	0.10	0.04	0.05	0.03	1.73	2.41	1.17	1.84	2.71	1.73	2.63	4.43	2.53
C.D. (P = 0.05)		0.46	0.43	0.35	0.16	0.19	0.11	6.12	8.51	4.14	6.49	9.59	6.13	9.28	15.63	8.93
B. Sub plot – Weed Management - 05																
1. Unweeded	WM_0	3.16	3.23	3.19	1.17	1.16	1.16	31.94	36.30	34.12	38.23	38.68	38.45	70.17	74.98	72.57
2. Weed free	WM_1	3.60	3.89	3.74	1.53	1.65	1.59	73.04	83.32	78.18	59.22	64.97	62.09	132.26	148.29	140.27
3. Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS	WM_2	3.51	3.61	3.56	1.51	1.62	1.56	65.39	71.29	68.34	57.62	62.92	60.27	123.01	134.21	128.61
4. Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS	WM_3	3.41	3.53	3.47	1.45	1.57	1.51	52.34	58.24	55.29	53.76	59.23	56.49	106.1	117.47	111.78
5. Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS	WM_4	3.38	3.47	3.42	1.40	1.51	1.45	43.33	48.09	45.71	45.89	50.64	48.26	89.22	98.73	93.97
S.E(m)±		0.20	0.20	0.16	0.09	0.06	0.06	2.88	3.69	2.55	4.07	2.81	2.70	5.53	5.12	4.25
C.D. (P = 0.05)		NS	NS	NS	NS	NS	NS	8.33	10.67	7.39	11.78	10.15	7.83	16.00	14.8	12.32

Table 5: Phosphorus content (%) and uptake (kg ha^{-1}) of field pea as influenced by nutrient and weed management practices

Treatments	Notations	Phosphorus content (%) and uptake (kg ha^{-1})														
		Phosphorus content (%) in grain			Phosphorus content (%) in straw			Phosphorus uptake (kg ha^{-1}) by grain			Phosphorus uptake (kg ha^{-1}) by straw			Total Phosphorus uptake (kg ha^{-1})		
		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
A. Main plot – Nutrient Management - 04																
1. Control (No nutrient)	NM_0	0.41	0.47	0.44	0.20	0.23	0.21	4.52	5.49	5.00	6.88	8.08	7.48	11.40	13.57	12.49
2. 100% RDF (20:40:20 NPK kg ha^{-1})	NM_1	0.61	0.70	0.65	0.35	0.43	0.39	9.89	12.46	11.17	12.48	15.60	14.04	22.37	28.06	25.22
3. 75% RDF + 2 t FYM ha^{-1}	NM_2	0.58	0.66	0.62	0.33	0.41	0.37	9.26	11.09	10.17	11.72	14.90	13.31	20.98	25.99	23.49
4. 75% RDF + 2 t FYM ha^{-1} +*Rhizobium* + *PSB*	NM_3	0.68	0.75	0.71	0.40	0.49	0.44	12.41	14.93	13.67	15.16	18.85	17.00	27.57	33.78	30.68
S.E(m)±		0.01	0.02	0.02	0.02	0.02	0.02	0.28	1.04	0.61	1.01	1.18	1.08	1.25	2.21	1.68
C.D. (P = 0.05)		0.05	0.10	0.07	0.08	0.08	0.08	1.00	3.67	2.17	3.59	4.16	3.81	4.41	7.81	5.95
B. Sub plot – Weed Management - 05																
1. Unweeded	WM_0	0.44	0.55	0.49	0.21	0.28	0.24	4.44	6.18	5.31	6.86	9.33	8.09	11.30	15.51	13.41
2. Weed free	WM_1	0.70	0.73	0.66	0.46	0.50	0.48	14.20	15.63	14.91	17.80	19.69	18.74	32.00	35.32	33.66
3. Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS	WM_2	0.62	0.70	0.62	0.37	0.44	0.40	11.55	13.82	12.68	14.11	17.08	15.59	25.66	30.90	28.28
4. Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS	WM_3	0.57	0.65	0.61	0.31	0.39	0.35	8.74	10.72	9.73	11.49	14.71	13.10	20.23	25.43	22.83
5. Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS	WM_4	0.52	0.60	0.56	0.25	0.34	0.29	6.66	8.31	7.48	8.19	11.40	9.79	14.85	19.71	17.28
S.E(m)±		0.01	0.03	0.02	0.009	0.02	0.01	0.37	0.98	0.60	0.42	0.92	0.55	0.61	1.80	1.11
C.D. (P = 0.05)		0.03	0.09	0.06	0.025	0.05	0.03	1.08	2.83	1.76	1.21	2.66	1.61	1.77	5.22	3.23

