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RESEARCH ARTICLE

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Study on Tillage, Organic and Inorganic Nutrient Sources: A Short-term Agronomic and Economic Analysis of Soybean (*Glycine max* L.) under Sub Humid Agro-climatic Conditions

Shilpa[1], Janardan Singh[2], Pooja[1], Raveena[1], Parita[1], Navneet Kaur[1]

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ABSTRACT

Background: Tillage systems such as zero tillage and minimum or reduced tillage leave more crop residues and offer greater protection to soil erosion. Besides appropriate selection of tillage practices, the improvement in average yield per hectare can be achieved by maintaining the soil fertility through proper rate and mode of application of fertilizers. Inorganic and organic sources of nutrients have potential in reversing the declining soil-health and crop productivity by correcting the marginal deficiencies of secondary and micro-nutrients, micro-flora and fauna and their beneficial influence on physical and biological properties of soil.

Methods: Experiment was laid out for two years (2020 and 2021) at the Experimental Farm, Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. There were twelve treatment combinations comprising three tillage practices (zero tillage, reduced tillage and conventional tillage) and four organic and inorganic nutrient sources (75 and 100% recommended dose of nitrogen through FYM and 75 and 100% recommended dose of fertilizer through urea, single super phosphate and muriate of potash) which were tested in split plot design with tillage practices in main plots and different nutrient sources in sub plots.

Result: Among different tillage practices adapted, reduced tillage recorded higher yield, nutrient uptake, protein content, oil content and economics of soybean, whereas among different nutrient sources tested, use of 100 per cent recommended dose of fertilizers provided highest profitability and productivity of soybean under mustard-soybean cropping system.

Key words: Farm yard manure, Nutrient sources, Productivity, Profitability, Soil fertility, Tillage.

INTRODUCTION

Soybean plays a vital role in global food production and is the most important crop grown in India which accounts for more than 95 per cent of total production (NMOOP, 2018). It is most flexible leguminous crop, consumed as both food and feed source. High protein content (40%), oil content (20%), together with various useful supplements (essential amino acids, plant-based protein, fiber and healthy fats) and bioactive variables, make it a profoundly enthralling product of decision (Tukamuhabwa, 2010). India, being a leading exporter of oil meals, especially soybean, benefits from its diverse agro-ecological areas suitable for their cultivation. Soybean farming is both economically rewarding and contributes to enhancing the socio-economic status of farmers. As a result, oil crops play a pivotal role in fostering a sustainable production system within Indian agriculture. With the expanding cultivation of soybean in recent years, the integration of soybean and mustard as a sequential cropping option has emerged as a significant alternative. The soybean-mustard cropping system possesses enormous potential to enhance oilseed production in the country. Throughout centuries, conventional tillage has been widely adopted as the primary method for crop establishment, playing a crucial role in the evolution of agriculture and food production (Lal, 2009) but besides these benefits, they are having harmful consequences to the natural resources and environmental health (Haddaway *et al*., 2017). Continuous utilization of heavy machinery leads to soil compaction, which hampers water infiltration, restricts root growth and negatively affects crop production. Furthermore, conventional tillage practices contribute to soil fertility degradation through enhanced soil organic matter oxidation and increased soil erosion (Wang *et al*., 2017). Based on these limitations, it is important to reduce primary tillage practices as much as possible to maintain soil fertility and productivity. On the other hand, it is mandatory to satisfy the growing human population's food demand through agricultural practices based on sustainable land management (Sanaullah *et al*., 2019; Tahat *et al*., 2020). The researchers and farmers are looking to adopt an

[1]Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 061, Himachal Pradesh, India.
[2]Department of Organic Agriculture and Natural Farming, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 061, Himachal Pradesh, India.