Table 6: Potassium content (%) and uptake (kg ha^{-1}) of field pea as influenced by nutrient and weed management practices

Treatments	Notations	Potassium content (%) and uptake (kg ha^{-1})														
		Potassium content (%) in grain			Potassium content (%) in straw			Potassium uptake (kg ha^{-1}) by grain			Potassium uptake (kg ha^{-1}) by straw			Total Potassium uptake (kg ha^{-1})		
		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
A. Main plot – Nutrient Management - 04																
1. Control (No nutrient)	NM_0	0.61	0.63	0.62	1.15	1.19	1.17	6.73	7.36	7.04	39.58	41.84	40.71	46.31	49.20	47.76
2. 100% RDF (20:40:20 NPK kg ha^{-1})	NM_1	0.74	0.80	0.77	1.22	1.27	1.24	12.20	14.24	13.22	43.52	46.08	44.80	55.72	60.32	58.02
3. 75% RDF + 2 t FYM ha^{-1}	NM_2	0.75	0.82	0.78	1.30	1.38	1.34	11.97	13.78	12.87	46.20	50.17	48.18	58.17	63.95	61.06
4. 75% RDF + 2 t FYM ha^{-1} +*Rhizobium* + *PSB*	NM_3	0.80	0.89	0.84	1.42	1.59	1.50	14.60	17.71	16.15	53.81	61.16	57.48	68.41	78.87	73.64
S.E(m)±		0.01	0.01	0.01	0.03	0.06	0.05	0.27	0.53	0.34	1.64	3.22	2.30	1.51	3.60	2.43
C.D. (P = 0.05)		0.04	0.03	0.03	0.13	0.23	0.17	0.95	1.89	1.22	5.73	11.38	8.11	5.35	12.69	8.57
B. Sub plot – Weed Management - 05																
1. Unweeded	WM_0	0.60	0.67	0.63	1.13	1.16	1.14	6.06	7.53	6.79	36.92	38.68	37.80	42.98	46.21	44.60
2. Weed free	WM_1	0.82	0.88	0.85	1.39	1.64	1.51	16.63	18.84	17.73	53.80	64.58	59.19	70.43	83.42	76.93
3. Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS	WM_2	0.80	0.86	0.83	1.34	1.37	1.35	14.90	16.98	15.94	51.13	53.21	52.17	66.03	70.19	68.11
4. Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS	WM_3	0.73	0.80	0.76	1.28	1.34	1.31	11.20	13.20	12.20	47.46	50.55	49.00	58.66	63.75	61.21
5. Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS	WM_4	0.67	0.73	0.70	1.23	1.27	1.25	8.58	10.11	9.34	40.31	42.59	41.45	48.89	52.70	50.80
S.E(m)±		0.007	0.01	0.007	0.03	0.06	0.03	0.35	0.37	0.31	1.61	2.72	1.62	1.67	2.70	1.69
C.D. (P = 0.05)		0.019	0.03	0.019	0.10	0.17	0.10	1.02	1.08	0.89	4.67	7.89	4.69	4.84	7.82	4.89

Table 7: Protein percent and protein yield (kg ha^{-1}) of field pea as influenced by nutrient and weed management practices