Corresponding Author: Shilpa, Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 061, Himachal Pradesh, India. Email: manhasshilpa8@gmail.com

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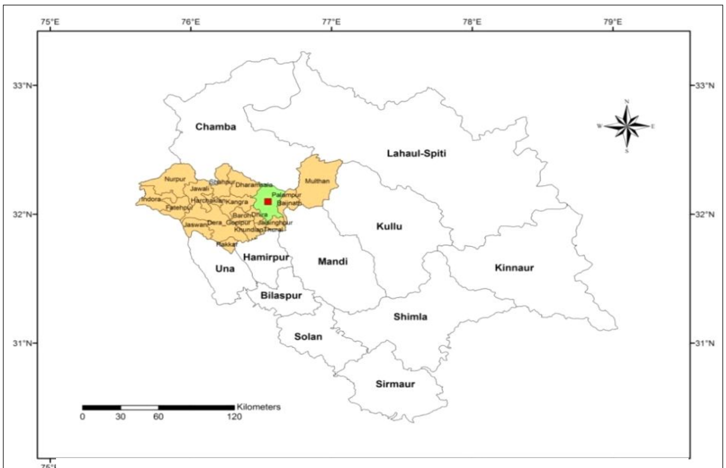
alternative tillage method due to environmental concern and cost involved. Considerable attention has been diverted towards conservation tillage methods *i.e*., reduced tillage or zero tillage. Tillage systems such as zero tillage and minimum or reduced tillage leave more crop residues and offer greater erosion control. Thus, they are fundamental for planning sustainable farming systems (Hobbs *et al*., 2007). Zero tillage not only promotes input-use efficiency but also strengthens natural resource base. Reduced tillage is said to be one of the potential ways to reverse land degradation and ultimately increase the productivity. In comparison with intensive tillage, reduced tillage practices provide lower macro-aggregate destruction, hence reducing the exposure of soil organic matter to mineralisation (Liu *et al*., 2021). This tillage is the system that leaves at least a third of the surface covered with residue after planting. Mulches have favourable effect on physical, chemical and biological properties of soil by stabilizing soil aggregates, enhancing soil organic matter, soil nutrients and reducing run off and soil erosion by intercepting rain drops. Soil moisture is the major limiting factor for crop production under *rainfed* situation, therefore, moisture conservation is important to achieve higher yield. Mulching among various soil moisture conservation practices, is assuming greater importance. As a whole, conservation tillage improves overall soil health (Li *et al*., 2019), increased soil microbial biomass (Chen *et al*., 2019) and affected soil aggregation in a positive way (Zhang *et al*., 2012).

In addition to land management practices, agricultural production is largely based on less efficient off-farm nutrient sources. The application of fertilizers is vital for improving crop productivity and sustainability. However, the current extensive use of chemical fertilizers, although effective in boosting yields, comes with significant environmental and health risks. Therefore, it is crucial to develop a sustainable production system that maximizes productivity while minimizing environmental pollution. One environmentally friendly approach is to substitute chemical or inorganic fertilizers with mixed inorganic/organic or sole organic fertilizers. This shift towards organic sources of nutrients promotes the production of safe and healthy foods, aids in soil fertility restoration and helps mitigate the adverse effects of climate change (Timsina, 2018).The importance of FYM in increasing yield and quality of crops on sustainable basis along with its residual effect on succeeding crops by improving the soil physical conditions and soil fertility is well recognized and documented (Shilpa *et al*., 2021). Identification of best tillage practice with quantifiable residue retention and fertility level to enhance crop yield can help the farmer to obtain more profit with less input use (Stagnari *et al*., 2017). The study aimed to evaluate various tillage practices and assess the effects of crop mulch retention under reduced tillage, along with different nutrient sources, on soybean's yield, nutrient uptake, protein and oil content and economic aspects during the *kharif* season. The findings from this research can provide valuable insights for the adoption of suitable crops in similar agro-climatic conditions and soil types.

MATERIALS AND METHODS

The experiment was conducted at the Research Farm, Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. The farm is situated at 32°11′N latitude, 76°32′E longitude and an elevation (altitude) of 1290 m above mean sea level in Palampur, Kangra district of Himachal Pradesh (Fig 1).