Treatments	Notations	Protein percent and protein yield (kg ha^{-1})											
		Protein (%) in grain			Protein (%) in straw			Protein yield (kg ha^{-1}) by grain			Protein yield (kg ha^{-1}) by straw		
		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
A. Main plot – Nutrient Management - 04													
1. Control (No nutrient)	NM_0	18.31	19.43	18.87	7.50	7.81	7.65	202.14	227.13	214.63	258.15	274.59	266.37
2. 100% RDF (20:40:20 NPK kg ha^{-1})	NM_1	21.68	22.50	22.09	8.75	9.18	8.96	357.50	400.00	379.00	312.20	333.14	322.67
3. 75% RDF + 2 t FYM ha^{-1}	NM_2	22.50	22.87	22.68	9.12	9.87	9.49	359.32	384.44	371.88	324.12	358.87	341.49
4. 75% RDF + 2 t FYM ha^{-1} +*Rhizobium* + *PSB*	NM_3	22.81	23.93	23.37	10.00	10.68	10.34	416.28	476.44	446.36	379.00	410.85	394.92
S.E(m)±		0.81	0.77	0.63	0.29	0.31	0.20	10.85	15.09	7.34	11.49	13.00	10.86
C.D. (P = 0.05)		2.87	2.74	2.23	1.04	1.12	0.73	38.30	53.23	25.91	40.55	45.88	38.32
B. Sub plot – Weed Management - 05													
1. Unweeded	WM_0	19.75	20.18	19.96	7.31	7.25	7.28	199.67	226.21	212.94	238.89	241.78	240.33
2. Weed free	WM_1	22.50	24.31	23.40	9.56	10.31	9.93	456.52	520.21	488.61	370.06	406.00	388.03
3. Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS	WM_2	21.93	22.56	22.24	9.43	10.12	9.77	408.55	445.56	427.05	359.84	393.06	376.45
4. Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS	WM_3	21.31	22.06	21.68	9.06	9.81	9.43	327.10	363.99	345.54	335.94	370.13	353.03
5. Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS	WM_4	21.12	21.68	21.40	8.75	9.43	9.09	270.75	357.72	314.23	286.82	316.28	301.55
S.E(m)±		1.30	1.30	1.03	0.60	0.32	0.40	17.99	23.06	15.96	25.44	15.51	16.93
C.D. (P = 0.05)		NS	NS	NS	NS	NS	NS	52.08	66.74	46.19	73.64	44.88	48.99

Table 8: Total weed density (no. m^{-2}) at different stages as influenced by nutrient and weed management practices

Treatments	Notations	Total no. of weeds metre^{-2}											
		30 DAS			60 DAS			90 DAS			At harvest		
		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
A. Main plot – Nutrient Management - 04													
1. Control (No nutrient)	NM_0	10.48 (43.86)	10.09 (40.20)	10.28 (42.03)	16.58 (112.98)	16.57 (113.85)	16.57 (113.41)	15.22 (96.52)	15.09 (95.19)	15.15 (95.85)	14.58 (88.95)	14.35 (86.07)	14.46 (87.51)
2. 100% RDF (20:40:20 NPK kg ha^{-1})	NM_1	9.85 (37.66)	9.29 (33.66)	9.57 (35.66)	15.22 (102.15)	15.11 (92.58)	15.16 (97.36)	13.62 (75.32)	13.51 (74.00)	13.56 (74.66)	13.12 (69.66)	12.99 (68.26)	13.05 (68.96)
3. 75% RDF + 2 t FYM ha^{-1}	NM_2	10.21 (40.86)	9.77 (37.46)	9.99 (39.16)	15.47 (96.85)	15.31 (95.72)	15.39 (96.28)	14.19 (82.12)	14.00 (80.79)	14.09 (81.45)	13.58 (75.60)	13.44 (73.61)	13.51 (74.60)
4. 75% RDF + 2 t FYM ha^{-1} +*Rhizobium* + *PSB*	NM_3	9.82 (37.53)	9.32 (33.33)	9.56 (35.43)	14.72 (87.29)	14.57 (85.35)	14.64 (86.32)	13.09 (69.19)	12.97 (67.85)	13.03 (68.52)	12.68 (64.50)	12.57 (63.61)	12.62 (64.05)
S.E(m)±		0.06	0.10	0.07	0.18	0.18	0.12	0.21	0.22	0.20	0.13	0.13	0.13
C.D. (P = 0.05)		0.21	0.35	0.25	0.65	0.63	0.45	0.75	0.76	0.71	0.46	0.47	0.46

B. Sub plot – Weed Management - 05													
1. Unweeded	WM_0	13.86 (68.16)	13.60 (65.66)	13.73 (66.91)	22.17 (169.45)	22.27 (171.33)	22.22 (170.39)	20.38 (145.73)	20.25 (144.07)	20.31 (144.90)	19.48 (134.25)	19.36 (132.46)	19.42 (133.35)
2. Weed free	WM_1	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
3. Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS	WM_2	9.64 (31.24)	8.78 (25.57)	9.21 (28.40)	13.94 (65.74)	13.58 (62.17)	13.76 (63.95)	12.59 (53.82)	12.39 (52.15)	12.49 (52.98)	12.04 (49.53)	11.74 (46.93)	11.89 (48.23)
4. Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS	WM_3	11.42 (45.07)	10.75 (39.83)	11.08 (42.45)	18.77 (121.27)	18.64 (119.75)	18.70 (120.51)	16.67 (96.73)	16.52 (95.07)	16.59 (95.90)	16.05 (89.72)	15.88 (87.43)	15.96 (88.57)
5. Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS	WM_4	12.56 (52.31)	11.96 (49.74)	12.26 (51.02)	19.61 (132.62)	19.52 (131.49)	19.56 (132.05)	17.54 (107.65)	17.41 (106.00)	17.47 (106.82)	16.88 (99.90)	16.70 (97.67)	16.79 (98.78)
S.E(m)±		0.16	0.19	0.13	0.21	0.15	0.15	0.19	0.20	0.21	0.21	0.23	0.22
C.D. (P = 0.05)		0.48	0.55	0.39	0.62	0.44	0.45	0.57	0.59	0.61	0.63	0.67	0.65

Table 9: Number of weed species (m^{-2}) at different stages as influenced by nutrient and weed management practices

Treatments	Notations	Number of weed species (m^{-2})											
		30 DAS			60 DAS			90 DAS			At harvest		
		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
A. Main plot – Nutrient Management - 04													
1. Control (No nutrient)	NM_0	3.00	2.93	2.96	5.60	6.00	5.80	7.66	8.13	7.89	5.96	5.53	5.74
2. 100% RDF (20:40:20 NPK kg ha^{-1})	NM_1	3.60	3.46	3.53	6.80	6.70	6.75	7.00	7.06	7.03	5.60	5.20	5.40
3. 75% RDF + 2 t FYM ha^{-1}	NM_2	3.26	3.13	3.19	6.13	6.20	6.16	7.46	7.53	7.49	5.93	5.46	5.69
4. 75% RDF + 2 t FYM ha^{-1} +*Rhizobium* + *PSB*	NM_3	4.06	4.00	4.03	6.86	6.93	6.89	6.46	6.40	6.43	5.33	4.80	5.06
S.E(m)±		0.06	0.26	0.15	0.06	0.05	0.04	0.03	0.10	0.05	0.24	0.19	0.22
C.D. (P = 0.05)		NS	NS	NS	0.22	0.23	0.16	0.11	0.36	0.16	NS	NS	NS
B. Sub plot – Weed Management - 05													
1. Unweeded	WM_0	4.91	4.83	4.87	8.91	9.50	9.20	9.66	10.08	9.87	7.75	7.16	7.45
2. Weed free	WM_1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS	WM_2	3.66	3.45	3.55	6.66	6.45	6.55	7.58	7.58	7.58	6.04	5.50	5.77
4. Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS	WM_3	4.16	4.12	4.14	7.58	7.66	7.62	9.16	9.25	9.20	7.33	6.75	7.04
5. Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS	WM_4	4.66	4.50	4.58	8.58	8.66	8.62	9.33	9.50	9.41	7.41	6.83	7.12
S.E(m)±		0.16	0.26	0.19	0.13	0.18	0.15	0.13	0.16	0.13	0.32	0.34	0.33
C.D. (P = 0.05)		0.47	0.76	0.55	0.39	0.53	0.45	0.38	0.47	0.39	0.93	1.00	0.96

Table 10: Fresh weight of weeds (g m^{-2}) at different stages as influenced by nutrient and weed management practices