Experiment comprised a total of 12 treatments which included 3 main plots [M_1 : (Zero tillage where no ploughing was done); M_2 : Reduced tillage (One ploughing was applied and residue retention (3 t/ha) was done); M_3: (Conventional tillage where two ploughings followed by harrowing was done] and 4 sub plots [S_1 : 75 per cent recommended dose of nitrogen through FYM; S_2 : 100 per cent recommended dose of nitrogen through FYM; S_3: 75 per cent recommended dose of fertilizers; S_4: 100 per cent recommended dose of fertilizers] which was laid out in split plot design and replicated thrice.



Sampling location 32°6`N, 76°3` E

Fig 1: Geographical location of the experimental site.

After sowing of soybean, crop residues from the previous season's mustard harvests were applied at the rate of 3 t ha^{-1}, to all the reduced tillage plots with the exception of zero tillage and conventional tillage plots by uniformly spreading on the field to conserve the soil moisture and to control the weed growth. Soybean variety (Harit Soya) was seeded on 14th June and 10th June with a spacing of 45 cm (inter –row) @100 kg/ha with fertilizers N: P_2O_5: K_2O @ 20:60:40 kg ha^{-1} (applied treatment wise) and harvested on 29th October and 27th October, respectively during *kharif* 2020 and 2021. In case of organic sources applied plots, FYM dose of 75 per cent RDN and 100 per cent RDN was applied on dry weight basis before one week of sowing in both the crops. In case of zero tillage plots and reduced tillage plots, Glyphosate (1.0 kg a.i. ha^{-1}) was applied a week before planting,

Observations recorded

Yield

The yields were studied in terms of seed yield, straw yield, biological yield and productivity. After threshing of crops, net plot seed yield was weighed and recorded for each plot individually. This was then expressed as seed yield (kg/ha). Crop from each net plot was harvested and sun dried separately for three days. After drying, it was weighed and expressed as biological yield in kg/ha. The straw yield was calculated by subtracting the seed yield from biological yield. Productivity was calculated by dividing the seed yield with duration of the crop. It indicated the yield per hectare per day (kg/ha/day).

Nutrients uptake

N, P and K uptake by crops were calculated by multiplying the percentage of each nutrient in seeds with seed yield (oven dried and brought to moisture content 9%) and percentage of each nutrient in straw with straw yield (kg/ha).

$$\text{Nutrient uptake (N/P/K) (kg/ha)} = \text{Nutrient (N/P/K) concentration (\%)} \times \text{Seed or straw yield (kg/ha) (Oven dried)}$$

Quality parameters

Protein content

Protein content of soybean was estimated by determining nitrogen content from different treatments by alkaline permanganate method (Subbiah and Asija 1956). Total N values thus obtained were multiplied with a factor 5. 71 to obtain the protein content in soybean (Krul, 2019).

Oil content

The estimation of oil content in present investigation in soybean seeds was determined by Soxhlet extraction method (AOAC 1970) using a sample size of 2 g oven dried seed material. Ether AR (40-60°C boiling point) was used as solvent for extraction.

Economics

Economic studies were made for soybean crop for two years after the harvest of crop and knowing the prices of all commodities. The studies included gross returns, net returns, benefit cost ratio and profitability in soybean.

Gross returns

The treatment-wise seed and straw yields were multiplied with their respective market prices. The gross returns (`/ha) were calculated by adding returns obtained from seed and straw yields.

Net returns

The treatment-wise net returns (`/ha) were obtained by subtracting the cost of cultivation from the gross returns for respective crops.

Benefit: cost

Benefit: Cost was obtained by dividing net returns with cost of cultivation.

Profitability

It was calculated by dividing the net returns with duration of the crop and it shows the returns per hectare per day (`/ha/day).

Statistical analysis

To test whether significant differences resulted from the split plot design, the data were analysed using analysis of variance (ANOVA) as per the procedure given by Gomez and Gomez (1984) and conclusions were drawn at 5% level of probability. Each case was subjected to a standard error of mean calculation. When the 'F' value from the analysis of variance tables was significant, a minimum significant difference was calculated.

RESULTS AND DISCUSSION

Yield

Reduced tillage recorded significantly higher yields (seed, straw and biological) of soybean (1427 kg/ha, 2481.1 kg/ha and 3908.1 kg/ha in 2020 and 1961.3 kg/ha, 3343.6 kg/ha and 5304.9 kg/ha in 2021) followed by conventional tillage (Table 1). The favourable impacts of tillage on soil structure, porosity, infiltration rate and nutrient absorption were identified as the key contributing reasons for higher soybean yields with reduced and conventional tillage. Retained residues in the reduced tillage treatments increased and prolonged soil moisture conservation, which favoured improved growth with higher photosynthetic efficiency thus enhancing yield attributes and resulting in greater crop yields (Jug *et al*., 2010). Significantly lower yield was recorded with zero tillage.This might be due to the reason that soybean production can be reduced in no-tillage systems due to poorer nitrogen availability and lower soil temperature due to greater soil saturation. Further, increase in yield during 2021 was due to the good environmental circumstances of mild summer temperatures and ample rainfall thus minimized water availability discrepancies. The organic and inorganic nutrient sources significantly affected the grain yield of soybean. Significantly higher seed, straw and biological yield were recorded with 100 per cent recommended dose of fertilizers (1499.2 kg/ha, 2640.8 and 4139.0 in 2020 and 1997.3 kg/ha, 3413.7kg/ha and5411.0 kg/ha in 2021) which was at par with 75 per cent recommended dose of fertilizers (Table 1). This might be due to crop establishment, which was aided by nutrients from mineral fertilizers (Agbede *et al*., 2008).

Higher productivity (10.81 kg/ha/day in 2020 and 15.09 kg/ha/day in 2021) was recorded with reduced tillage which was at par with conventional tillage (10.32 kg/ha/day in 2020 and 13.82 kg/ha/day in 2021). The reason might be the presence of crop residues in reduced tillage systems, which promoted the gradual release of organic matter into the soil. This organic matter enrichment enhanced soil fertility, microbial activity and nutrient cycling, thereby creating a more favorable environment for plant growth and productivity. Different nutrient sources significantly affected the productivity during 2020 and 2021. Among them, application of 100 per cent recommended dose of inorganic fertilizers recorded significantly higher productivity (11.36 and 15.36 kg/ha/day in 2020 and 202, respectively). As interaction among tillage and different nutrient sources was studied, it remained unaffected during both the years of experimentation.

Nitrogen uptake by seed and straw

The effect of tillage practices and nutrient sources on nitrogen uptake by soybean is given in Fig 2 and Fig 3. Reduced tillage had the highest seed (82.97 kg/ha and 115.69 kg/ha), straw (29.18 kg/ha and 44.69 kg/ha) and total nitrogen uptake (112.15 and 160.39 kg/ha) during 2020 and 2021, respectively. However it remained at par with conventional tillage. Reduced tillage practices help preserve soil organic matter, which serves as a reservoir of nitrogen. By minimizing soil disturbance, reduced tillage retains crop residues on the soil surface, allowing them to decompose gradually and release nitrogen into the soil. This leads to increased availability of nitrogen for plant uptake (Dyck *et al*., 2016). While, soybean grown in zero tillage plots, had the lowest nitrogen uptake. As far as nutrient sources were concerned, application of 100 per cent recommended dose of inorganic fertilizers had the highest seed, straw and total nitrogen uptake (88.06 and 118.37 kg/ha, 31.83 kg/ha

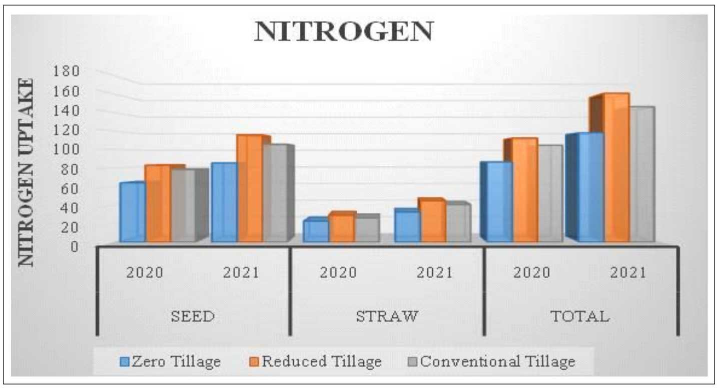


Fig 2: Effect of tillage on nitrogen uptake.