Treatments	Notations	Fresh weight of weeds (g m^{-2})											
		30 DAS			60 DAS			90 DAS			At harvest		
		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
A. Main plot – Nutrient Management - 04													
1. Control (No nutrient)	NM_0	4.91 (30.42)	4.76 (28.02)	4.83 (29.22)	7.40 (72.15)	7.38 (70.52)	7.39 (71.33)	8.17 (86.58)	8.01 (83.00)	8.09 (84.79)	8.07 (84.54)	7.90 (80.94)	7.98 (82.74)
2. 100% RDF (20:40:20 NPK kg ha^{-1})	NM_1	4.21 (21.92)	4.10 (20.57)	4.15 (21.24)	6.08 (49.45)	5.57 (42.81)	5.82 (46.13)	6.26 (49.59)	6.20 (48.68)	6.23 (49.13)	6.38 (52.41)	6.37 (52.19)	6.37 (52.30)
3. 75% RDF + 2 t FYM ha^{-1}	NM_2	4.49 (25.30)	4.43 (24.03)	4.46 (24.66)	6.80 (60.77)	6.73 (58.67)	6.76 (59.72)	7.41 (71.52)	7.28 (68.82)	7.34 (70.17)	7.27 (68.92)	7.09 (65.45)	7.18 (67.18)
4. 75% RDF + 2 t FYM ha^{-1} +*Rhizobium* + *PSB*	NM_3	4.02 (19.85)	3.90 (18.43)	3.96 (19.14)	6.07 (47.81)	5.92 (45.44)	5.99 (46.62)	6.50 (55.17)	6.42 (53.42)	6.46 (54.29)	6.48 (54.25)	6.30 (51.77)	6.39 (53.01)
S.E(m)±		0.09	0.12	0.10	0.10	0.21	0.10	0.18	0.20	0.16	0.19	0.18	0.15
C.D. (P = 0.05)		0.34	0.42	0.35	0.36	0.76	0.35	0.64	0.70	0.21	0.47	0.63	0.53
B. Sub plot – Weed Management - 05													
1. Unweeded	WM_0	8.28 (68.20)	7.84 (61.17)	8.06 (64.68)	12.69 (161.64)	12.16 (148.63)	12.42 (155.13)	13.09 (173.08)	12.64 (162.39)	12.86 (167.73)	13.09 (172.41)	12.78 (164.64)	12.93 (168.52)
2. Weed free	WM_1	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
3. Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS	WM_2	3.41 (10.95)	3.47 (11.32)	3.44 (11.13)	5.24 (27.27)	5.08 (26.51)	5.16 (26.89)	5.94 (35.36)	5.85 (35.46)	5.89 (35.41)	6.06 (36.90)	5.90 (35.26)	5.98 (36.08)
4. Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS	WM_3	4.31 (17.91)	4.26 (17.61)	4.28 (17.76)	6.58 (43.20)	6.40 (41.37)	6.49 (42.28)	7.26 (52.80)	7.25 (52.46)	7.25 (52.63)	6.92 (48.31)	6.72 (45.87)	6.82 (47.09)
5. Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS	WM_4	5.03 (24.80)	4.91 (23.73)	4.97 (24.26)	7.42 (55.61)	7.37 (55.29)	7.39 (55.45)	8.16 (67.34)	8.14 (67.10)	8.15 (67.22)	8.18 (67.55)	8.17 (67.18)	8.17 (67.36)
S.E(m)±		0.14	0.17	0.13	0.19	0.28	0.15	0.24	0.31	0.19	0.26	0.28	0.26
C.D. (P = 0.05)		0.40	0.50	0.37	0.57	0.81	0.46	0.69	0.89	0.56	0.76	0.82	0.75

Table 11: Dry weight of weeds (g m-2) at different stages as influenced by nutrient and weed management practices