Table 1: Effect of tillage practices, organic and inorganic nutrient sources on quality and yields in soybean.

Tillage practices	Protein (%)		Oil content (%)		Seed yield (kg/ha)		Straw yield (kg/ha)		Biological yield (kg/ha)		Productivity (kg/ha/day)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
ZT	35.89	36.44	18.98	19.07	1127.9	1483.3	2081.7	2533.9	3209.6	4017.2	8.54	11.41
RT	36.75	37.42	19.46	19.54	1427.0	1961.3	2481.1	3343.6	3908.1	5304.9	10.81	15.09
CT	36.35	37.18	19.41	19.48	1362.5	1796.2	2251.7	3033.7	3614.3	4830.0	10.32	13.82
SEm ±	0.61	0.66	0.09	0.06	50.3	49.9	58.4	80.0	94.2	124.3	0.38	0.38
LSD (P=0.05)	NS	NS	0.34	0.25	197.4	195.8	229.2	313.9	369.8	487.9	1.50	1.51
Nutrient sources												
75% RDN (FYM)	35.38	36.53	18.93	19.11	1102.3	1451.8	2049.2	2593.6	3151.5	4045.5	8.35	11.17
100% RDN (FYM)	35.84	36.81	19.07	19.14	1190.6	1668.4	2098.3	2755.8	3288.9	4424.2	9.02	12.83
75% RDF(Inorganic)	36.91	37.10	19.44	19.47	1431.2	1870.1	2299.7	3118.6	3729.9	4988.7	10.84	14.39
100% RDF (Inorganic)	37.18	37.62	19.69	19.72	1499.2	1997.3	2640.8	3413.7	4139.0	5411.0	11.36	15.36
SEm ±	0.66	0.55	0.16	0.12	52.9	57.9	76.6	106.6	107.6	112.4	0.40	0.45
LSD (P =0.05)	NS	NS	0.47	0.35	157.2	171.9	227.7	316.8	319.7	333.9	1.19	1.32

ZT: Zero tillage; RT: Reduced tillage + Residue; CT: Conventional tillage; RDN: Recommended dose of nitrogen through FYM; RDF: Recommended dose of fertilizers.

and 47.24 kg/ha and 119.88 kg/ha and 165.62 kg/ha during 2020 and 2021, respectively). This might be due to better utilization of nutrients by crops because of more root biomass and proliferation. Application of 75 per cent recommended dose of nitrogen through FYM recorded less nitrogen uptake by soybean. Organic nitrogen sources contain nitrogen in complex organic compound. Before plants can utilize this nitrogen, it must undergo mineralization, a process in which organic nitrogen is converted into inorganic forms by soil microorganisms. This mineralization process takes time and is influenced by various factors, such as temperature, moisture and microbial activity. Due to the slower release and conversion of nitrogen from organic sources, the availability of nitrogen for plant uptake is relatively slower compared to inorganic sources. This can result in reduced nitrogen uptake in the short term. Interaction among tillage practices, organic and inorganic sources for seed, straw and total nitrogen uptake was found to be non-significant during both the years of experimentation.

Phosphorus uptake by seed and straw

Tillage practices significantly affected the phosphorus uptake by soybean (Fig 4). Reduced tillage had the higher seed, straw and total phosphorus uptake (7.41 kg/ha and 10.53 kg/ha, 4.08 kg/ha and 5.99 kg/ha and 11.49 kg/ha and 16.52 kg/ha in 2020 and 2021) which was at par with conventional tillage during both the years. This might be due to the reason that tillage improves incorporated crop residue breakdown and mineralization by enhancing soil aeration and soil microbial activity. Furthermore, residue mineralization is closely linked to soil nutrient availability and crop nutrient uptake (Zhu *et al*., 2018). Significantly less phosphorus uptake was recorded under zero tillage. Among different nutrient sources tested, the treatment comprising 100 per cent recommended dose of inorganic fertilizers had the highest phosphorus uptake (8.05 kg/ha and 11.08 kg/ha by seed, 4.24 kg/ha and 6.23 kg/ha by straw and total uptake 12.26 kg/ha and 17.31 kg/ha during 2020 and 2021) by soybean which was at par with 75 per cent recommended dose of fertilizers. Lower phosphorus uptake was recorded with 100 per cent and 75 per cent recommended dose of nitrogen through FYM during both the years of experimentation (Fig 5). As an interaction effect was observed, it remained non-significant between tillage and nutrient sources during both the years.

Potassium uptake by seed and straw

Reduced tillage had the highest seed (16.89 and 23.98 kg/ha) straw (53.81 and 73.17 kg/ha) and total (70.70 kg/ha in 2020 and 97.14 kg/ha) potassium uptake by soybean during 2020 and 2021, respectively, which was at par with conventional tillage (Fig 6). Reduced tillage practices help preserve soil

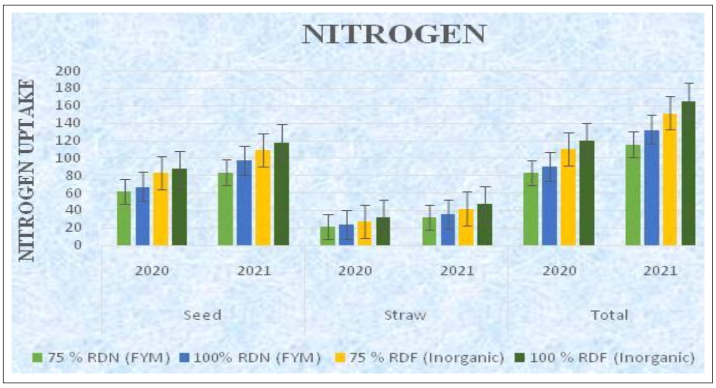


Fig 3: Effect of nutrient sources on nitrogen uptake.

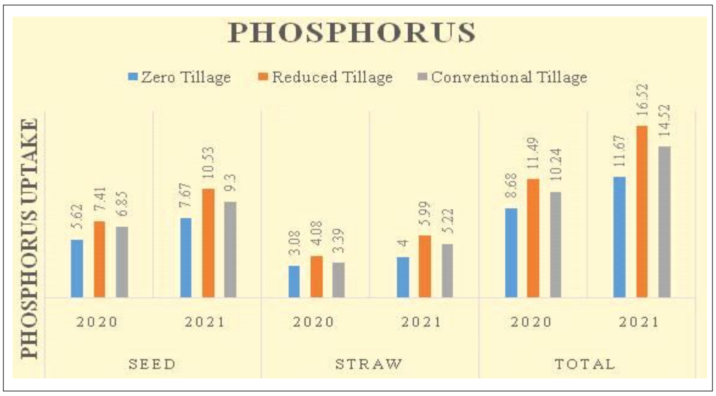


Fig 4: Effect of tillage on phosphorus uptake.

organic matter, which is a significant source of potassium. By minimizing soil disturbance and leaving crop residues on the soil surface, reduced tillage promotes the gradual decomposition of organic matter. As organic matter breaks down, it releases potassium ions, making them more available for plant uptake. Mulch was ascribed to increase crop nutrient availability and uptake in the reduced tillage treatment due to increased mineralization of crop residue deposited at the soil surface from tillage. Findings were supported by Singh *et al*.(2020). However, Dyck *et al*. (2016) found that after four years of reversing no tillage to reduced tillage, there was a higher nutrient uptake (N, P) and crop yield. Increased N, P and K uptake could have come from better nutrient consumption by crops in reduced tillage treatment due to increased root biomass and proliferation. Zero tillage recorded minimum potassium uptake during both the years. Among different fertility levels, application of 100 per cent recommended dose of inorganic fertilizers had the higher seed, straw and total potassium uptake (18.03 kg/ha and 24.76 kg/ha, 53.81 and 73.17 kg/ha and 76.17 and 100.55 kg/ha during 2020 and 2021, respectively) which was at par with 75 per cent recommended dose of inorganic