Treatments	Notations	Dry weight of weeds (g m^{-2})											
		30 DAS			60 DAS			90 DAS			At harvest		
		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
A. Main plot – Nutrient Management - 04													
1. Control (No nutrient)	NM_0	3.47 (13.99)	3.42 (13.26)	3.44 (13.62)	4.86 (29.79)	4.79 (28.44)	4.82 (29.11)	4.90 (30.51)	4.86 (29.89)	4.88 (30.20)	4.83 (29.28)	4.77 (28.94)	4.80 (29.11)
2. 100% RDF (20:40:20 NPK kg ha^{-1})	NM_1	2.85 (9.08)	2.75 (8.37)	2.80 (8.72)	3.98 (20.07)	3.92 (18.99)	3.95 (19.53)	4.05 (20.84)	4.00 (20.13)	4.02 (20.48)	3.96 (20.12)	3.89 (19.24)	3.92 (19.68)
3. 75% RDF + 2 t FYM ha^{-1}	NM_2	3.17 (11.56)	3.11 (10.86)	3.14 (11.21)	4.33 (23.81)	4.30 (22.95)	4.31 (23.38)	4.45 (25.10)	4.37 (24.15)	4.41 (24.62)	4.34 (24.27)	4.27 (23.34)	4.30 (23.80)
4. 75% RDF + 2 t FYM ha^{-1} +*Rhizobium* + *PSB*	NM_3	2.56 (7.33)	2.49 (6.88)	2.52 (7.10)	3.57 (16.34)	3.50 (15.49)	3.53 (15.91)	3.61 (16.91)	3.57 (16.45)	3.59 (16.68)	3.52 (16.29)	3.42 (15.47)	3.47 (15.87)
S.E(m)±		0.09	0.05	0.05	0.11	0.06	0.07	0.09	0.11	0.17	0.08	0.08	0.06
C.D. (P = 0.05)		0.33	0.20	0.19	0.39	0.23	0.25	0.31	0.41	0.27	0.28	0.31	0.23
B. Sub plot – Weed Management - 05													
1. Unweeded	WM_0	5.41 (28.68)	5.19 (26.41)	5.30 (26.54)	8.15 (65.95)	7.89 (61.67)	8.02 (63.81)	8.31 (68.74)	8.17 (66.53)	8.24 (67.63)	8.21 (67.65)	8.13 (65.62)	8.17 (66.63)
2. Weed free	WM_1	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
3. Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS	WM_2	2.36 (4.71)	2.33 (4.57)	2.34 (4.64)	3.30 (10.20)	3.29 (10.01)	3.29 (10.10)	3.34 (10.58)	3.32 (10.42)	3.33 (10.50)	3.23 (9.88)	3.08 (9.07)	3.15 (9.47)
4. Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS	WM_3	3.01 (8.68)	2.97 (8.38)	2.99 (8.53)	4.09 (17.02)	4.10 (16.68)	4.09 (16.85)	4.14 (17.25)	4.13 (16.87)	4.13 (17.06)	4.03 (16.45)	3.94 (15.67)	3.98 (16.06)
5. Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS	WM_4	3.29 (10.38)	3.23 (9.86)	3.26 (10.04)	4.40 (19.34)	4.37 (18.99)	4.38 (19.16)	4.46 (20.13)	4.40 (19.46)	4.43 (19.79)	4.35 (19.20)	4.29 (18.39)	4.32 (18.79)
S.E(m)±		0.14	0.12	0.08	0.20	0.14	0.15	0.21	0.19	0.11	0.26	0.20	0.18
C.D. (P = 0.05)		0.42	0.35	0.25	0.59	0.41	0.44	0.63	0.57	0.34	0.76	0.59	0.53

Table 12: Weed control efficiency (%) at different stages as influenced by nutrient and weed management practices