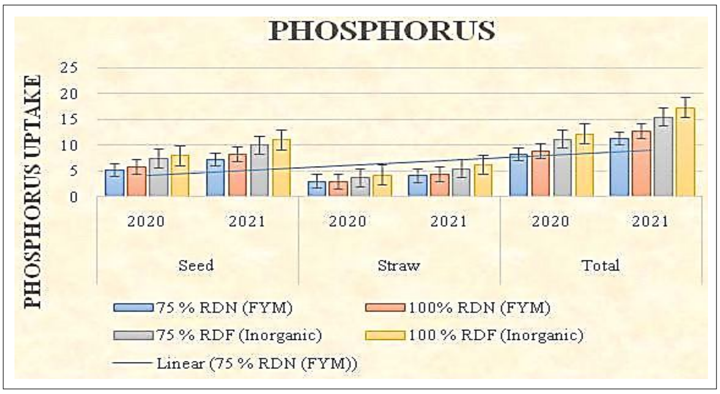


Fig 5: Effect of nutrient sources on phosphorus uptake.

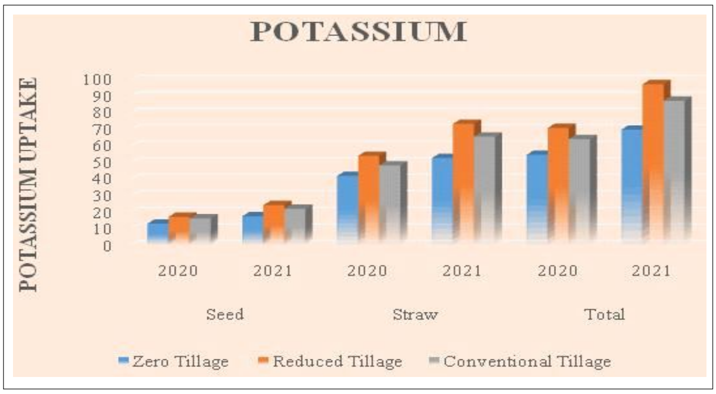


Fig 6: Effect of tillage on potassium uptake.

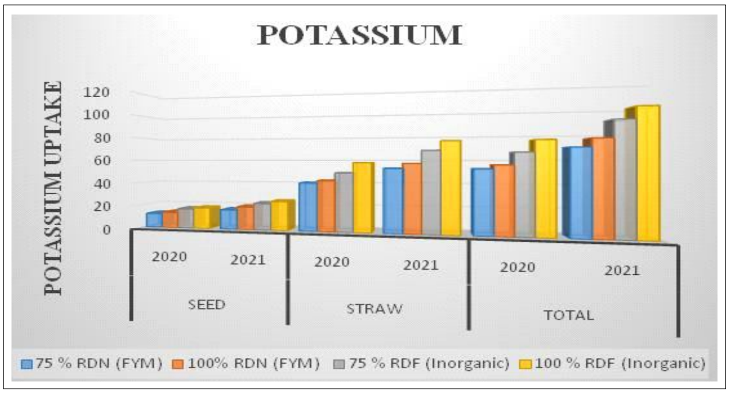


Fig 7: Effect of nutrient sources on potassium uptake.

Table 2: Effect of tillage practices, organic and inorganic nutrient sources on economics of soybean.

	Gross returns (`/ha)		Net returns (`/ha)		Benefit cost ratio		Profitability (`/ha/day)	
	2020	2021	2020	2021	2020	2021	2020	2021
Tillage practices								
ZT	73170	95849	32923	55603	0.81	1.37	249	428
RT	92314	126957	49568	84211	1.15	1.96	376	648
CT	87758	116126	46912	75280	1.14	1.84	355	579
Nutrient sources								
75% RDN (FYM)	71536	94141	31743	54348	0.80	1.36	240	418
100% RDN (FYM)	76982	107623	36389	67030	0.89	1.65	276	516
75% RDF (Inorganic)	92018	120814	50363	79159	1.20	1.90	382	609
100% RDF (Inorganic)	97119	129331	54043	86255	1.25	2.00	409	663

ZT: Zero tillage; RT: Reduced tillage + Residue; CT: Conventional tillage; RDN: Recommended dose of nitrogen through FYM; RDF: Recommended dose of fertilizers.

fertilizers (Fig 7). Balanced fertilization provided better soil environment for improved root development and ensured better nutrient availability with increased forage area by the roots for nutrient extraction. Interaction effect of tillage practices, organic and inorganic nutrient sources on potassium uptake was found to be non-significant during both the years of experimentation.

Quality

Protein

Protein content remained unaffected due to different tillage practices and nutrient sources during both the years of experimentation (Table 1). However, among tillage practices, reduced tillage recorded the highest protein content (36.75% in 2020 and 37.42% in 2021). The lowest protein content (35.89 and 36.44% during 2020 and 2021, respectively) was obtained from zero tillage. Among organic and inorganic nutrient sources, highest protein content (37.18% in 2020 and 37.62% in 2021) was obtained from 100 per cent recommended dose of fertilizer whereas, lowest was recorded with application of 75 per cent recommended dose of nitrogen (Table 1). Similar findings were submitted by Rana *et al*., (2019) which reported higher protein content of soybean with the application of 100 per cent recommended dose of fertilizer. This might be owing to higher application of fertilizers that resulted in more availability of nutrients. Interaction between tillage practices, organic and inorganic nutrient sources for protein content was found to be non-significant.

Oil

Oil content of soybean was significantly affected due to different tillage practices and nutrient sources during both the years (Table 1). Among tillage practices, reduced tillage recorded the highest oil content (19.46% in 2020 and 19.54% in 2021). The lowest oil content was obtained from zero tillage. Zero tillage systems may experience reduced soil aeration and increased soil moisture, particularly in the early stages of crop growth. Excessive soil moisture can lead to oxygen deprivation in the root zone, negatively affecting root health and function. Impaired root function can, in turn, impact the uptake and assimilation of nutrients, including those involved in oil synthesis, resulting in decreased oil content in the crop. Rana *et al*. (2020) also reported significantly lower oil content of soybean with zero tillage. Among organic and inorganic nutrient sources, highest oil content (19.69% in 2020 and 19.72% in 2021) was obtained from 100 per cent recommended dose of fertilizer whereas, lowest was recorded with application of 75 per cent recommended dose of nitrogen. Interaction among tillage practices and nutrient sources on protein content was found to be non-significant.

Economics

Data on effect of tillage practices, organic and inorganic nutrient sources on gross returns, net returns, benefit cost ratio and profitability have been presented in Table 2. Reduced tillage recorded the highest gross returns, net returns, benefit cost ratio and profitability (92314 `/ha, 49568 `/ha, 1.15 and 376 `/ha/day in 2020 and 126957 `/ha, 84211 `/ha, 1.96 and 648 `/ha/day in 2021). Conventional tillage was the second economical treatment during 2020 and 2021, respectively. The lowest gross returns, net returns, benefit cost ratio and profitability were recorded under zero tillage. As far as nutrient sources are concerned, application of 100 per cent recommended dose of inorganic fertilizers recorded the highest gross returns, net returns, benefit cost ratio and profitability (97119 `/ha, 54043 `/ha, 1.25 and 409 `/ha/day in 2020 and 129331 `/ha, 86255 `/ha, 2.00 and 663 `/ha/day in 2021). The lowest gross returns were recorded with 75 per cent recommended dose of nitrogen. Prabhamani and Babalad (2018) recorded increased net returns in conservation tillage mainly due to reduced fuel burning by reducing tillage intensity and increased crop yields.

CONCLUSION

India has a high percentage of population with protein energy malnutrition (PEM). The increased production of pulses is also required for nutritional security of the weaker section of our society. Based on the study findings, it can be concluded that farmer should involve legumes in cropping system to enrich the soil organic matter. Conventional tillage can be replaced with reduced tillage for higher nutrient uptake, productivity and profitability respectively. Also amongst different nutrient sources, 100 per cent recommended dose of fertilizers gave better results regarding agronomical and economical parameters.

Conflict of interest: None.

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