Treatments	Notations	Weed control efficiency (%)											
		30 DAS			60 DAS			90 DAS			At harvest		
		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
A. Main plot – Nutrient Management - 04													
1. Control (No nutrient)	NM_0	59.99	60.57	60.28	62.98	62.37	62.67	63.50	63.25	63.37	63.26	64.04	63.65
2. 100% RDF (20:40:20 NPK kg ha^{-1})	NM_1	64.96	64.86	64.91	66.47	65.85	66.16	66.35	66.45	66.40	66.29	67.44	66.86
3. 75% RDF + 2 t FYM ha^{-1}	NM_2	60.64	60.32	60.48	65.13	64.14	64.63	64.56	64.39	64.47	65.23	65.68	65.45
4. 75% RDF + 2 t FYM ha^{-1} +*Rhizobium* + *PSB*	NM_3	68.82	67.26	68.04	70.20	69.78	69.99	70.47	70.00	70.23	70.04	71.48	70.76
S.E(m)±		1.94	1.82	0.65	1.02	0.70	0.66	1.34	1.73	0.82	0.99	0.63	0.60
C.D. (P = 0.05)		NS	NS	NS	3.62	2.48	2.33	4.75	4.80	2.91	3.50	2.22	2.14
B. Sub plot – Weed Management - 05													
1. Unweeded	WM_0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Weed free	WM_1	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
3. Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS	WM_2	83.63	82.09	82.86	84.61	84.01	84.31	84.59	84.42	84.50	84.74	86.32	85.53
4. Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS	WM_3	69.50	69.55	69.52	75.51	73.62	74.56	75.47	74.69	75.08	75.99	77.39	76.69
5. Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS	WM_4	64.90	64.63	64.76	70.87	70.06	70.46	71.04	71.00	71.02	70.30	72.09	71.19
S.E(m)±		2.88	2.14	1.95	2.55	1.97	1.95	2.67	2.35	1.43	3.06	2.40	2.13
C.D. (P = 0.05)		8.36	6.21	5.65	7.40	5.71	5.64	7.73	6.82	4.15	8.87	6.96	6.17

Table 13: Economics of field pea as influenced by nutrient and weed management practices

Treatments	Notations	Cost of cultivation (Rs. ha^{-1})			Gross returns (Rs. ha^{-1})			Net returns (Rs. ha^{-1})			B:C ratio		
		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
A. Main plot – Nutrient Management - 04													
1. Control (No nutrient)	NM_0	25818	25818	25818	60266	63171	61718	34448	37353	35900	1.33	1.44	1.38
2. 100% RDF (20:40:20 NPK kg ha^{-1})	NM_1	28344	28344	28344	82151	87565	84858	53807	59221	56514	1.89	2.08	1.98
3. 75% RDF + 2 t FYM ha^{-1}	NM_2	31629	31629	31629	80053	83654	81853	48424	52025	50224	1.53	1.64	1.58
4. 75% RDF + 2 t FYM ha^{-1} +*Rhizobium* + *PSB*	NM_3	32089	32089	32089	98425	105184	101804	66336	73095	69715	2.06	2.27	2.16
B. Sub plot – Weed Management - 05													
1. Unweeded	WM_0	25753	25753	25753	55769	60511	58140	30016	34758	32387	1.16	1.34	1.25
2. Weed free	WM_1	39227	39227	39227	98486	103228	100857	59259	64001	61630	1.51	1.63	1.57
3. Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS	WM_2	31142	31142	31142	91737	96445	94091	60595	65303	62949	1.94	2.09	2.01
4. Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS	WM_3	24754	24754	24754	78405	83215	80810	53651	58461	56056	2.16	2.36	2.26
5. Quizalofop ethyl 5% EC @ 75 g *a.i.* ha^{-1} as *PoE* at 10-15 DAS	WM_4	26457	26457	26457	66388	70824	68606	39931	44367	42149	1.50	1.67	1.58

Conclusion

Highest growth characters, per plant studies, yield and yield attributes and qualitative studies of field pea have been achieved with the application of 75% RDF + 2 t FYM ha^{-1} + *Rhizobium* + *PSB* with weed control using pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS, and the maximum net returns was fetched when nutrient management was done by application of 75% RDF + 2 t FYM ha^{-1} + *Rhizobium* + *PSB*, (Rs. 66336, 73095 and 69715 ha^{-1}) and weeds were controlled with pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as *PE* + 1 Hand weeding at 30 DAS, (Rs. 60595, 65303 and 62949 ha^{-1}), during first year, second year and pooled respectively. But, Maximum B: C ratio was fetched when nutrient management was done by application of 75% RDF + 2 t FYM ha^{-1} + *Rhizobium* + *PSB*, (2.06, 2.27 and 2.16) and weeds were controlled by Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS, (2.16, 2.36 and 2.26) during both the years and pooled respectively, of experimentation.

Recommendation

Maximum productivity and economic returns from field pea can be achieved with the application of 75% RDF + 2 t FYM ha^{-1} + *Rhizobium* + *PSB* with weed control using Imazethapyr 10% SL @ 25 ml *a.i.* ha^{-1} as *PoE* at 15-20 DAS.

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